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STAFF APPRAISAL REPORT

SECOND URBAN TRANSPORT (PORTO ALEGRE)

BRAZIL

April 17, 1980

Projects Department
Latin America and the Caribbean Regional Office

Currency Equivalents

Currency Unit = Cruzeiro (Cr$) divided into 100 cents

Exchange Rates:	Average for Year
1975	US$1 = Cr$ 8.10
1976	US$1 = Cr$ 10.70
1977	US$1 = Cr$ 14.15
1978	US$1 = Cr$ 18.10
1979	US$1 = Cr$ 26.00
1980	US$1 = Cr$ 43.00 (January 1980)

Fiscal Year

January 1 to December 31

Units of Weights and Measures: Metric

Metric: British/US Equivalent

1 kilometer (km)	=	0.62 mile (mi)
1 meter (m)	=	3.28 feet (ft)
1 square kilometer (km^2)	=	0.386 square mile (sq mi)
1 hectare (ha)	=	2.47 acres (ac)
1 metric ton (m ton)	=	0.98 long ton (lg ton)
1 metric ton (m ton)	=	1.1 US short tons (sh ton)
1 liter	=	0.2642 gallons

Abbreviations and Acronyms

BNDE	-	National Development Bank
BNH	-	National Housing Bank
CBD	-	Central Business District of the Municipality of Porto Alegre
CEEE	-	State Electric Company of Rio Grande do Sul
CIP	-	Interministerial Council on Prices
COHAB	-	State Housing Company
CNDU	-	National Council on Urban Development
CNPU	-	National Commission on Metropolitan Regions and Urban Policy
CTC	-	Centralized Traffic Control
DEMHAB	-	Porto Alegre Housing Agency
DNER	-	Federal Highway Department
DNOS	-	National Department for Sanitation
EBTU	-	Brazilian Urban Transport Corporation
EMTU	-	Metropolitan Transport Agency
FDTU	-	Urban Transport Development Fund
FNDU	-	National Urban Development Fund
GEIPOT	-	National Transport Planning Agency
METROPLAN	-	Metropolitan Planning Agency of Porto Alegre
MRPA	-	Metropolitan Region of Porto Alegre
NEP	-	Project Implementing Office of TRENSURB/P.A.
NMTU	-	Agency for the Coordination and Regulation of Transportation in MRPA
NPV	-	Net Present Value
PCU	-	Passenger Car Units
PME	-	Energy Mobilization Program
RFFSA	-	Federal Railway Company
SEAP	-	Secretariat for Supply and Prices in the Ministry of Planning
SEPLAN	-	Ministry of Planning
TRENSURB/P.A.	-	Porto Alegre Metropolitan Rail Mass Transit Company

BRAZIL

SECOND URBAN TRANSPORT (PORTO ALEGRE) PROJECT

STAFF APPRAISAL REPORT

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This report is based on the findings of an appraisal mission which visited Brazil during September-October 1979. The mission comprised Messrs. M. Staab (Economist), J. Baigorria and C. Buratti (Engineers), E. Haythorne (Lawyer), R. Mosse (Financial Analyst) and C. Turner (Consultant). The report has been edited by Miss V. Foster.

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I. SECTOR BACKGROUND

A. Urban Structure and Trends

1.01 Brazil's urban growth during the period 1950-1970 was quite rapid, with the country's urban population (as measured by an international standard definition of 20,000 or more inhabitants) increasing from 11 million in 1950 to 36 million in 1970, an increase of about 6% per annum compared with a figure of about 3% per annum for the overall rate of population growth in the country. The proportion of total population that is urbanized increased from a level of only 16% in 1940 to nearly 40% in 1970 (Table 1.1). The highest growth rates in the 1960s were recorded in medium-sized cities of between 100,000 and 200,000 inhabitants. During the 1970s, these trends are believed to have continued, but definitive data will not be available until the 1980 census is completed.

1.02 Geographically, urbanization has been unevenly distributed. Growth rates have been highest in the central western region, primarily because of the growth of Belo Horizonte and Brasilia, and lowest in the northeast region despite the rapid growth of its three metropolitan areas: Fortaleza, Recife and Salvador. The dominance of the southeast (mainly Sao Paulo and Rio de Janeiro) in the urban population has been offset somewhat by the growth of cities in the central west and in the state of Parana in the south, although not sufficiently to alter the large imbalance between the southeast and other regions in the ratio of urban to total population.

1.03 The rapid rate of population growth in the large metropolitan areas is mostly explained by migration from the interior. Large numbers of this migrant labor force, which is relatively poor and lacking in industrial skills, are forced to seek low paying jobs, sometimes in the informal sector. Municipal governments, therefore, are faced with the problem of supplying essential public services to an expanding urban population, while the tax base to support these services is not growing nearly as fast. These trends have become of increasing concern to urban planners.

B. Urban Policy

1.04 Federal urban policy was first directed at the large metropolitan areas. In order to deal with the problem of coordinating urban policy in these areas, the Government, in 1973, established the administrative boundaries for eight metropolitan areas: Belem, Fortaleza, Recife, Salvador, Belo Horizonte, Sao Paulo, Curitiba and Porto Alegre. The ninth, Rio de Janeiro, was added in 1974. The states in which these metropolitan areas are located have all established metropolitan planning agencies, the responsibilities of which range between those which are purely planning agencies (e.g., Porto Alegre) and those which also fund and execute projects (e.g., Recife). However, none of these state agencies has a government status. The hierarchy of governments in Brazil goes from the municipal to the state to the federal level. There is no metropolitan government as such, which sometimes makes coordination among municipalities difficult.

1.05 A national urban policy was initiated with the Second National Development Plan (II PND), which covered the period 1975 to 1979. The urban development strategy contained within the II PND sought to:

(a) consolidate the system of metropolitan areas and introduce measures to prevent the additional concentration of demographic and economic growth in the southeast region, particularly in Rio de Janeiro and Sao Paulo;

(b) encourage the development of medium-sized cities (between 50,000 and 500,000 inhabitants) in all regions to reinforce an existing development trend; and

(c) encourage the development of settlements in the interior.

Overall, federal government actions have been consistent with these objectives regarding the pattern of urbanization. Nevertheless, despite these efforts, the large metropolitan areas continue to attract many migrants - a trend which is expected to persist unabated through most of the next decade. State governments will have to increase their efforts if the national objectives are to be substantially realized. The urban strategy contained in the recently formulated Third Development Plan (1980-1985) further promotes these objectives, but, in addition, emphasizes the development of agriculture to reduce the overall rate of urbanization.

1.06 The institutional structure exists for carrying out the federal government's urban policy. In 1974, the National Commission on Metropolitan Regions and Urban Policy (CNPU) was set up as an interministerial agency to promote and coordinate national urban development policy. To finance urban development projects, the National Urban Development Fund (FNDU) was also created. A special Urban Transport Development Fund (FDTU) was established as a sub-account of FNDU to specifically finance urban transport projects. The Brazilian Urban Transport Corporation (EBTU) was later established to administer the FDTU (para 1.15).

1.07 Following the change of government in March 1979, CNPU was terminated and the new government created the National Council on Urban Development (CNDU). The Ministries of Planning, Finance, Industry, Commerce, Transport and the Interior are represented on the Council, together with the Secretary General of the Ministry of Planning (SEPLAN) and the presidents of the National Housing Bank (BNH) and EBTU. The Council is chaired by the Minister of the Interior. CNDU has assumed all of the responsibilities of the former CNPU and has recently defined the nation's urban policy objectives for the period 1980-1985. Consistent with the objectives of the II and III PND in seeking to redirect migration from the metropolitan areas to the secondary and smaller cities, CNDU is proposing that the nine metropolitan areas, medium-sized cities and small cities receive about 50, 40 and 10% of the available federal funds, respectively, over the period 1980-1985. This allocation would be effected and monitored by the respective executing agencies, namely EBTU, BNH and the National Department for Sanitation (DNOS).

1.08 There are, however, several reasons to be concerned about the probability of the above policy objectives being successfully implemented. First, although responsible for the overall coordination and integration of urban policy, it has yet to be seen whether CNDU will be able to exercise any influence on urban area policies other than through an advisory role. Specifically, the metropolitan area master plans are not approved by CNDU, but by the respective states. The metropolitan areas send their master plans to CNDU only after approval by the state. CNDU's role is essentially to review the various sector investment items within the master plans in order to coordinate any possible involvement of federal sector agencies. CNDU is

currently studying the need for new legislation that would make participation of federal sectoral agencies in a given metropolitan area conditional upon CNDU's approval of the master plan. If such legislation is adopted, CNDU could use any newly acquired influence to try to strengthen the planning agencies at the local level rather than to direct their activities from Brasilia. However, to be successful in performing even this limited additional function, CNDU, with only about 20 professional staff at present, would have to recruit more qualified personnel.

C. Urban Transport

(i) General

1.09 An overview of urban transport in Brazil reveals certain problems, patterns and changes which are common to many of the country's urban areas. During the last several years, most urban areas have experienced large increases in the demand for transport services. In the nine metropolitan regions, the number of daily passenger trips by all modes increased by 9% per annum between 1968 and 1975, almost twice the rate of growth of the urban population. As previously mentioned (para 1.03), a large portion of the population growth in these areas is explained by in-migration from the rural areas within the same state and, in some cases, from the neighboring states as well. From a transport point of view, what is important is that this migrating population, which is generally of low income, tends to locate on the periphery and non-central parts of the metropolitan region, where housing is cheaper but where transport service (including access to job market centers) as well as other public services is more limited. In contrast, transport infrastructure tends to be concentrated in those parts of the metropolitan region which are closest to the central city and which link centers of employment with the residences of higher and middle income groups whose principal mode of transport is the private automobile. It is no coincidence that the transport infrastructure serving these areas tends to be primarily road based, further encouraging the use of private automobiles, normally to an extent well beyond the space limitations of the central area, resulting in high economic and environmental costs.

1.10 This situation is reflected in the usage and characteristics of the principal urban transport modes of bus and automobile: the users of the former being largely of low income and traveling longer commuting distances to work from areas that are not particularly well served by public transport (bus or other modes); and the users of the latter being essentially of high or middle income and traveling shorter commuting distances on roads for whose limited space buses must compete with the automobile. In the last few years, however, bus services in certain corridors in some urban areas have been given priority through the introduction of exclusive bus lanes. This approach is an important part of the First Urban Transport Project (Loan No. 1563-BR), the scope and status of which are discussed in Annex 1. For the most part, however, in Brazil, as in many other countries, this type of change is relatively new.

1.11 Urban rail transport is a significant mode of transport only in Rio de Janeiro and Sao Paulo, where each of the systems carries about 500,000 passengers daily. Very limited suburban railway services also exist in Belo Horizonte, Salvador and Recife. The service in Porto Alegre (the site for the proposed project) is virtually non-existent with only two commuting trains daily in each direction on a deteriorated track system (para 2.20).

1.12 In 1976, the modal distribution of total daily person trips in the nine metropolitan regions ranged as follows: for buses, from 71% in Recife and Belo Horizonte to 54% in Sao Paulo; for autos, from 35% in Sao Paulo to 22% in Rio de Janeiro; for taxis, from 7.6% in Belem to 1.6% in Porto Alegre; and for person trips by other modes, 8% in Sao Paulo to 1.0% in Curitiba. While the bulk of demand is carried by buses, their share of traffic has been falling at the expense of the car. Moreover, in terms of the number and composition of vehicles during the peak period, which determines road capacity, cars in many urban corridors represent as much as 75% of the total number of vehicles on the road despite the fact that they may account for only 30% of the total passengers carried. Since 1965, the automobile fleet has grown at an average rate of 11% per annum. In 1975, private vehicle ownership in the nine metropolitan regions reached 2.3 million vehicles, resulting in an average motorization rate of 80 automobiles per 1,000 inhabitants. A comparison of motorization rates in selected urban areas is shown in Table 1.2. Clearly, a reduction in the use of the private automobile in urban areas and a corresponding increase in the use and provision of public transport services should be and, in fact, is a fundamental objective of national urban transport policy. This objective is important not only because of the attendant fuel savings, which would be significant, but because, in many cases, lack of public transport access to job centers more than proportionately affects the urban poor.

(ii) Coordination and Planning at the Local Level

1.13 The extent and quality of urban transport coordination and planning vary among the different regions but all are faced with a similar problem--how to plan and manage a transport system in a metropolitan region consisting of many municipalities, each with its own administrative powers, when the necessary inputs for, and effects of, this transport system extend well beyond the administrative boundaries of any one municipality. A possible solution would be to create a metropolitan-wide transport coordinating/regulatory agency, which sometimes requires a state law. In some Brazilian metropolitan areas, adaptations of this type of institution already exist, and, in others, plans (or, in some cases, draft legislation) exist to create them. These organizations are sometimes referred to by the name Empresa Metropolitana de Transportes Urbanos (EMTU). In addition to regulation and coordination, some of the existing organizations are also involved in the operation of some transport enterprises. This practice has a high probability of creating a conflict of interest, and it is, in principle, undesirable for such organizations to become directly involved with the ownership or operation of transport enterprises. An entity, called Nucleo Metropolitano de Transportes (NMTU), with only coordinating and regulatory responsibilities, was recently created (December, 1979) by the State Governor of Rio Grande do Sul for the Porto Alegre Metropolitan Area, the influence area for the proposed project (para 2.27 through 2.29).

(iii) National Planning, Investment and Policy

1.14 Federal government involvement in urban transport is accomplished directly through an organization specifically established to serve in this capacity, the Brazilian Urban Transport Corporation (EBTU), and indirectly through the government's support to the Federal Railway (RFFSA) and the Federal Highway Department (DNER), both of which, to some extent, invest in urban

transport projects. However, investments of this type by RFFSA and DNER are expected, in the future, to become much smaller since present policy, as much as possible, is to channel all federal spending in this sector through EBTU.

1.15 EBTU was established by law in November 1975. It is a federal government-owned enterprise under the jurisdiction of the Ministry of Transport but having administrative and financial autonomy, independent juridical status and its own assets and liabilities. The organizational structure of EBTU is shown in Chart 1. EBTU agreed during negotiations to employ consultants, by December 31, 1980, to improve its internal accounting, budgeting and control procedures and to discuss with the Bank the consultants' recommendations. The details regarding EBTU's organizational structure, financial performance, budget, accounting and audit systems are presented in Annex 2. The Company's basic function is to promote national urban transport policies through its support of certain projects and programs which it deems to be in this interest (EBTU's relation to and support of the proposed project is presented in paragraphs 4.07 and 4.10). To finance its expenditures, EBTU has in the past drawn its resources almost entirely from the Urban Transport Development Fund (FDTU) (para 1.06), which is derived from vehicle registration and fuel taxes. Commencing in 1980, EBTU will be able to draw on an additional major source of funds from the Energy Mobilization Program (PME), recently created under a new law. 1/ Under this new financing scheme, beginning in 1980, EBTU will receive about 65% of the PME plus the FDTU. 2/

1.16 The federal government has already taken some fairly progressive action with regard to the conservation of petroleum resources in the transport sector by promoting the alcohol fuel program (at present, automotive gasoline consists of a 20% mixture of alcohol, and all new government cars and taxis will use 100% alcohol), by eliminating the subsidy element from gasoline prices and by raising taxes on petroleum products quite substantially. EBTU, during the first three years of its existence (1976-1978), oversaw an estimated US$884.6 million (1979 prices) of expenditures on various urban transport projects. The components selected generally fit within a set of categories that broadly reflect EBTU's policy goals of promoting public transport and the efficient management of the urban transport system. However, EBTU has not had sufficient expertise to convert general national guidelines into an integrated, high priority investment program. For this type of work, there are few experienced professional economists or policy-oriented urban transport planners on EBTU's current staff. The staff, just over 300, consists mostly of engineers and architects, the effect of which, to date, has been to impart an overly physical orientation to the planning function. While the quality of economic work is beginning to improve, further improvement is necessary. Under the First Urban Transport Project, it was agreed that EBTU would engage consultants to, among other things, strengthen this area of its operation. Some consultants have

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1/ Law 1691 of August 2, 1979. The PME is derived from a new surtax of 12.5% on the CIF value of imported crude oil plus 26% of the revenue from the existing vehicle registration tax.

2/ The FDTU, beginning in 1980, will be composed of 12% of the existing vehicle registration tax and 45% of the existing surtax (12%) on lubricants and liquid and gaseous fuels.

been working with the technical directorate, and more are expected to be engaged shortly. This process is having a positive impact. However, additional experienced, professionally trained economists and planners are needed to occupy staff, as well as managerial, positions within the organization. In order for the technical directorate to begin to play a more critical role in EBTU's investment decisions, improvements in the quality and quantity of technical staff are essential. Having EBTU rely more heavily upon its technical directorate is an orientation that the Bank has continued to promote.

(iv) Future Investment Plans

1.17 EBTU's investment plan for the next three years (1980-1982), which includes the proposed project, was recently formulated by the Ministry of Transport in order to make use of the resources which are expected to become available from the PME (para 1.15). The investment plan includes items which EBTU had already identified and was in the process of preparing plus some new items introduced by the Ministry of Transport, primarily in the urban rail subsector, which are expected to save fuel. The average annual expenditure of this plan (US$883 million) is about three times the amount spent per annum during the period 1976-1978. The plan's overall objective is the conservation of energy through heavier reliance on public transport. This is the general rationale; however, benefit-cost analyses, for the most part, have not yet been carried out except for a few projects, one of which is the proposed project for Porto Alegre. Given the large expenditures associated with the plan, which, if realized, would involve significant changes in intersectoral priorities that have not yet been promoted by the Government, the plan is still likely to undergo considerable change in the near future, especially after the results from further study become available.

1.18 The modal distribution of expenditures under the plan is as follows: suburban railways in seven metropolitan areas, 59%; urban roads including buses, 25%; trolley-buses where these already exist, 11%; and marine passenger ferries, 5%. This modal distribution is significantly different from EBTU's earlier plan, which emphasized road-related public transport investments. The change is largely based on the Government's desire to save fuel and, through the reduction of petroleum imports, also to mitigate its serious balance-of-payments problems. As desirable as these objectives are, they represent only a partial view without complete technical and economic studies. Furthermore, for the rail projects identified, it has not yet been demonstrated how these particular objectives are served. The suburban railway investment subprogram needs further careful scrutiny also because of the general policy of the Ministry of Transport to convert all diesel train services to electric traction, to substitute broad for all meter gauge track and to build freight bypasses, when necessary, to separate freight completely from suburban passenger trains. While, under some circumstances, such actions may be justified, as has been demonstrated in the case of the proposed project in Porto Alegre (Chapter VI), it would not be economically sound to regard this approach as having universal applicability.

1.19 In view of the foregoing, it would be desirable for the Bank to participate in discussions with the Government as the national urban transport investment plan begins to be firmed up and more concrete decisions are taken.

EBTU has already agreed, under the First Urban Transport Project, to adopt, by June 1980, economic and technical criteria for selecting projects. While it already appears that there may be some delays in meeting this target, and, in any case, some further work will need to be done on the criteria for selecting urban rail projects, work in this area is proceeding. What remains to be arranged is the review process by which the Bank can have some positive impact on the formulation of the urban transport investment plan. During negotiations, agreement was reached that, at least once per year, the Government, through EBTU, would inform the Bank of its National Urban Transport Investment Plan. These reviews would provide the Bank an opportunity to exchange views with the Government on the Plan. A draft investment policy statement by EBTU was also discussed during negotiations. This statement is a quite useful beginning and provides a sound general framework within which to develop more specific guidelines. The investment policy statement was formally approved by EBTU's Administrative Council. It was agreed during negotiations that, before making any substantial change in this statement, EBTU would review and discuss such changes with the Bank.

D. Bank Involvement in the Urban Sector

1.20 The Bank's involvement in the urban sector focuses on two main objectives: the provision of needed services and employment opportunities for the urban poor, and the strengthening of the planning and implementation capacity of sectoral institutions at the federal and local levels. Beginning in 1970, the Bank participated in the financing of a series of water supply and sewerage projects through BNH in the states of Minas Gerais, Pernambuco, Bahia and Ceara and in Greater Sao Paulo. The first Urban Transport Project in five metropolitan areas was approved in June 1978 and is under execution (Annex 1). A Sites and Services and Low-Cost Housing Project in Greater Sao Paulo, Bahia and Pernambuco was approved in January 1979. The Medium-Sized Cities Project, approved in May 1979, contains subprojects in eight cities. A water supply and sewerage project for the southern states was just approved in March 1980. Urban projects, now under preparation, include a third water supply and sewerage project for the state of Minas Gerais, an integrated urban development project and a third urban transport project.

II. AREA OF INFLUENCE - PORTO ALEGRE METROPOLITAN REGION

A. Geography

2.01 The suburban railway system to be constructed under the proposed project would traverse the Metropolitan Region of Porto Alegre (MRPA) from north to south (Map IBRD 14688). MRPA covers a total area of 5,718 km^2 and is located at the head of an inland waterway which runs parallel to the coast in the central part of the state of Rio Grande do Sul, the southernmost state in the country. The principal area of influence for the proposed project is MRPA's north-south corridor, which comprises ten municipalities including Porto Alegre (where the line originates) and has a population of

1.9 million at present. 1/ The line would also serve, although to a more limited extent, through car and feeder bus connections, the Region's other four municipalities. 2/ The total population of MRPA is 2.38 million.

B. Demographic and Economic Base

2.02 MRPA represents over 25% of the State's total population; in 1940, its share was only 13%. This quite large relative growth of the Region in the State is essentially explained by the very high rate of migration into MRPA, predominantly (about 90%) from the secondary centers and small towns in the interior of the State and, to a lesser extent, from the State of Santa Catarina to the north. Thus, while annual average rates of population growth in MRPA have been on the order of 4% since 1960 and closer to 5% since the mid-1970s, migration has accounted for about 82% of this increase, while natural population growth has accounted for only about 18%.

2.03 The period since 1950 has also experienced some changes in the distribution of population growth within MRPA. In the 1950s, the municipality of Porto Alegre grew at an annual rate of 5% and, by 1960, accounted for some 62% of MRPA's total population. However, by the early 1970s, Porto Alegre's growth rate had declined to 3.3%, and, by 1974, its proportion of the total population had fallen to 54%, contrasting with the experience of the outlying municipalities, whose average rate of growth has been over 5% between 1960 and 1970, and even higher in the 1970s (Tables 2.1 and 2.2). Significantly, although the population of Porto Alegre itself declined in relative terms, it increased in absolute terms by some 130,000 inhabitants between 1970 and 1974. The region's north-south corridor grew by over 100,000 in the same period, which represents a greater absolute, but smaller relative, increase than that of the east-west corridor. Survey work carried out since 1974 confirms a continuation of these trends.

2.04 The dominance of MRPA within the State is also reflected in its relative share of economic activity: in 1970, MRPA accounted for almost 50% of all industrial production and 40% of total output in the State. Recent evidence indicates that the rate of economic growth within the Region is continuing at a high level.

2.05 Total employment in MRPA continues to grow rapidly, increasing from 439,000 in 1971 to an estimated 609,000 by 1976, an annual increase of 5.6%. The composition of this employment is given in Table 2.3, which shows the relative decline of the primary and secondary (industrial) sectors and the striking relative shift of employment to the tertiary or service sector, which, in absolute terms, increased from 236,000 in 1971 to 377,000 in 1976. This reflects the rapid increase in the migrant labor force, which is relatively unskilled.

1/ The ten municipalities in the north-south corridor include: Cachoeirinha, Compo Bom, Canoas, Estancia Velha, Esteio, Novo Hamburgo, Porto Alegre, Sao Leopoldo, Sapiranga, and Sapucaia do Sul. The line would pass directly throgh Porto Alegre, Canoas, Esteio and Sapucaia do Sul.

2/ The other four municipalities, which comprise the so-called east-west corridor, include: Alvorada, Gravatai, Guaiba and Viamao.

2.06 Despite the relative decline of the secondary sector, there has been some growth within the sector in the dynamic/higher wage paying industries such as the electronics and electrical industries. The traditional manufacturing industries in the region include metallurgy, machinery, chemicals and, particularly in Novo Hamburgo, leather and footwear.

2.07 The spatial distribution of total employment by sector is shown in Table 2.4. While it can be seen that Porto Alegre dominates MRPA's economic structure, its dominance is greatest in the sector experiencing the most rapid growth, namely, services. Also, employment outside Porto Alegre, particularly in the secondary sector, is concentrated in the north-south corridor.

C. Distribution of Income, Housing and Public Services

2.08 With respect to the distribution of income in MRPA, interpretation of trends is difficult both because of the broad census income classes adopted and also because of the absence of comprehensive income data since 1970. However, some comparison of the size of the "low income" population between 1970 and 1974 is possible on the basis of census figures for 1970 and survey figures for 1974. The income level that is commonly accepted in Brazil as the cutoff point for families in poverty is three times the average minimum wage, which at present is roughly equivalent to the Bank's relative poverty definition of one-third of national per capita disposable family income. The data reveal that, in 1970, 32.9% of all metropolitan households had earnings below two minimum wages. Although the survey data do not permit an exact comparison, they indicate that, in 1974, some 42% of all metropolitan area households had earnings of less than 2.5 minimum wages (Table 2.5). Thus, despite the Region's relatively high average income per capita in national terms, the inequality of the income distribution in MRPA is such that between one-third and one-half of urban households can be defined as the urban poor.

2.09 Reinforcing this conclusion is the available information on MRPA's housing stock and supply of essential public services. In 1970, roughly 8.3% of the Region's population was housed in what, by local standards, would be considered improvised, substandard dwellings, and this figure does not take into account access to basic infrastructure services. The highest proportions of such housing were to be found in the municipalities of Sapucaia do Sul, Sao Leopoldo, Alvorada, Novo Hamburgo and Porto Alegre. Studies by DEMHAB (the municipal housing department of Porto Alegre) indicate that, in 1972, in Porto Alegre alone, roughly 124,000 individuals, or about 12.5% of the municipal population, were living in impoverished, substandard dwellings. By 1977, it is estimated that the number of persons living in this type of housing had increased to about 150,000 in the central city alone. Recent information is not available on the housing conditions of the low income population living in the peripheral municipalities. However, given the rapid increase in the migrant population in such locations and the socio-economic characteristics of this population, it is probable that the housing conditions of the major migrant residential areas are at least as unsatisfactory as those in Porto Alegre. In this respect, it is significant to note that, outside Porto Alegre, both Alvorada and Cachoeirinha (major recipients of migration), were among the municipalities with the highest population densities in the 1970s.

2.10 The availability of water and sewerage infrastructure within MRPA is also quite limited. In 1970, the two municipalities having the greatest proportion of improvised dwellings, Alvorada and Sapucaia do Sul, had the lowest proportion of their population served by water and sewerage systems; at that date, less than 20% of the MRPA population was served by a main sewerage system. There appears to have been little investment in either water or sewerage since that time despite the rapid growth of population. Under the recently approved Southern States Water Supply and Sewerage Project, some of the municipalities in MRPA, including Campo Bom, Viamao and Alvorada, are expected to receive assistance.

D. Metropolitan Planning and Coordination

2.11 The Metropolitan Region's development master plan was published in 1973. With a horizon year of 1992, the master plan visualized a metropolitan population by that date of 3.2 million. These projections assumed a more rapid rate of growth for the metropolitan area's economic base (measured in terms of job opportunities) than for population; total jobs per person were expected to increase from 25% in 1970 to 35% in 1992. In addition, the adopted land use strategy involved the consolidation of growth in the north-south axis between Porto Alegre and Novo Hamburgo by establishing a few large centers of development in the corridor. It was assumed that this growth would be drawn largely from the central area of Porto Alegre. The master plan also had as its objective the redirection of some population and employment growth along the east-west axis between Guaiba and Gravatai.

2.12 In August 1975, the Metropolitan Planning Agency (METROPLAN) was created for the purpose of coordinating land use, social and economic activities, and public services in MRPA in order to achieve the plan's objectives. METROPLAN is funded by the State of Rio Grande do Sul, although it is not an implementing agency. Its role is, rather, one of seeking the required funding for projects which it identifies and which are then carried out by the executing agencies. In the area of housing, for example, METROPLAN identifies the appropriate locations for the construction of low income housing, with the construction being carried out by the State Housing Company (COHAB), and, in the case of the municipality of Porto Alegre, its own housing agency (DEMHAB). To carry out its functions, METROPLAN employs about 55 professional staff.

2.13 The basic problems confronting METROPLAN essentially relate, in the first place, to the fact that it does not have the legal authority to require the municipalities to follow the metropolitan master plan; further, it needs additional technical expertise to assess and plan for the type of basic structural economic and demographic changes that the metropolitan area is presently experiencing (paras 2.02-2.07) and that were not anticipated by the master plan. The master plan did not forecast the large increase in the relatively unskilled, low income migrant labor force or the concentration of informal job opportunities in the north-south corridor and the attraction of this axis for the new migrants. A more complete assessment of the master plan is given in Annex 3. Technical assistance is included in the proposed project to help METROPLAN revise its present master plan in order to address these unforeseen large demographic and economic changes (para 3.27).

E. Prognosis for the Metropolitan Region

2.14 Having assessed the master plan in the light of the most recent evidence on the growth, structure and spatial distribution of population and employment and found its projections to be at variance with the evidence, it is necessary to put forward a new prognosis concerning the metropolitan area's development. It is also necessary to assess the role of the suburban railway in the light of this prognosis.

2.15 Considering first the question of migration, it is likely that migration would continue to exceed that assumed in the plan, although this high rate could be reduced by the implementation of an effective state investment program for the interior. At present, however, there is no evidence to suggest that such a policy would be forthcoming in the short term, and, furthermore, it is far from evident whether such a policy to try and reverse present migration trends would be desirable on economic grounds. Given this situation, the continuation of present migration rates through the 1980s would not seem unreasonable.

2.16 The realization of this migration rate would produce a metropolitan area population of over 3.2 million by 1985 (the master plan had forecast that this level would be reached in 1992), 4 million by 1990, and, depending on the rate at which migration subsides in the future, from 4.5 to 5 million by 2000. This population is also likely to be of a different socio-economic composition (poorer and less skilled) and to have different locational characteristics than those assumed in the plan.

2.17 It is also probable that the activity rate of registered employment to population would not increase to the extent assumed by the master plan, if, indeed, at all. What is likely to increase is informal sector employment, particularly in tertiary sector activities. Thus, even allowing for the fact that the adoption of a constant activity rate represents a conservative employment growth assumption, the clear indication is that population growth is likely to be higher and registered employment growth lower and of different sectoral structure than previously assumed. METROPLAN and local staff of the National Transport Planning Agency (GEIPOT) are generally in agreement with this scenario.

2.18 The suburban railway project should be considered in the light of these more probable trends for the future. The most important point is that recent events have combined to produce a greater need and stronger justification for the suburban railway project than had followed from the objectives of the master plan, essentially because the north-south corridor is developing much more rapidly than was anticipated. Moreover, the creation of new activity centers along the line, if introduced under the right conditions (para 3.27), is likely to facilitate the master plan's objective of dispersing tertiary sector employment from the Porto Alegre Central Business District (CBD).

F. Transport Sector

(i) Basic Network

2.19 MRPA's transport system is shown on Map IBRD 14688; it consists essentially of roads. A main north-south trunk road, BR-116, centrally located

in the corridor, connects the southern- and northernmost municipalities of the Region. This is a four-lane divided highway with limited access, and, throughout most of its 42 km except near the city of Porto Alegre, it has two service lanes on each side to serve the local traffic. Several smaller two-lane east-west roads feed into BR-116 from both sides. In addition, an east-west trunk road, BR-290, with four lanes, crosses BR-116 within the municipality of Porto Alegre at the southern end of the Region. The total route length of the primary road system within MRPA is about 400 km. The route lengths and number of lanes for the main roads are shown in Table 2.6.

2.20 An old meter gauge railway line parallels BR-116 between Porto Alegre and Rio dos Sinos (39 km); it is double track from Porto Alegre to Km 12 and single track from Km 12 to Rio dos Sinos. There are also the remnants of a roadbed, where a railway line used to exist, between Rio dos Sinos and Novo Hamburgo (6 km). The existing track is over 100 years old and is beyond economical repair. The rolling stock consists of some 15 dilapidated wooden cars over 50 years old and two diesel locomotives. The federal railway (RFFSA), which owns these assets, runs two commuter trains daily in each direction and carries about 700 passengers daily. A suburban train service, therefore, is virtually non-existent. Freight trains destined for or leaving the port (three trains daily on average) use this line for some 10 km. The port itself would be considered medium-size in Brazil. It handled about 5 million tons in 1977, of which grains represented about 80%. The main port for the state of Rio Grande do Sul is Rio Grande, which is about 300 km to the south of Porto Alegre.

2.21 So far as planned transport projects in MRPA are concerned, the local DNER in Porto Alegre has a project proposal (presently shelved) to build a new highway in the north-south corridor between Porto Alegre and Scharlau (24 km). The design for this project is completed, but the project has not been approved, nor is there any indication that it is likely to be approved in the foreseeable future. Nevertheless, in view of the considerable adverse effect that such a project would have on the proposed suburban railway project and the fact that the economic analysis (Chapter VI) indicates that the proposed project is preferable to this road project if considered an alternative, it was agreed with the Federal Government during negotiations that the Porto Alegre-Scharlau road project would not be implemented until a proper economic feasibility study, satisfactory to the Bank, is carried out and shows that this project is economically justified. For other projects, not yet known, a more general agreement was reached; EBTU, through 1988, agreed to inform the Bank of any proposed passenger transport related investments exceeding US$10 million in the influence area of the Bank project, provide the Bank with information on the expected impact of the proposed investment on the Bank project, and consult with the Bank before a commitment is made.

(ii) Operations and Traffic

2.22 The dominant mode of travel within MRPA is bus. Of a total of 1.95 million daily person trips by all modes in 1979, buses account for 1.3 million, or 67%. Cars and taxis account for 27.5 and 1.6% of total person trips, respectively. All of the bus companies operating in MRPA are privately owned. Ten companies are licensed by the State of Rio Grande do

Sul to provide intermunicipal services and 32 companies (22 in Porto Alegre alone) are licensed by the municipalities to provide a municipal service (Table 2.7). The average fleet size per company providing intermunicipal services is fairly large (117 buses). The fleet sizes for the companies providing municipal services vary widely, with those in Porto Alegre averaging about 68 buses and those in the other cities about 22 buses (Table 2.7). Tariffs for the intermunicipal and municipal services are regulated by the State and the municipalities, respectively, both of whose decisions are reviewed by the National Interministerial Council on Prices (CIP), which was recently incorporated into the newly created Secretariat for Supply and Prices (SEAP) within the Ministry of Planning. Mid-1979 tariffs for municipal and intermunicipal bus services average around Cr$ 0.20 and Cr$ 0.30 per pass-km, respectively. With these tariffs and present costs, all of the bus companies in MRPA are operating at a profit, although often at the expense of comfort to the passenger; during the peak hours on many routes, occupancy rates are double the seating capacity (Table 2.8).

2.23 Despite the dominance of buses as a mode of transport in MRPA, cars represent, on average, about 50% of the total vehicles on the road system; on some main roads, such as BR-116, the figure is as high as 74%. During the last 10 years, car ownership in MRPA has increased from 103,000 to 251,000 vehicles, a compound annual growth rate of about 12%, almost three times the rate of growth of the population. The bus fleet, on the other hand, increased by only about 7% per annum during this period (Table 2.9). To date, little has been done to discourage the use of the private automobile. The creation of exclusive pedestrian walkways in the Porto Alegre CBD (about 2,520 meters of street or about 8% of the total street length of the CBD) has helped to a degree, but a substantial amount of day-term car parking is available in the central area at relatively low cost (Table 2.10). Private automobile sales, property and user taxes are shown in Table 2.11.

2.24 Of the total daily person trips by all modes in MRPA, roughly 65% are between work and home, 25% are study-related and 10% are made for other purposes. About 72% of all trips are made during the three main peak periods comprising six hours: 6-8 in the morning, 12-2 in the afternoon and 5-7 in the evening (Table 2.12). Efforts by the municipality of Porto Alegre to convince private businesses to stagger working hours and thus to spread this peak have met with limited success.

2.25 Because of the spatial distribution of population and jobs within MRPA (paras 2.02-2.07), travel demand is high. With a limited residential population of only 63,000 or 2.6% of the total Region's population, the CBD, because of its attraction as a regional job center for the residential populations living in the suburbs, generates about 266,000 passenger trips daily, corresponding to a trip generation rate of 4.25 trips per inhabitant per day. The rest of the municipality of Porto Alegre, which has a fairly large residential population of more than one million inhabitants, generates another 300,000 trips involving other municipalities. The average trip generation rate for MRPA is 0.82 (Table 2.13). Average journey distances range from 9 km for automobile passengers to 21 km for intermunicipal bus passengers (Table 2.8). About 55% of all trips at present are intramunicipal (Table 2.13).

2.26 Traffic on many sections of BR-116, the main trunk road in the Region serving the north-south corridor, has already reached saturation levels. Daily and peak hour vehicle traffic and growth rates on BR-116 are shown in Table 2.14. During the peak period, traffic on BR-116 ranges from some 845 vehicles (1,020 passenger car units, PCUs) per hour in one direction in the Esteio-Sao Leopoldo section to some 1,371 vehicles (1,771 PCUs) and 2,294 vehicles (2,814 PCUs) in the Esteio-Canoas and Canoas-Porto Alegre sections, respectively. These congestion levels of traffic between Porto Alegre and Esteio give rise to very high operating costs and long travel times which are reflected in average bus speeds of 15-20 km per hour during the peak period. Much of this congestion is due to the large number of automobiles on the road. As mentioned (para 2.23), car traffic, which has been growing at about 4.5% per annum on this road, now accounts for about 74% of the total vehicles on BR-116. An exclusive bus express lane will soon be introduced on a section of road within the municipality of Porto Alegre after some road resurfacing is completed under the First Urban Transport Project (Annex 1). This action should help to mitigate the problem somewhat, but, on this section, and certainly on the rest of the road which serves the metropolitan area, high levels of congestion will remain and become much worse unless measures are taken to make the available corridor capacity more efficient by reducing car usage and increasing public transport. To accomplish this goal, in addition to the type of operational improvement provided under the First Urban Transport Project, a major expansion of exclusively public transport infrastructure will be required. It is in this context that the suburban rail solution, designed to attract car and bus users, has been considered and several mutually exclusive alternatives have been analyzed (Economic Analysis, Chapter VI).

(iii) Policy, Planning and Coordination

2.27 A transport master plan for MRPA, which, among other things, recommended a suburban train service for the north-south corridor, was completed by GEIPOT in 1976. 1/ Until recently, a specialized metropolitan-wide transport agency to promote the plan's implementation did not exist. Transport planning in MRPA was essentially the responsibility of the individual municipalities, and all licensing, franchises and fares were regulated either by the municipalities or the State of Rio Grande do Sul, depending on whether the service, facility, etc. was within or outside the jurisdiction of a single municipality. During several project preparation missions, the Bank discussed this situation with local and state government officials who were acutely aware of the need for coordination at the metropolitan level. In response to this problem, in December 1979, the State Governor of Rio Grande do Sul created the Nucleo Metropolitano de Transportes Urbanos (NMTU) to coordinate and regulate the activities of all transport-related activities within MRPA.

2.28 NMTU replaces the several state agencies previously involved in the coordination and regulation of transport in MRPA. In addition, under an existing federal law, the newly created NMTU, in the interest of the Metropolitan Area and in order to improve its transport system, has the authority

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1/ Plano Diretor de Transportes Urbanos da Regiao Metropolitana de Porto Alegre, 1976.

to also perform many of the regulatory functions which were previously the exclusive responsibility of the municipalities. During negotiations, the State of Rio Grande do Sul agreed that NMTU would perform the following functions:

(a) grant and review franchises for intra- and intermunicipal bus companies and taxi operators;

(b) specify bus routes;

(c) coordinate levels of service at intermodal connections;

(d) specify, regulate and review safety standards for all modes;

(e) provide transport enterprises with guidelines for the setting of tariffs, monitor such tariffs and, if necessary, require such enterprises to propose tariff changes. (While CIP's approval of tariffs is still required (para 2.22), it is hoped that, at some time in the not too distant future, this regulatory control would be relinquished and only the monitoring activities of NMTU would be retained.)

(f) regulate the use of the private car through the coordination of municipal parking policies, user charges and taxes and the increased availability of public transport;

(g) review and advise on all proposed transport infrastructure investment decisions in the metropolitan area; and

(h) prepare and annually update an indicative rolling five-year transport plan to serve as a guide to public and private investment decisions.

2.29 So far, it is too early to judge the performance of this newly created agency. Many of NMTU's authorized powers, particularly with regard to regulation, have not yet, in practice, been transferred from the municipalities. This aspect should be carefully monitored during project supervision to ensure that NMTU achieves its intended objective. Technical assistance to help NMTU perform its designated functions is included in the proposed project (paras 3.23-3.26).

G. Travel Demand Forecasts

2.30 For the purpose of forecasting traffic in MRPA, the latter was divided into a total of 46 zones. With the assistance of METROPLAN, the employment and population characteristics of each zone were forecast under four alternative land use scenarios. After analyzing these four alternatives in the light of recent trends in the growth and spatial distribution of population and employment (paras 2.02-2.07) and the revised prognosis for the development of MRPA (paras 2.14-2.18), it was concluded that two alternatives were most representative of the future evolution of the metropolitan area. Both involved the same overall rate of growth of employment and population in the Region, but with somewhat different spatial distributions. Specifically,

the growth in tertiary employment that was forecast for the CBD of Porto Alegre under one alternative was redistributed to a few commercial centers along the railway right-of-way under the second land use alternative. The alternative with the growth in tertiary employment concentrated in the CBD of Porto Alegre was adopted as the population and employment base for the travel demand forecasts to be applied to all the project alternatives examined in the economic analysis (Chapter VI) with the exception of the two alternatives involving rapid rail mass transit, namely, the proposed project and a light rail alternative. In both of these cases, the second land use alternative, which takes into account the development of commercial centers along the line, was adopted. Then, for each of these two land use alternatives and for each of the forecast years (1985, 1990 and 2000), the number of trips generated by each zone, the distribution of trips between zones and, finally, the modal distribution of trips between zones were estimated. A description of the four land use alternatives and how the above steps in the transport model were accomplished is presented in Annex 4.

2.31 The forecast of total daily person trips in the region by mode, under the assumption that the proposed suburban railway project is implemented, is summarized below:

Forecast Total Daily Person Trips by Mode in MRPA

Year/Mode	Car	Bus	Train	Total
1985	693,371	1,361,255	260,779	2,315,405
1990	746,191	1,533,560	386,180	2,665,931
2000	924,805	1,882,874	586,069	3,393,748

2.32 Under the second land use alternative, in which the rate of economic growth is the same but its spatial distribution is different, the total number of trips in the Region is forecast to be the same as that above, but the distribution of trips, trip lengths and the modal composition are different, reflecting the fact that the growth in employment expected around certain stations would, instead, without the rapid rail mass transit system, be concentrated in the CBD of Porto Alegre. The assumption that the rate of economic growth in the Region would be the same with or without the rapid rail mass transit system is generally consistent with the evidence accumulated from elsewhere, which shows that the introduction of such a system is of itself unlikely to bring about an increase in a metropolitan area's rate of economic growth. It does appear, on the evidence available, however, that a rapid rail mass transit system can influence the distribution of economic growth and job creation when the growth potential already exists, as appears to be the case in the north-south corridor of MRPA.

H. Train Ridership

2.33 After obtaining the forecast of suburban train passengers as described above, the 46 x 46 matrix of train passenger flows was collapsed into a 14 x 14 station-to-station matrix. The station-to-station, origin and destination flows of train passengers in 1985, 1990 and 2000 are presented in Tables 2.15, 2.16 and 2.17. The most important stations in the system,

in terms of passengers, are: Mercado Central, Sapucaia, Farrapos, Niteroi and Canoas. Of the 261,000 train passengers forecast for 1985, about 21,400 passengers are expected to be diverted from cars and the rest from buses. The car diversion figure is expected to reach 72,500 passengers in 1990.

2.34 In 1985, the maximum peak hour flow is forecast at about 39,000 passengers or about 15% of total daily traffic, of which about 80% or 31,000 passengers are forecast to move in the principal direction. This figure of peak hour traffic in the principal direction is forecast to reach 46,000 passengers in 1990 and 70,000 passengers in 2000. The practical design capacity of the system under the project is estimated at 48,000 passengers per hour in one direction, stretchable to 72,000 passengers with some relatively small investments (para 3.06). Thus, sometime in the early 1990s, some small changes in the system may be required, but otherwise, the proposed project should be able to serve the demand quite efficiently through at least the remainder of this century.

III. PROJECT OBJECTIVES, DESCRIPTION AND COST ESTIMATES

A. Project Objectives

3.01 The principal objectives of the proposed project to provide a suburban rail mass transit system in the metropolitan region of Porto Alegre may be grouped into three main categories: (i) institutional, (ii) economic efficiency and (iii) urban development.

(i) Institutional

3.02 As part of the preparation of the proposed project, a new company (the Porto Alegre Metropolitan Rail Mass Transit Company, TRENSURB/P.A.) was created in mid-April 1980. This company, when fully established, would be the first of its kind in Brazil, independent of the federal railway. TRENSURB/P.A. would own and operate the suburban train facilities and equipment provided under the project. This new institution would also break with past tradition insofar as it is proposed to be run on a commercial basis, whereby tariffs would be set at levels sufficient to cover at least all operating costs.

(ii) Economic Efficiency

3.03 The proposed project is expected to achieve a significantly more efficient modal distribution of traffic and use of all transport facilities in the metropolitan region's north-south corridor by diverting as many car passengers as possible and a significant proportion of the intermunicipal bus passengers to the suburban train service while retaining buses on feeder lines and on those longer routes which are most economically served by bus. The reduction of trips made in automobiles, accompanied by the substitution of public for private modes of transport, is an important element of the project design.

(iii) Urban Development

3.04 The suburban railway system (with stations approximately every 2 km) is expected to contribute to the attainment of the metropolitan region's land use strategy of developing selected employment growth poles in the north-south corridor by providing the growth stimulus for the development of centers around certain railway stations along the line. On the basis of all supporting evidence, it is unlikely that this type of spatial development could be achieved by providing additional road capacity which would tend to support a more linear expansion of the city of Porto Alegre.

B. Physical Works and Equipment

3.05 The proposed project entails the construction of a surface suburban rail mass transit system with electric unit trains between the central market in downtown Porto Alegre and the municipality of Sapucaia, 26.7 km to the north (Map IBRD 14688). The line basically follows the same right-of-way as RFFSA's existing obsolete railway line (para 2.20), except for a few deviations to improve the new line's geometry and also to provide a 2.3 km access to the central market in Porto Alegre where no railway right-of-way exists at present. RFFSA has already transferred the right-of-way to TRENSURB/P.A. in exchange for capital shares (para 5.03). This project constitutes Phase I of a larger scheme which includes, in Phase II, the stretch between Sapucaia and Novo Hamburgo (an additional 16 km). Detailed engineering for the entire 42.7 km has been completed by GEIPOT. An economic and financial feasibility study of Phase II is included in the proposed project (para 3.22). The major items of the proposed project (Phase I) are: tracks, pedestrian and road vehicle under/over passes, stations, a train maintenance depot with related yard and equipment, substations and catenary for the provision of electric power, electric unit trains, automatic signaling, telecommunications, satellite automobile parks near some stations to attract car users, related civil works and technical assistance.

3.06 The automatic signaling system is designed for a minimum headway of three minutes between trains, which would permit a maximum of 20 trains per hour in each direction. The station platform lengths, which can be increased in the future as the situation warrants, are 176 m and can accommodate trains with compositions of up to eight cars. Thus, with a maximum occupancy of 300 passengers per car (para 5.07), eight cars per train and 20 trains per hour, the system is estimated to have a practical design capacity of 48,000 passengers per hour in one direction. By lengthening the platforms to accommodate trains with 12 cars and by making a few other relatively small changes in the passenger areas of the stations, the catenary and substations, and by lengthening some of the sidings, the system's capacity could be increased to 72,000 passengers per hour in each direction. A more detailed description of the project is presented below.

(i) Track, Bridges and Related Works

3.07 The new line will consist of two broad gauge (1.6 m) tracks. It will begin in the CBD of Porto Alegre near an old, and architecturally significant, city landmark--the central market building. From Mercado Central station, which is the most central point in the CBD, the line will proceed north following Avenida Maua (presently five lanes with traffic in one direction

which will become four lanes with the railway line) until it reaches the second station at Km 0.9 (Rodoviaria). There the line will join BR-116, which at this point is called Avenida Castelo Branco. At this juncture, a road bridge will be built over the railway line, which will continue on its northerly course on the western side of BR-116 in the existing railway right-of-way until Km 19.5. At this point, another road bridge on BR-116 will be built over the railway line, which will then continue on the eastern side of BR-116 until it reaches the terminal station of Sapucaia (Km 26.7). The line will be protected along its entire length by a concrete post fence on the urban access to the CBD and by a precast concrete and wire fence for the remainder. There are no level crossings; along the route there are 16 pedestrian over/under passes, ten road vehicle bridges and six railway bridges.

3.08 The old track will be removed and the new track put in place. The new track will have welded rails. The line will be relatively straight (minimum radius in the curves of 200 m, which occurs in only one place) and level (maximum gradient of 2%, which occurs in a few places on the line). About 172,000 m^3 of ballast, 93,000 concrete sleepers, 65,000 wooden sleepers and 9,800 tons of rail will be used. Rail fittings, switches and crossings, and rail welding materials are also included.

3.09 In order not to cut off the access of freight trains to the port, which presently use the existing line (para 2.20), a 10-km meter gauge track, parallel to the two suburban tracks, will be built between Canoas, where RFFSA's freight line enters the Region, and Km 3.8, where the freight line deviates to follow its own separate alignment to the port. To the extent possible, salvageable materials from the old meter gauge tracks will be used on the parallel freight line. Also, RFFSA's long-distance passenger trains will originate/terminate in Diretor Pestana station (near the airport), which is in close walking distance to the suburban line. 1/ Thus, only the suburban trains will be run on the suburban system.

(ii) Stations

3.10 A total of 14 stations, spaced approximately every 2 km, will be built along the line (Map IBRD 14688). Mercado Central station (Km 0) with convenient access to bus transportation and the rest of the Porto Alegre CBD, will be partly underground and connected to the railway platforms and to the street above by underground tunnels. Rodoviaria station (Km 0.9), which is also partly underground, will be conveniently located next to the city's main bus terminal. Aeroporto station (Km 6.1) will have a 330 m underground tunnel connecting it with the terminal at the airport. 2/ Satellite automobile parks adjacent to several stations, having a combined capacity of 13,500 automobile spaces, are also included in the project. Some of the most important stations, from the point of view of demand for satellite automobile

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1/ RFFSA's long-distance passenger service involving Porto Alegre is insignificant, with, on average, about one train per day. This situation is not expected to change in the foreseeable future.

2/ About one million passengers a year arrive at and leave from Porto Alegre Airport. The visitor-to-passenger ratio is about three to one on average. At present, more than 90% of all passengers and visitors arrive at or leave from the airport in private automobiles or taxis, which clearly represents a potential market for the rail mass transit system.

parking facilities, include: Farrapos (Km 4.8), Niteroi (Km 10.5), Canoas (Km 14.8), Luiz Pasteur (Km 24.7) and Sapucaia (Km 26.7). Consultants, engaged under the technical assistance program (para 3.23), would identify the precise locations and sizes of the satellite automobile parking lots.

3.11 Four stations, including the two terminals--Mercado (Km 0) and Sapucaia (Km 26.7)--and two intermediate stations--Ceasa (Km 8) and Matias Velho (Km 16.2)--will be provided with railway switches and sidings to allow for the formation and return of trains. Passengers will enter the platforms through automatic turnstiles after inserting their tickets. These tickets will be purchased from ticket sellers in booths in the stations.

(iii) Substations and Catenary

3.12 The line between Mercado Central and Sapucaia will be electrified with 3 kV (kilo volt) direct current fed into the overhead catenary by two 6 MVA (Mega Volt Ampere) substations located at Km 4.5 and Km 17.9. Electric energy (hydrogeneration) will be supplied by the State Electric Company (CEEE). The proposed project can be accommodated within CEEE's present expansion plans. Under a Bank loan approved in March 1980, CEEE will expand its sub-transmission and distribution system in the State.

(iv) Electric Unit Trains and Spare Parts

3.13 The project includes 25 electric unit trains (and related spare parts) of the same type now being used in Rio de Janeiro. This number should be sufficient for the first few years of operation. The requirement is worked out in Table 3.1. Each unit train consists of four cars (two motor coaches and two trailers). The unit trains can be coupled together, the limit essentially determined by the lengths of sidings and platforms. Initially, two unit trains will be coupled together during the peak periods (para 5.06). The cars will be made of stainless steel and be 22 m long, 2.94 m wide and 3.91 m high. Each car will have 108 seats. The trains will have a maximum acceleration rate of 0.8 m/sec^2 and a maximum speed of 90 km/hr.

(v) Train Depot and Administration Building

3.14 A train depot for the normal maintenance of trains will be built at Km 7.3 in an area now owned by RFFSA (Diretor Pestana Yard). The depot will have six main tracks with a capacity to provide normal periodic maintenance for nine unit trains. The average unit train, which is expected to run about 95,000 km a year, should visit the maintenance depot approximately once a week for 15 man-hours of work and every two months, four months, and 12 months for 70, 100 and 150 man-hours of work, respectively. General overhauls should not be required for at least 0.5 million km, or during the first five years of operation. Thus, a workshop for general overhaul is included only in Phase II. A small administration building will be constructed next to the train depot, which will house the train operations center and all the administrative offices.

(vi) Track Maintenance and Maintenance Depot Equipment

3.15 The proposed project also includes equipment for track maintenance and for the train maintenance depot (Tables 3.2 and 3.3).

(vii) Signaling

3.16 The signaling system will be bidirectional centralized traffic control (CTC) which, if necessary, will permit trains on the same track to run safely in opposite directions between stations. The CTC control room will be located in the operations center of the administration building. The operations center, from information recorded on its display panel, will be able to follow all line operations, train locations and switch and signal positions.

(viii) Telecommunications

3.17 The telecommunications system will provide for telephone units every 500 m along the line and, through an underground cable, the capability for communication between the control room and every station, between stations, and between the management and stations/depot/operations center and points outside the system. There will also be telephone communication between the trains and the stations and operations center.

(ix) Land

3.18 The project cost estimates (para 3.28) include the expropriation of some private land which is required for the satellite automobile parks (297,000 m^2) and for the construction of some under/over passes and substations (42,000 m^2) which are partly outside RFFSA's existing right-of-way. No particular difficulties are expected in acquiring this land for the project. In addition, the project cost estimates include provision for the expropriation of some private land to be reserved for the construction of additional satellite car parks in the future (for about 9,000 automobile parking spaces) and for the continuation of the line to Novo Hamburgo under Phase II when it becomes economically justified (63,000 m^2). The public lands, which are included in the project (but not in the cost estimates) and which have been contributed to the project in exchange for capital shares in TRENSURB/P.A. (para 5.03), include: RFFSA's right-of-way and the area for the train depot and administration building (500,000 m^2) and State land near Aeroporto Station (12,000 m^2). Porto Alegre municipal land for Mercado Station and the urban access along Avenida Maua (about 24,000 m^2) has been designated for this purpose and is expected to be transferred to TRENSURB/P.A. in the next few months in exchange for equity shares in the company (para. 5.03).

C. Complementary Institutions and Policies

3.19 To complement the physical work, certain institutional/organizational changes are also included in the project: (a) the development of the newly established NMTU so that it may become an effective transport coordinating and regulatory agency at the metropolitan level (paras 3.23-3.26); and (b) the setting up of TRENSURB/P.A. to own and operate the suburban rail service (Chapter V). Also, in addition to the incentive policy of providing satellite automobile parks in some of the outer stations to attract automobile passengers to the suburban train system (para 3.10), experience elsewhere has shown that it would be necessary to have a disincentive policy as well, to discourage commuters from using their cars. The automobile parking restrictions program recently adopted by the municipality of Porto Alegre provides a useful framework within which to work. A program, including the necessary enforcement, to reduce substantially the availability of day-term automobile parking spaces in the CBD of Porto Alegre, in conjunction with the introduction of the suburban

train service, is included in the proposed project. During negotiations, the Federal Government, through an existing agreement with the Municipality of Porto Alegre, agreed to cause the latter to implement this program which consists of (i) the elimination of all commuter-related day-term street and open-lot automobile parking in the CBD of Porto Alegre, and within the first ring road that surrounds it, within three months of the commencement of TRENSURB's operations, and (ii) the continuation of the Municipality's prohibition on the construction of new automobile parking garages in this area. The State, which employs the police force in MRPA, agreed, during negotiations, to enforce the above program. Further measures to control the use of private automobiles, such as area license and other pricing schemes, taxes, restricted zones and car pooling would be examined by consultants during project implementation (para 3.24).

D. Technical Assistance

3.20 The scope, timing and cost of the technical assistance provided under the proposed project are shown in Table 3.4. There are basically three parts to this technical assistance program which relate to (i) the setting up and operation of TRENSURB/P.A.; (ii) other complementary transport policies and programs which would be carried out by NMTU; and (iii) the urban impact of the proposed project. The consultants, to provide the technical assistance, would be retained by TRENSURB/P.A., NMTU and METROPLAN as described below (paras 3.21-3.27). Consultants for the supervision of the physical works and procurement of equipment are discussed in paragraph 4.03.

(i) TRENSURB/P.A.

(a) Setting Up TRENSURB/P.A.

3.21 Consultants are needed to assist with the setting up of TRENSURB/P.A. All that exists at present is a legal structure for a company. The consultants would be retained by TRENSURB/P.A. They would advise on staffing, the training of personnel before and after train service begins, organizational structure, management, accounting, finance and operations. In addition, the consultants would assist with the implementation of some of their recommendations during the first year of operation.

(b) Phase II Economic and Financial Feasibility Study

3.22 Consultants are needed to carry out an economic and financial feasibility study for Phase II, which involves extension of the system from Sapucaia to Novo Hamburgo (16 km). Only if the extension of the system in the next five years is economically justified would the consultants work out the details regarding the required changes in operations, staffing, management, accounts, tariffs, etc., the changes needed in bus routes and the financing plan for this new capital investment. The consultants would be retained by TRENSURB/P.A.

(ii) Other Complementary Policies and Programs

(a) Satellite Automobile Parks, Auto Restraint Policy and Monitoring

3.23 While some preliminary analysis has been carried out with respect to the demand, and available space, for satellite automobile parks, and provision for a certain global capacity of 13,500 automobile spaces has been included in the project, more details are required before a definitive construction plan can be executed. Consultants would be engaged to identify the precise location and sizes of the satellite automobile parking lots, to design such facilities and to identify the land which should be expropriated now for the future provision of an additional 9,000 automobile parking spaces at satellite automobile parks.

3.24 The consultants would also study the various options, in addition to parking controls (para 3.19), to restrain auto use in MRPA in general and in the north-south corridor in particular, and to recommend a complete auto restraint program which the Bank and the State Government would then discuss in order that the State, through NMTU, might take appropriate action. In addition, the consultants would, during the first two years that the railway is operating, monitor the impact of the auto restraint program on the entire Region, as well as the extent of car passenger diversion to the rail mass transit system. Should certain problems arise, the consultants would propose solutions which the Bank and the State Government through NMTU would discuss prior to a course of action being adopted. The arrangements for these Bank-Government discussions at the end of the study period and during the monitoring phase, and the State Government's commitment to take appropriate action, through NMTU, were discussed and agreed during negotiations. The consultants to carry out all of the above work would be retained by NMTU.

(b) Bus Routes

3.25 With the train service, some existing bus routes become uneconomical; others become more important as feeder links to the railway line, and others should simply continue because they serve a population which is more economically served by bus. In the modal split and economic analyses, these factors have been taken into account in a general way, but it was not possible to identify the specific bus routes in each case. Before the railway service is operational, however, this detailed information would be needed by NMTU, which would be responsible for implementing the new bus program. Therefore, consultants would be engaged to identify those specific bus routes which should be discontinued and those which should serve as feeder links to the railway line. The consultants would also make recommendations on actions regarding those bus companies which would be adversely affected by these changes. The consultants would be retained by NMTU.

(c) Tariff Policy

3.26 Consultants are needed to study the levels and structure of all transport tariffs in the Region, including the charges for satellite and other automobile parking, and to make specific recommendations on how they should be set after considering all economic efficiency, income distributional and fiscal factors. The consultants would be retained by NMTU.

(iii) Urban Impact

(a) Commercial Center Development and Master Plan Assistance

3.27 With the introduction of the suburban railway service, the areas around some stations are expected to become more attractive for certain kinds of commercial development. This type of development has been assumed to occur under the land use alternative adopted for the analysis of the proposed project. However, this analysis was undertaken with the limited objective of deriving the distribution of employment and population by zone in order to generate person trips in the transport model. Specific questions concerning the potential for different types of businesses and the conditions necessary for its realization and implementation were not addressed. Therefore, consultants are needed to assist METROPLAN, which has agreed to participate in such an exercise, in identifying the potential for specific types of commercial development at certain locations along the line where such development would be beneficial from a social as well as private point

of view, and to recommend how best to create the planning and organizational conditions necessary for the achievement of such development. This would include consideration of the issue of whether or not a public real estate company or some other institution would be needed to manage the development. The real estate within the stations would be managed by the new railway company. The consultants would be retained by METROPLAN. The same consultants would also assist METROPLAN with the updating and revision of its land use master plan (para 2.13).

E. Cost Estimates

3.28 The cost estimates for the proposed project are based on the GEIPOT engineering design study of 1976, adjusted for changes suggested in discussions with the Bank. Base period unit prices are estimated as of January 1980. The cost of the technical assistance has been estimated on the basis of some 351 man-months of consulting services at an average cost per man-month of US$10,000 and US$6,000 for foreign and local consultants, respectively (Table 3.4). The total cost estimates for the entire project, broken down by foreign and local costs for each year, are shown in Table 3.5 and summarized in paragraph 4.06. The total project cost is estimated at Cr$ 10.0 billion in January 1980 prices (US$232.8 million equivalent) with a foreign exchange component of US$117.2 million or 50%. To these base period estimates, price and physical contingencies have been added. Physical contingencies include 5% for cement, 3% for steel, 5% for cables, 5% for substation spare parts and 10% for fuel. Price contingencies were based on the following cost increases for both civil works and equipment: 10.5% in 1980, 9% in 1981, 8% in 1982, and 7% in both 1983 and 1984. No differentiation was made between local and foreign price contingencies on the assumption, which is considered reasonable, that the cruzeiro would be devalued frequently in order to maintain a relatively constant relationship between local and foreign prices. The physical and price contingencies taken together represent about a 34% increase over the base cost estimates.

IV. PROJECT IMPLEMENTATION AND THE PROPOSED LOAN AND BORROWER

A. Project-Implementing Office

4.01 To implement the proposed project, which is estimated to take three-and-a-half years (para 4.04), a project-implementing office or Nucleo Executivo de Projecto (NEP) would be established within TRENSURB/P.A. The structure and key staffing of NEP were discussed during the preparation of the project. The establishment of NEP within TRENSURB, with staff satisfactory to the Bank, would be a condition for loan effectiveness. Since the first order of priority would be the commencement of the physical works, initially TRENSURB/P.A. would consist almost entirely of NEP with a few other personnel to handle the administrative responsibilities of the new company until its full structure and staffing (to be recommended by consultants, para 3.21) are in place. All aspects of TRENSURB/P.A., in addition to its relation to NEP, are discussed in Chapter V.

4.02 Some steps have already been taken toward the formation of NEP. A highly qualified GEIPOT engineer, who has been supervising the project design since 1976, has been chosen as the future head of NEP. In addition, some other engineers from GEIPOT, RFFSA and EBTU are already working with him.

Also RFFSA, EBTU, GEIPOT and METROPLAN have been designated by the Minister of Transport to provide NEP with the necessary technical services. It is envisaged that RFFSA would play a key role in carrying out railway physical works. During negotiations, agreement was obtained from RFFSA, EBTU, GEIPOT and METROPLAN that they would provide the necessary technical services to NEP.

4.03 During project implementation, the principal functions of NEP within TRENSURB/P.A. would be (a) to arrange for the expropriation of all land under the project, including the land for the satellite automobile parks; (b) to prepare contracts and to call for and evaluate bids; and (c) to award contracts to carry out the physical work as well as the technical assistance according to the agreed schedule. Supervision of construction and equipment procurement would be provided by consultants. Provision for the cost of operating NEP and the consultants is included in the project costs (Table 3.5). At the end of project implementation, NEP within TRENSURB/P.A. would be disbanded, but it is possible that NEP and much of its staff could be incorporated into the technical department of TRENSURB/P.A. These matters would be studied by consultants under the technical assistance program (para 3.21).

B. Implementation Schedule

4.04 The project implementation schedule is shown in Table 4.1. The preparation and award of contracts are expected to be accomplished during the latter part of 1980 and the early part of 1981. Actual physical work is expected to begin on a large scale by mid-1981 and to be completed by the early part of 1984. Trains are expected to be running by mid-1984. The first full year of operations would be 1985. The work on various items would begin at essentially the same time at several different points along the line. Thus, work on track infrastructure, stations, bridges and buildings is expected to begin by mid-1981, followed by the construction of the track. This work is expected to be divided into many different contracts. In order not to interrupt freight traffic for the port during construction, one of the existing tracks would continue in use until the new freight line is in place on the side of the suburban line. The supply of equipment and material for electrification and signaling would begin in early 1982 and the corresponding physical work in mid-1982. The supply of equipment and material for the telecommunications system and the first deliveries of unit trains would begin in mid-1982. During the construction of the elevation of Avenida Castelo Branco and the urban access to Mercado Station on Avenida Maua, certain temporary traffic arrangements would need to be made, for which the assistance of the Municipality of Porto Alegre would be required.

C. The Proposed Loan

4.05 A loan of US$159 million is proposed, which would cover the full foreign exchange costs (including contingencies) of the project. The equipment and services, which would be financed by the proposed loan, are shown in Table 4.2 and include unit trains and spare parts, track materials, signaling equipment, catenary and substation equipment, maintenance depot equipment, track maintenance equipment and technical assistance.

4.06 A comparison of the total project costs and the proposed Bank loan are shown below:

	US$ thousand equivalent (including all contingencies)			
	Project Costs			Proposed Bank
	Local	Foreign	Total	Loan
Track infrastructure	13,159	1,841	15,000	-
Track superstructure	20,416	14,003	34,419	12,615
Pedestrian and road vehicle under/over passes	30,968	4,617	35,585	-
Stations	15,589	7,448	23,037	-
Administration and maintenance depot buildings	9,936	795	10,731	-
Maintenance depot equipment	208	2,542	2,750	2,542
Permanent way maintenance equipment	-	474	474	474
Telecommunications	2,094	3,341	5,435	-
Signaling	3,383	9,228	12,611	8,410
Electrification	4,630	12,480	17,110	10,683
Satellite car parking	3,560	846	4,406	-
Expropriations	23,266	-	23,266	-
Unit trains	22,891	91,560	114,451	114,451
Unit train spare parts	1,915	7,665	9,580	7,665
Technical assistance	1,752	2,160	3,912	2,160
Total	153,768	159,000	312,768	159,000

Note: The division between local and foreign costs is based on an analysis of whether Brazil is a net importer of a particular item and on the likely source of supply. Specifically, in the case of unit trains, it was assumed that local bidders would be successful.

D. The Borrower, Onlending and Project Agreements

4.07 The Borrower of the proposed loan would be the Federative Republic of Brazil. EBTU, in its capacity as the financial agent for the Government, would then onlend to TRENSURB/P.A. the total equivalent of the Bank loan in cruzeiros. TRENSURB/P.A. would repay EBTU such principal amount over a period of 12 years, with payments beginning after the third full year of train operations. The value of the cruzeiros borrowed would be subject to a monetary correction factor in accordance with changes in the national treasury bond index. The interest rate would be 5% per annum, which is the prevailing rate of interest charged by the National Development Bank (BNDE) for similar projects in Brazil. This onlending arrangement is considered practicable in view of TRENSURB's prospective financial capability (para 5.15). These matters were agreed during negotiations. The signing of a Subsidiary Loan Agreement, which includes the above conditions, between EBTU on behalf of the borrower and TRENSURB/P.A., would be a condition for effectiveness of the proposed Loan Agreement. The Bank would also enter into a joint Project Agreement covering all aspects of the project with EBTU, GEIPOT, RFFSA, the State of Rio Grande do Sul and METROPLAN.

E. Procurement

4.08 All items to be procured under the proposed loan would be subject to international competitive bidding (ICB) in accordance with Bank guidelines. In bid evaluation, Brazilian manufacturers of equipment would be allowed a preferential margin of 15% of the CIF cost of competing imports, or the relevant prevailing level of customs duties, whichever is lower.

F. Disbursements

4.09 Disbursements would be made as follows:

(a) 100% of the foreign expenditures for imported equipment, materials and unit trains; and/or

(b) 100% of the ex-factory cost of locally manufactured equipment, materials and unit trains; and

(c) 60% of the cost of the technical assistance.

An estimated schedule of disbursements is given in Table 4.3. This schedule is based on the assumption that the proposed loan would become effective by November 1, 1980.

G. Financing Plan

4.10 The sources of finance for the capital cost of the proposed project include: (i) the Bank loan of US$159 million which would be onlent to TRENSURB/P.A. (para 4.07); (ii) the cash contributions of shareholders of US$153.8 million in exchange for equity shares in TRENSURB/P.A. (the shareholding arrangements are discussed in paras 5.01 through 5.04); and (iii) the land contributions of the shareholders (estimated at US$27.8 million), also in exchange for equity shares in TRENSURB/P.A. The financing plan is as follows:

Financing Plan
(US$ million)

	FY 1980	1981	1982	1983	1984	1985	Total
Loan	-	0.10	26.60	63.40	68.50	0.40	159.00
Equity:							
EBTU	1.44	4.32	24.60	25.30	17.90	0.10	73.66
RFFSA	23.00 a/	-	19.30	7.60	17.90	0.10	67.90
State of R.G. do S.	0.50 a/	0.62	4.30	6.60	5.40	0.10	17.52
Municipality of P.A.	4.30 a/	-	-	-	-	-	4.30
Other(s) b/	-	1.42	4.80	7.30	4.60	0.10	18.22
Total	29.24	6.46	79.60	110.20	114.30	0.80	340.60

a/ Land
b/ See para 5.04 for an explanation of the term "other(s)".

H. Project Risk

4.11 With regard to the execution of the physical works included in the proposed project, there are no unusual risks. NEP within TRENSURB/P.A., with the technical support of RFFSA, GEIPOT, EBTU and METROPLAN, should be able to complete the project according to the agreed implementation schedule, which is considered realistic. Significant delays in this area, therefore, are not expected. With respect to the institutional and policy aspects of the project, which refer essentially to the operation and financial performance of TRENSURB/P.A. in the context of the urban structure and transport system of MRPA, more caution is warranted. (These matters are discussed in more detail in the next chapter, which deals entirely with TRENSURB/P.A.) Suffice it to say that the proposed project involves several innovations in institutions and policies in Brazil (e.g., the first metropolitan rapid rail mass transit company, the adoption of a pricing principle that allows tariffs to cover at least all operating expenses, a significant program of auto restraint measures and the diversion of a large number of car users to the railway), all of which will have to be monitored very closely. Therefore, there is a risk inherent in new undertakings of this kind. However, the Government shares the Bank's desire to have this project succeed in the institutional and policy areas and thereby serve as a model for the rest of the country. Sufficient agreements with all the agencies involved, with clearly defined commitments, have been reached during negotiations. These commitments, coupled with the technical assistance program, have reduced the risks to an acceptable level to justify the Bank's participation. During project supervision, particular attention should be given to monitoring the development of the NMTU (para 2.29) and to ensuring that the shareholding structure of TRENSURB/P.A. changes in accordance with the agreed schedule (para 5.03).

V. THE NEW METROPOLITAN RAIL MASS TRANSIT COMPANY

A. Ownership, Organization and Financial Policy

5.01 During the preparation of the proposed project, several alternative approaches to establishing the company to own and operate the suburban railway service were examined. After considering the various issues, it was agreed that the most practicable approach, at the present time, would be to initially establish the new company as a subsidiary of RFFSA (a step which does not require federal legislation but only the approval of RFFSA's Administrative Council), and then to increase, as quickly as possible, the shareholdings of some other shareholders such as EBTU, the State of Rio Grande do Sul, the municipalities of MRPA and possibly some others (e.g. BNDE), until RFFSA's shares are equaled or exceeded by those of at least one other shareholder. As long as no federal agency other than RFFSA would become the largest single shareholder, federal legislation would not be required. Thus, perhaps more gradually but with less political uncertainty, the desired result could be achieved. The intention would be to fully accomplish the shift from the status of a subsidiary of RFFSA to an independent company with a more diversified share structure well before train operations begin.

5.02 Because all the other approaches involved federal legislative action which could be lengthy with quite uncertain outcomes and because RFFSA would play the most important role during the first few years of physical implementation in any case, the subsidiary approach, as a temporary arrangement, was considered acceptable provided agreement could be reached on the time frame for achieving the desired result of an independent metropolitan rail mass transit company. This time frame was agreed.

5.03 Thus, in mid-April 1980, RFFSA created the subsidiary company of TRENSURB/P.A. RFFSA's initial participation is based on its contribution of land. Other shareholders at this time include EBTU, through its contribution of cash and the State of Rio Grande do Sul through its contributions of land. The municipality of Porto Alegre is expected to join in the next few months in exchange for its contribution of land. To confirm their commitment to establishing TRENSURB as a company, independent of RFFSA, the shareholders and the Borrower agreed during negotiations to a schedule indicating the transition of TRENSURB/P.A. from a subsidiary at the outset in which RFFSA holds 78% of the shares to a non-subsidiary legal status in which, by June 30, 1983, RFFSA would hold the same proportion of the total shares as EBTU, namely, 39%. The agreed schedule is as follows:

Cumulative Percentage Shareholding in TRENSURB/P.A.

	% by 6/30/80	% by 6/30/81	% by 6/30/82	% by 6/30/83 and thereafter
RFFSA	78	65	51	39
EBTU	5	16	31	39
The State	2	3	6	9
Municipality of PA	15	12	5	3
Other(s)	-	4	7	10

5.04 In the above schedule, the shareholder category "others" could include some other municipalities besides Porto Alegre (although their present difficult financial position makes it impossible for them to commit at this time) as well as BNDE. The prospect for BNDE's participation looks promising, but, again, no commitment can be made at this time. In the event that the balance of the total shares is not taken up, EBTU and RFFSA would take up the balance in equal proportion. Hopefully, this contingency plan would not need to be implemented, and both the other municipalities and BNDE would be able to participate in the near future. This aspect, as well as the whole matter of transition from a subsidiary status to corporate independence, would need to be carefully monitored during project supervision.

5.05 It is expected that TRENSURB/P.A. would be fully operational by the time the physical works are completed in mid-1984. Most of the details regarding TRENSURB's organizational structure, staffing, operation, etc, would be

worked out under technical assistance provided in the project (para 3.21). It is expected that because the company would be inexperienced at the outset, although considerable training during project implementation is provided in the technical assistance program, TRENSURB/P.A. would have to rely to some extent on RFFSA or on some pool of railway expertise for the provision of certain technical services. However, TRENSURB/P.A. like any other commercial enterprise, would obtain these services by entering into normal business contracts. TRENSURB/P.A. would be run as a commercial enterprise and be governed by normal financial practices. The financial analysis (para 5.16) indicates that this is a realistic principle provided that the recommended operating plan and tariff policy (paras 5.08 and 5.15) are adopted, both of which are considered reasonable, equitable and economically efficient.

B. Operations

5.06 During the initial years of operation, TRENSURB/P.A. is expected to run 11 trains per hour during the peak hours (6-8 in the morning, 12-2 in the afternoon and 5-7 in the evening) and four trains per hour during the off-peak period. Thus, the headway between trains would be about 5-1/2 minutes during the peak hours and 15 minutes during the off-peak period. Train formations are planned to consist of eight cars or two unit trains coupled together during the peak hours and four cars or one unit train during the off-peak period. The fleet requirement has been derived on the basis that, at any given time, 15% of the fleet would be in the maintenance depot and therefore unavailable. The average commercial speed of a train, which includes station stops, is expected to be about 42 km/hr. Thus, with the new train service, it should take about 38 minutes to go from one end of the line (Central Market, Porto Alegre) to the other (Sapucaia, Km 26.7).

5.07 The fleet requirement has been derived on the assumption of a maximum car capacity of 300 passengers. This implies 192 passengers standing in an area of 32 m^2 or five to six passengers/m^2. This parameter was a matter of considerable interest since comfort will be an important determinant of the extent to which the train can attract car passengers. It was generally agreed that 300 passengers per car represents a fairly good, but not excessive, level of service during the peak hours and that occupancy rates above this level should be avoided by increasing the size or frequency of trains.

5.08 To run the entire operation during the first few years of train service, it is estimated that almost 650 employees would be required (Table 3.1). These are indicative estimates which, in addition to the detailed structure and total operation of the new company, need to be studied by consultants during project implementation (para 3.21). However, because these personnel estimates, along with the projections of train operations (para 5.06), form the basis for the costing analysis (para 5.11), on which the tariff policy (para 5.15) is based, agreement was reached during negotiations on the staffing and operating plans for TRENSURB/P.A., subject to the findings and recommendations of the consultants. The agreed plans are presented below:

Staffing Plan

Levels of Daily Passenger Traffic	Ceiling No. of Staff
100,000	400
150,000	500
200,000	550
250,000	650
300,000	700
350,000	800
400,000	850
450,000	950
500,000	1,000

Initial Operating Plan a/

Operating Day	:	18 hours
Peak	:	6 hours
Off-Peak	:	12 hours
Headway between Trains		
Peak Hours	:	5.5 minutes
Off-Peak Hours	:	15 minutes
Train Composition		
Peak Hours	:	8 cars (2 unit trains)
Off-Peak Hours	:	4 cars (1 unit train)
Average Commercial Train Speed	:	42 km/hr
Average Fleet Availability	:	85%
Maximum Staff	:	650 employees

a/ Considered applicable for the first few years of operation.

C. Accounts

5.09 TRENSURB/P.A. would maintain an accounting system based on sound commercial practices. The accounts would be designed by consultants under the technical assistance program (para 3.21). During negotiations, TRENSURB/P.A. agreed that its financial statements, in addition to the project accounts, would be audited annually by independent external auditors satisfactory to the Bank and that these statements would be produced annually and furnished to the Bank within four months of the end of TRENSURB's fiscal year.

D. Assets and Liabilities

5.10 The forecast of TRENSURB's assets and liabilities in constant mid-1979 prices for the period 1985-1990 is shown in Table 5.1. TRENSURB's assets during this period are forecast to consist exclusively of the items in the proposed project, including the right-of-way and some other small parcels of land (para 3.18). In addition, it is estimated that TRENSURB would accumulate reserves, built up from its forecast net surplus, which, it is assumed, TRENSURB would hold in the form of interest-bearing bank deposits. TRENSURB's liabilities during this period are forecast to consist entirely of one long-term debt based on the loan from EBTU (para 4.07). TRENSURB's equity would consist of (a) share capital, which represents the equity contributions from TRENSURB's shareholders (para 5.03); and (b) reserves, which represent the accumulation of TRENSURB's yearly net surplus. It would not be financially prudent for the new company to enter into additional new borrowings during the first three years of operation. During negotiations, TRENSURB/P.A. agreed that that it would not enter into borrowings, other than the one mentioned above, before the fourth year of full operations, and then only if such borrowings would not result in a total annual debt service, including the loan from EBTU, which is greater than the average annual net operating income plus depreciation for either the immediately preceding two years of operation or for a later 24-month period ended prior to the incurrence of such debt service, whichever is greater.

E. Operating Costs

5.11 A forecast of TRENSURB's operating costs, in constant mid-1979 prices, at different levels of traffic, is shown in Table 3.1. During the initial period of operation when train ridership is expected to reach about 260,000 passengers daily, total working costs are estimated to be about Cr$ 2.66 per passenger. After allowing for depreciation on all fixed assets, total operating costs are estimated at Cr$ 4.82 per passenger. Depreciation, personnel, material and energy costs represent about 45%, 38%, 9% and 8% of the total operating costs, respectively. At the level of traffic forecast for 1990 (around 386,000 passengers daily), unit operating costs fall to about Cr$ 4.06 per passenger, indicating some modest economies of scale.

5.12 These estimates are based on various operating assumptions which were analyzed in considerable detail in joint discussions between the Bank and the technical experts from RFFSA and GEIPOT. In particular, staffing, which represents about 38% of the total operating costs, is a critical factor. After examining each category of work, it was mutually agreed that some 634 employees constitute a reasonably efficient but practical number of staff for the initial operation. However, if this number were to increase by 30, 60 and 100%, the cost per passenger would increase from Cr$ 4.82 to Cr$ 5.50, Cr$ 6.17 and Cr$ 7.07, respectively. A cost per passenger of Cr$ 7.07 could jeopardize the financial feasibility of the new enterprise (para 5.14). For this reason, it is imperative that the operating plan for TRENSURB (para 5.08) be carried out generally in accordance with what has been assumed.

F. Tariffs

5.13 The question arises of whether TRENSURB would be able to charge a competitive tariff and still cover its operating costs. Determining a competitive tariff for the train service is somewhat problematic since TRENSURB,

with its higher speed and greater comfort during the peak periods, would be offering a better quality of service than the bus companies and, therefore, would be competing on more than price grounds alone. Furthermore, the train would be competing with the private automobile as well, and, for these passengers, the demand for the train is fairly price inelastic; convenience in terms of station connections (e.g., satellite station parking and feeder buses), waiting time, service frequency and comfort tend to be more important. The proposed project is designed to provide present automobile users with an acceptable substitute. Nevertheless, if the train is to replace buses on many routes on which the former provide a more economical solution, the train tariff should be somewhere in line with the bus tariff even if the train provides a higher quality of service, in order that the rail tariff does not impose an additional financial burden on those who would otherwise be bus users (i.e., the lower income part of the population), which would be politically unacceptable. The task of identifying and implementing a new system of bus routes would be carried out by NMTU with technical assistance included in the project (para 3.25).

5.14 An analysis of bus tariffs in the influence area of the train indicates that, indeed, TRENSURB ought to be able to charge a tariff that covers its total operating costs (estimated at Cr$ 4.82 per passenger in constant mid-1979 prices, para 5.11) and yet is below the average bus tariff, which, in mid-1979, in the area to be served by the train, was Cr$ 7.0 per passenger. For the longest route (Porto Alegre-Esteio-Sapucaia), the fare was about Cr$ 9.0 per passenger. The minimum fare for some of the shorter routes was Cr$ 5.0 per passenger. Thus, not only could TRENSURB cover its operating costs, but it seems likely that it could also earn a return on invested capital as well and still not exceed the average bus tariff. This result can be expected to be reinforced in the future as petroleum prices rise and, other things being equal, bus costs increase more rapidly than rail costs, given the simple fact that the electric (hydrogeneration) rail service does not use this input. The question of the levels and structure of tariffs for all modes of transport in MRPA would be studied by consultants under the technical assistance program (para 3.26). Among other things, these consultants would examine the practicability of introducing distance-related and peak/off-peak rail pricing.

5.15 The administration of tariff policy should be the responsibility of TRENSURB's management. During negotiations, the Bank obtained agreement from TRENSURB that it would promptly, as necessary, seek the authorization of CIP to charge tariffs which shall provide it with revenues sufficient to cover at least all operating expenses including overhead costs, adequate maintenance expenses, taxes, depreciation and interest. During negotiations, agreement was also reached that, on the basis of a review to be undertaken not less than once every six months or whenever tariffs of passenger services competitive with those of TRENSURB are adjusted, if adjusted more frequently, the Borrower would authorize such adjustments in tariffs to permit TRENSURB to cover at least all of the above operating expenses. If economic circumstances, in the judgment of the Government, do not permit TRENSURB to charge tariffs which would cover operating expenses, the Government and TRENSURB have agreed to promptly inform the Bank of such circumstances and the tariff levels proposed.

G. Financial Results

5.16 In the indicative analysis that has been carried out, the rail tariff has been assumed to be Cr$ 6.0 per passenger, a level consistent with TRENSURB's agreed tariff policy (para 5.15), and generally constrained by average bus tariffs in the influence area. The forecasts of TRENSURB's income accounts and balance sheets in constant mid-1979 prices for the period 1985-1990 are shown in Table 5.1. TRENSURB's net surplus in 1985 expressed in mid-1979 prices is estimated at Cr$ 99.0 million or US$3.8 million. This figure is expected to increase gradually, reaching US$7.2 million in 1987. In 1988, TRENSURB's net surplus is estimated to fall to US$0.3 million because of debt service payments on the loan from EBTU (para 4.07). Thereafter, the net surplus is forecast to increase in the succeeding years. Thus, based on a tariff that is approximately equal to the average bus tariff, TRENSURB is expected to have sufficient resources to cover its operating costs, repay its debt and still have a small surplus during the period analyzed. The working and operating ratios in 1985 are estimated to be 44 and 80 respectively, improving further to 38 and 68 by 1990. TRENSURB's estimated operating profit per passenger in mid-1979 prices is forecast to increase from Cr$ 1.18 in 1985 to Cr$ 1.94 in 1990. This profit corresponds to a return on revalued net fixed assets of 1.5% and 4.3% in 1985 and 1990 respectively. By 1995, this return is forecast to reach 8%.

5.17 Of course, if the costs of operation are higher, as indicated in the sensitivity tests (para 5.11), the financial results deteriorate significantly. With a cost per passenger of Cr$ 7.07 corresponding to a 100% increase in staff, TRENSURB's working and operating ratios in 1985 increase from 44 and 80, respectively, to 75 and 111. If, in addition, the tariff is set at Cr$ 3 instead of Cr$ 6, the working and operating ratios increase further to 149 and 221. (More details of this sensitivity analysis are presented in Table 5.2.) There is no doubt that the attainment of the goals set forth in the operating plan (para 5.08) and the adoption of an economic tariff policy are essential to the financial success of the new company.

5.18 In addition, TRENSURB's estimated operating revenues refer only to the proceeds of passenger fares. TRENSURB may also generate additional revenues from other sources such as satellite car parking fees and from the leasing of commercial space inside the stations. Projections of these revenues have not been made. The matter of parking fees would be part of the overall tariff study included in the technical assistance (para 3.26).

VI. ECONOMIC ANALYSIS

A. Alternatives

6.01 For the economic analysis, five mutually exclusive project alternatives were analyzed: six, if one considers the base case, i.e., without project situation. The five project alternatives include: (i) the removal of the existing tracks and the construction of an express busway in the present railway right-of-way; (ii) the improvement of the existing antiquated diesel railway service; (iii) a rail mass transit system (i.e., the proposed project); (iv) a light rail system; and (v) a new road with a bus expressway.

6.02 For each of the five project alternatives, a net present value (NPV) was calculated. 1/ The alternative with the highest NPV represents the preferred solution. The rate of return for this solution was then calculated. This analysis established the superiority of the proposed project or alternative (iii). A summary of the analysis follows.

6.03 All prices used in the analysis, both on the benefit and cost sides, exclude taxes and are held constant at mid-1979 levels. The economic costs for each proposed project alternative consist of the capital investment costs plus the incremental road and/or rail maintenance costs. Physical contingencies are included in the capital cost estimates. Summaries of the capital investment costs distributed over the implementation period of each project alternative and the right-of-way maintenance costs are presented in Tables 6.1 through 6.5.

6.04 The benefits associated with each project alternative were calculated as follows: first, each project alternative implies a different transport system, the characteristics of which were specified (for all practical purposes, the transport system in each case is limited to the north-south corridor, which fairly well defines the total area of influence for all the alternatives); second, the travel demand in the corridor associated with each project alternative was estimated (as explained in paragraph 2.30, one land use scenario was adopted as the base to forecast trips for the without project situation and project alternatives (i), (ii), and (v), and another land use scenario was adopted as the base to forecast trips for alternatives (iii) and (iv)) 2/; third, all the transport costs associated with meeting the forecast travel demand in the corridor under each alternative transport system (i.e., project alternative) were calculated; fourth, the transport costs associated with meeting the forecast travel demand in the corridor without any of the project alternatives (i.e., the base case transport system) were calculated; and last, for each project alternative, the costs under step three were subtracted from the costs under step four to obtain the cost savings or benefits associated with each project alternative. The types of transport costs which were compared for the benefit calculation include vehicle operating and passenger travel time (including transfer or walk/wait time) costs. Summaries of these costs over the life of each project alternative and in the base case are given in Tables 6.2 through 6.6. The unit cost basis for the road and rail operating cost calculations are derived and presented in Tables 6.7 and 6.8. The derivation of the value of passenger travel time is given in Table 6.9. The highlights of the base case, project alternatives, and results are presented below.

1/ When comparing mutually exclusive alternatives, the rate of return criterion may give ambiguous results. Thus, net present value was used.

2/ Since the two alternative land use scenarios do not involve different overall rates of economic growth for the region, and, thus, the total number of trips is the same for both alternatives, it was not necessary to deal with the question of generated traffic. The differences in the distribution of trips, trip lengths and modal composition arising from the different spatial distributions of growth under each land use alternative are accounted for in the calculation of transport costs.

6.05 The base case or without project situation, which is compared with each alternative, essentially refers to the existing transport system with committed operational and physical improvements. The most important committed improvements for the north-south corridor include pavement repair, the installation of lights and signals and the erection of barriers for the creation of an express bus lane on Avenida Farropas which connects BR-116 with downtown Porto Alegre. These improvements are being made under the Bank's First Urban Transport Project (Annex 1).

(i) Bus Expressway in the Railway Right-of-Way

6.06 This alternative involves the removal of the existing tracks and the construction of an exclusive bus expressway (25 km) in the existing railway right-of-way plus the relocation of the existing freight line to the side of the new expressway. An elevated road access to the CBD of Porto Alegre is also included. In considering the present solution, two alternative designs were examined: three and four lanes. Since some sections of the railway right-of-way are quite narrow, some expropriation of land and demolition of buildings would be required for both designs but more for the four-lane solution. These costs have been taken into account. The three-lane alternative was found to have a higher NPV than the four-lane alternative. Thus, the three-lane design was adopted for comparison with the other alternatives. For this alternative, one can begin to see an appreciable reduction in the level of operating and passenger travel time costs when compared with the base case. However, because of the large number of buses circulating in the densely developed CBD of Porto Alegre during the peak periods, congestion costs, as reflected in vehicle operation (as well as environmental costs, such as air and noise pollution, which have not been quantified), in this central area begin to rise quite steeply.

(ii) An Improved Diesel Train Service

6.07 Under this alternative, the existing track system, which is over 100 years old, would have to be totally replaced and all new installations provided. Because of the existing state of the railway, this alternative is almost equivalent to starting from nothing. The present alternative also includes an urban access line to Mercado Station on Avenida Maua as in alternative (iii) following. The use of diesel locomotives in a densely developed urban area would involve some additional environmental costs in terms of noise pollution that should be kept in mind but which have not been formally taken into account in this analysis. From the outset, under this alternative, the diesel rail system would have to operate at full capacity during the peak hours (estimated at 12 trains per hour in one direction). Despite this consideration, the road system in the corridor (basically BR-116) would still have to absorb the major share of passenger trips because of the large total demand. Furthermore, the diesel system is not expected to be competitive with the private automobile. Its ridership would be drawn essentially from bus users. Under these conditions, road transport costs in the corridor are expected to increase quite rapidly, especially after 1990.

(iii) Rail Mass Transit System (Proposed Project)

6.08 The proposed project is described in detail in Chapter IV. The economic capital investment costs are shown in Table 6.3. Rail passenger-km costs under the present alternative are estimated to be about 25% higher

than under the diesel alternative. However, road transport costs in the corridor under this alternative are substantially lower than under the diesel rail alternative because of the rail mass transit system's higher capacity and ability to divert car passengers from the road system. This alternative also has considerably less congestion cost in the CBD than any of the other alternatives, essentially because of the high capacity, non-stop, and fixed right-of-way characteristics of the urban rail connection.

(iv) Light Rail

6.09 Light rail systems are sometimes considered prior to introducing a full rapid rail mass transit system. They sometimes involve a fixed right-of-way, but not always. Monorails, most often seen in airports, are illustrative of the former type, whereas the trolley-bus controlled by overhead cables is an example of the latter. In the Porto Alegre Metropolitan Region, it is quite clear that the long distances involved and the large population to be served make the monorail solution, with its very limited capacity, impractical. Also, the population density in a fairly narrow band along the existing railway right-of-way is quite high, suggesting that there is probably no advantage to deviating from this route. Thus, the system chosen to be tested has essentially the same overall design as alternative (iii) but a lower capacity (approximately one-third, or 17,000 passengers per hour in one direction), resulting mostly from the use of smaller and lighter unit trains and from the substitution of automatic level crossing guards for many of the vehicle under/over passes. The type of unit train considered is the one now in use on a branch line in the Rio de Janeiro suburbs. Under the present alternative, car passengers are expected to divert to the train in approximately the same proportion to the total train passengers as in alternative (iii). Rail passenger-km costs are only slightly higher than for the full rail mass transit system, alternative (iii). However, given the limited capacity of the light rail system, road vehicle operating costs are forecast to rise quite substantially.

(v) New Road with Exclusive Bus Expressway

6.10 Because of soil, flood and present land use conditions, it is impossible to construct a new road close to the centers which would be served by all the other project alternatives without considering a totally elevated highway, which would be prohibitively expensive, esthetically unattractive and generally unacceptable to local authorities. The alignment chosen, therefore, was the one once proposed for a new road in this corridor, i.e., the Porto Alegre-Scharlau highway (para 2.21). This highway would run from Porto Alegre (starting on Avenida Assis Brasil at the intersection with BR-290) to Scharlau following a route, which, on average, is about 6 km to the east of BR-116 and which crosses BR-116 just north of Sapacaia. To compensate for the lack of access to the same urban centers served by the other alternatives, four lateral road connections with lengths of 5, 4, 3 and 2 km each were included in this alternative. The road would have six lanes and be 24 km long. Under this alternative, road transport costs in the north-south corridor (excluding intramunicipal trips) are forecast to rise from Cr$ 2,410 million in 1985 to Cr$ 5,645 million in 2000. These relatively large numbers reflect the large growth in private automobile traffic on the road system and in the central area of Porto Alegre that is expected to occur with the provision of more road capacity, a phenomenon that is experienced worldwide.

(vi) Results

6.11 The NPV associated with each of the five project alternatives is presented below:

Project Alternative	(i)	(ii)	(iii)	(iv)	(v)
NPV (Cr$ million) at 11%	5,269	4,409	7,070	2,362	3,388

It is interesting to note that all of the mutually exclusive project alternatives have a positive NPV. This result is not surprising in view of the fact that, without any of the project alternatives (para 6.05), the Region's only north-south trunk road, BR-116, an already congested arterial (para 2.26), would become completely saturated, and, as speeds diminished further, road transport costs would rise very steeply. A major increase in transport capacity in the corridor is clearly justified. The analysis shows that, among the five alternatives, the full rail mass transit system, alternative (iii), is the preferred solution with an NPV of Cr$ 7,070 million, which is about 34% higher than the second best solution, alternative (i), the construction of a new bus expressway in the present railway right-of-way.

6.12 The rate of return for alternative (iii) is 24%, and the first year rate of return is 11%, indicating that the proposed project is well justified and that the starting date is optimal. The considerable spread between the first year rate of return and the rate of return over the project's economic life is basically explained by the fact that the benefits are quite substantial in the later years as road transport costs in the base case relative to the project situation build up quite rapidly.

6.13 Petroleum savings, which are accounted for in the benefits as part of the road vehicle operating cost savings, are worth mentioning separately. In 1985 (the first full year of train operations), the proposed project, when compared with the base case, would result in petroleum (diesel fuel and gasoline) savings of some 20.7 million liters, increasing to about 47.8 million liters in 1990 and to about 63.4 million liters by the year 2000. In terms of constant mid-1979 prices, these savings amount to US$5.5 million for 1985, US$13.8 million in 1990 and US$20.5 million in 2000. Such savings arise from the substitution of passenger trips made in electric powered (hydrogeneration) unit trains for trips which would otherwise be made in cars and buses and from less congested (more fuel-efficient) traffic conditions for the vehicle fleet on the existing road system. The above savings in 1985, 1990 and 2000 represent about 2.5, 6.0 and 7.7%, respectively, of the total annual gasoline and diesel oil consumption in MRPA at the present time. These percentages would be even smaller if the savings were compared with estimates of total consumption in MRPA in the same future years. Thus, while these savings are substantial and are a part of the justification for the proposed project, when compared with total gasoline and diesel oil consumption in MRPA, let alone in the State and entire country, the impact is relatively small. The facts simply do not permit one to argue that the proposed project makes a significant contribution to reducing the country's dependence on imported oil--a claim often made to justify projects like the one proposed. The proposed project should be, and has been, justified on the basis of a total benefit-cost analysis.

B. Risk and Sensitivity Analysis

6.14 The following sensitivity tests were performed:

(a) a 15% increase in the capital investment costs of each project alternative;

(b) the elimination of all passenger travel time benefits from all the alternatives;

(c) a shortfall in the forecast of car passenger diversion to the suburban railway in alternatives (iii) and (iv); specifically, in alternative (iii), 10% of total intermunicipal corridor car passengers are assumed to divert to the railway over the entire life of the project instead of, as originally forecast, 10% in 1985, increasing to 25% in 1990 and remaining at that rate until 2000 (the same relative decrease for alternative (iv)); and

(d) a 15% decrease in the total benefits associated with each project alternative.

6.15 These changes tend to cover the most likely types and magnitudes of risk associated with the various project alternatives as well as the concern sometimes expressed that transport projects in developing countries should be justified on resource grounds without consideration of time savings (sensitivity test (b)). The results are summarized below:

Net Present Value
(Cr$ million, mid-1979)

Project Alternative / Sensitivity Test	(i)	(ii)	(iii)	(iv)	(v)
(a)	5,000	4,135	6,641	1,960	2,975
(b)	855	778	2,681	-649	-419
(c)	5,269	4,409	5,903	2,175	3,388
(d)	4,214	3,458	5,564	1,597	2,469

Note: at 11% rate of discount

6.16 Under all the sensitivity tests, the ranking of project alternatives remains the same as in the base case with the proposed project, alternative (iii), clearly emerging as the most economical solution. It is interesting to note that, under sensitivity test (b) (without passenger travel time savings), project alternatives (iv) and (v) (the light rail and new road solutions) become uneconomical. Also, with a shortfall in the diversion of automobile users to the suburban railway (sensitivity test (c)), the rail mass transit alternative maintains its superiority but is only marginally better (12% higher NPV) than alternative (i). Clearly, automobile diversion is an essential component of the proposed project. The rates of return for alternative (iii) under sensitivity tests (a),(b),(c) and (d) are 22%, 17%, 19% and 22%, respectively.

C. Distributional Impact

6.17 In order to assess the equity or distributional impact of the project, it is necessary to identify how the benefits are distributed among the different income groups that are affected by the project. First, it should be

noted that passenger travel time savings for all modes and automobile vehicle operating cost savings accrue directly to the users, whereas public vehicle operating cost savings accrue directly to the bus companies. However, to the extent that there is effective competition among the bus companies in MRPA (and evidence suggests that there is), one can reasonably assume that bus tariffs would be lower under a regime of lower operating costs than what they would otherwise be without the project. Further, fare regulation relates tariff increases to operating costs. Thus, users of buses also benefit from reductions in bus vehicle operating costs, although somewhat indirectly.

6.18 While it was not possible to obtain a detailed income profile of the entire beneficiary population, average income by general user group has been estimated and is considered indicative. It is estimated that the average bus passenger has an average monthly income which is approximately two times the minimum wage, or Cr$ 4,200 and that the average car user has a monthly income which is about seven times the minimum wage, or Cr$ 14,700. Train passengers consist of persons who would otherwise travel by car or bus. (Over the life of the project, potential car and bus users are, on average, expected to comprise 19% and 81% of the total train ridership.) Therefore, the benefits that have been measured (passenger travel time savings, car operating cost savings and bus operating cost savings), can be related to two beneficiary groups with incomes corresponding to the average automobile and bus user. The distribution of benefits among these two income groups is as follows:

% of Total Project Benefits

Average Income Cr$	Time Savings	Car Operating Cost Savings	Bus Operating Cost Savings	Total
4,200	34	0	39.5	73.5
14,700	8	18.5	0	26.5
	42	18.5	39.5	100.0

6.19 As can be seen from this analysis, almost three-fourths of the total project benefits are expected to accrue directly or indirectly to the lowest income group. At least 34% is expected to accrue directly to this group in the form of less travel time. Thus, the project may be said to have quite desirable distributional effects.

VII. AGREEMENTS REACHED AND RECOMMENDATION

7.01 During negotiations, agreement was reached with the concerned parties on the following:

I. With the Federative Republic of Brazil (Loan Agreement)

(a) to, not less than once per year, through EBTU, inform the Bank of its National Urban Transport Investment Plan (para 1.19);

(b) to not implement the Porto Alegre-Scharlau Highway Project until a proper feasibility study, satisfactory to the Bank, is completed and shows that this project is economically justified (para 2.21);

(c) to, on the basis of an existing agreement with the Municipality of Porto Alegre, cause the latter to implement the agreed parking restrictions program for the CBD of Porto Alegre (para 3.19);

(d) to onlend the Bank loan to TRENSURB/P.A. on the agreed terms (para 7.02(b) following) (para 4.07);

(e) to, on the basis of a review to be undertaken not less than once every six months or whenever tariffs of passenger services competitive with those of TRENSURB are adjusted, if adjusted more frequently, authorize such adjustments in tariffs that would permit TRENSURB to cover at least all of its operating expenses as set out in the agreement under V(e) following (para 5.15); and

(f) to take all action as necessary to assist in ensuring that all other agreements under V following are fully complied with.

II. With EBTU (Joint Project Agreement)

(a) to employ consultants, by December 31, 1980, to improve its internal accounting, budgeting and control procedures and to discuss with the Bank the consultants' recommendations (para 1.15);

(b) to review and discuss with the Bank any proposals to substantially change its investment policy statement which was discussed during negotiations and recently approved by EBTU's Administrative Council (para 1.19); and

(c) to inform the Bank through 1988 of any proposed passenger transport-related investments exceeding US$10 million to be undertaken in the influence area of the Bank project, provide the Bank with information regarding the expected impact on the Bank project and consult with the Bank prior to making a commitment (para 2.21).

III. With the State of Rio Grande do Sul (Joint Project Agreement)

(a) to cause the newly created NMTU to carry out its agreed functions (para 2.28);

(b) to provide the necessary personnel to enforce the parking restrictions program for the CBD of Port Alegre, set out in the agreement under I(c) above (para 3.19); and

(c) to discuss with the Bank the recommendations of the consultants on auto restraint measures for MRPA when they become available and, through NMTU, proceed to implement an appropriate plan of action as a result (para 3.24).

IV. With EBTU, RFFSA, GEIPOT and METROPLAN (Joint Project Agreement)

(a) to provide the necessary technical services to NEP within TRENSURB/P.A. (para. 4.02).

V. With TRENSURB/P.A. (Joint Project Agreement)

(a) to accomplish the shift in TRENSURB's status from a subsidiary of RFFSA to a more diversified share structure according to the agreed schedule (para 5.03);

(b) to carry out the agreed operating and staffing plans (para 5.08);

(c) to have its accounts, including those with respect to the proposed project, audited annually by independent external auditors satisfactory to the Bank, and to have these accounts produced annually, and furnished to the Bank within four months of the end of TRENSURB's fiscal year (para 5.09);

(d) to not enter into borrowings, other than the loan with EBTU, before the fourth year of full operations, and then only if such borrowings would not result in a debt service which is greater than the average annual net operating income plus depreciation for either the immediately preceding two years of operation or for a later 24-month period ended prior to the incurrence of such debt service, whichever is greater (para 5.10); and

(e) to promptly, as necessary, seek the authorization of CIP to charge tariffs which shall provide it with revenues sufficient to cover at least all operating expenses, including overhead costs, adequate maintenance expenses, taxes, depreciation and interest (para 5.15).

7.02 As conditions for loan effectiveness of the proposed loan agreement, the following should be accomplished:

(a) the establishment of NEP within TRENSURB with staff satisfactory to the Bank (para 4.01); and

(b) the signing of the Subsidiary Loan Agreement, on the agreed terms, between EBTU and TRENSURB/P.A. (para 4.07).

7.03 With the agreements and understandings obtained, the proposed project would be suitable for a Bank loan of US$159.0 million. The loan would be amortized in 15 years, including a three-year grace period.

April 17, 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Urban and Regional Population Size in Brazil

(1872-1970)

Year	Total Population (000)	Urban Population (Percent of Total)		Regional Population (Percent of Total)			Regional Urban Population b/ (Percent of Region)		
		Official a/ Definition	Municipalities of 20,000 or more	Northeast	Southeast	Frontier	Northeast	Southeast	Frontier
1872	9,931	N.A.	7.9	46.7	47.7	5.6	N.A.	N.A.	N.A.
1900	17,434	N.A.	10.0	38.7	55.2	6.1	N.A.	N.A.	N.A.
1940	41,236	31.2	16.0	35.0	58.4	6.6	N.A.	N.A.	N.A.
1950	51,944	36.2	21.1	34.6	58.5	6.9	26.4	42.9	28.0
1960	70,119	45.6	28.1	31.6	60.5	7.9	34.0	52.9	37.1
1970	93,140	55.9	38.8	30.2	60.5	9.3	41.8	64.4	46.8

a/ Officially, urban places are defined according to political administrative criteria. This administrative definition leads to a larger urban share than would be the case with a specific size limit, as the data in the third column, based on 20,000 or more inhabitants, indicates.

b/ Official definition.

Source: Bank Report, Brazil Division, Human Resources Special Report

January 1980

TABLE 1.1

TABLE 1.2

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Motorization Rates in Selected Urban Areas

Urban Areas	(Automobiles/1,000 inhabitants) 1970	1975	1977
Metropolitan Areas of Rio de Janeiro and Sao Paulo	61.4	103.1	111.1
Metropolitan Areas of Recife, Porto Alegre, Belo Horizonte and Salvador	43.9	68.5	75.8
Metropolitan Areas of Curitiba, Fortaleza and Belem	39.5	69.4	N.A.
Capital Cities outside the Metropolitan Areas	33.6	74.1	85.5
Medium Sized Cities	45.3	90.1	102.0
Brazil	25.0	52.1	59.9

Source: Ministerio Dos Transportes, GEIPOT, Plano Nacional de Tranportes, Diagnostico, VIII.

January 1980

TABLE 2.1

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Population by Municipality in the MRPA (1970, 1974, 1979)

Municipalities	1970		1974		1979	
	Number	%	Number	%	Number	%
Alvorada	40,376	2.64	66,340	3.56	101,000	4.24
Cachoeirinha	31,020	2.03	46,370	2.49	78,000	3.28
Campo Bom	16,621	1.09	23,320	1.25	34,000	1.43
Canoas	153,823	10.04	188,080	10.09	241,000	10.13
Estancia Velha	8,896	0.58	11,890	0.64	15,000	0.63
Esteio	34,587	2.26	40,390	2.17	53,000	2.23
Gravatai	52,454	3.42	71,570	3.84	118,000	4.96
Guaiba	33,692	2.20	43,740	2.35	69,000	2.90
Novo Hamburgo	85,353	5.57	104,960	5.63	139,000	5.84
Porto Alegre	885,944	57.84	1,015,710	54.51	1,217,000	51.12
Sao Leopoldo	64,309	4.20	72,910	3.91	94,000	3.95
Sapiranga	16,403	1.07	23,380	1.25	30,000	1.26
Sapucaia do Sul	41,750	2.73	58,690	3.15	89,000	3.74
Viamao	66,375	4.33	96,150	5.16	102,000	4.29
MRPA TOTAL	1,531,603	100.00	1,863,500	100.00	2,380,000	100.00

Source: METROPLAN 1979

January 1980

TABLE 2.2

BRAZIL

SECOND URBAN TRANSPORT PROJECT

The Location of Population Within the MRPA
(1970, 1974, 1979)

Location	1970		1974		1979	
	Number	%	Number	%	Number	%
North-South Corridor	421,742	27.54	523,620	28.10	695,000	29.2
East-West Corridor	157,542	10.29	228,020	12.24	366,000	15.4
Porto Alegre	885,944	57.84	1,015,710	54.51	1,217,000	51.1
Viamao	66,375	4.33	96,150	5.16	102,000	4.3
MRPA	1,531,603	100	1,863,500	100	2,380,000	100

Source: METROPLAN, 1979

November 1979

TABLE 2.3

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Sectoral Distribution of Employment in the MRPA
(1971-1976)

Sector	1971 % of total	1973 % of total	1976 % of total
Primary	7	5	4.5
Secondary	39.3	34.5	33.5
Tertiary	53.7	60.5	62
Total	439,262	503,851	608,764

Source: METROPLAN

November 1979

TABLE 2.4

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Spatial and Sectoral Distribution of Employment in the MRPA
(1973)

Location	Secondary Sector		Tertiary Sector		Total	
	Number	%	Number	%	Number	%
North-South Corridor	73,113	43.17	35,591	11.68	108,704	22.93
East-West Corridor	10,266	6.06	8,180	2.69	18,446	3.89
Porto Alegre	85,813	50.66	258,193	84.75	344,006	72.57
Viamao	185	0.11	2,687	0.88	2,872	0.61
Total MRPA	169,377	100.00	304,651	100.00	474,028	100.00

Source: METROPLAN, 1979

November 1979

TABLE 2.5

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Distribution of Household Income By Municipality in the MRPA

(In Percent)

Municipalities	Income Classes			
	Cr$ 0-1,810	Cr$ 1,811-5,410	Cr$ 5,411-21,050	Above Cr$ 21,050
Alvorda	8	63	28	1
Cachoeirinha	3	50	43	4
Campo Bom	3	47	43	7
Canoas	4	46	42	8
Estancia Velha	6	50	37	7
Esteio	6	43	43	8
Gravatai	7	55	34	4
Guaiba	7	53	33	7
Novo Hamburgo	4	41	43	12
Porto Alegre	3	30	43	24
Sao Leopoldo	5	42	38	15
Sapiranga	3	38	51	8
Sapucaia do Sul	8	57	32	3
Viamao	10	60	28	2
Total MRPA	4	38	41	17

Note: 1974 distribution in terms of 1979 prices

Source: METROPLAN, 1979

November 1979

TABLE 2.6

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Road Transport Infrastructure in the MRPA

BR-290	Km	Number of Lanes
S.Antonio da Patrulha/Gravatai -Interseçao RS-118(Gravatai)	32	4
Interseçao 118-Porto Alegre	21	4
Common section with BR-116	16	2
BR-116 - Guaiba/Arroio dos Ratos	36	2
BR-116		
Interseçao BR-290 - Guaíba/Barra do Ribeiro	22	2
Porto Alegre - Canoas	14	4 + 2 service lanes
Canoas - Esteio	7	4 + 2 service lanes
Esteio - Sao Leopoldo	9	4 + 2 service lanes
Sao Leopoldo - Acesso Novo Hamburgo	8	4
Novo Hamburgo - Estancia Velha/ Ivoti	4	2
BR-386		
Canoas/Montenegro - BR-116(Canoas)	19	2
BR-122		
Interseçao BR-116(Scharlau)-Sao Leopoldo/Portao	6	2
RS-239		
BR-116(Novo Hamburgo) - Sapiranga/Taquara	31	2
RS-118		
BR-116(Esteio/Sapucaia do Sul) -BR-290(Gravatai)	22	2
BR-290(Gravataí) - ES-040	17	2
[illegible]		
BR-[illegible](Porto Alegre) - Grava- [illegible]		
RS-020		
RS-030(Cachoeirinha) - Gravataí/ /Taquara	27	2
RS-040		
Av. Antonio de Carvalho(P.A.) -RS-118 (Viamao)	17	2
RS-118(Viamao) - Viamao/Osorio	48	2

Source: DNER, Porto Alegre

January 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Number, Type and Fleet Size of Municipal and Intermunicipal Bus Companies in the MRPA
(1979)

LOCAL	Type of Company					Fleet Size	Average Fleet/Company
	Number of Companies	Private Corporation	Public/ Private Corp.	Partnership	Individual		
Inter-municipal - total	10	3	-	7	-	1,168	117
Municipal							
Porto Alegre	22	-	1	21	-	1,500	68
Alvorada	1	-	-	1	-	11	11
Campo Bom	1	-	-	1	-	7	7
Canoas	1	-	-	1	-	68	68
Gravatai	1	-	-	1	-	8	8
Novo Hamburgo	2	-	-	2	-	85	42
Sao Leopoldo	4	-	-	4	-	37	9
Total	42	3	1	38	-	2,904	69

Source: Cadastro das Empresas de Transporte Coletivo.

January 1980

TABLE 2.7

TABLE 2.8

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Vehicle Occupancy, Trip Distance, Speeds and Fares by Mode in the MRPA
(1979)

VEHICLE	Passenger Vehicle Occupancy (pass/veh) Principal Direction	Other Direction	Daily Average	Average Pass Trip Distance (km)	Average Speed (km/hr)	Fares (Cr$/pass-km)
Automobiles			1.33	9		
Peak	1.66	1.27			30	-
Off-peak	1.27	1.27			45	
Urban bus			45	13		0.2048
Peak	85	30			15	
Off-peak	40	40			20	
Interurban bus			42	21		0.3058
Peak	81	15			20	
Off-peak	40	40			50	
Taxi						Cr$ 10 + Cr$ 4.0/km
Peak	2.32 (includes driver)			9	30	
Off-peak					50	
Train (at present)	178/train			12	29	0.1666

Source: GEIPOT, Porto Alegre

January 1980

BRAZIL

[illegible] URBAN TRANSPORT PROJECT

Vehicle Registration by Municipality in the MDPA

(1970-1979)

Municipality	CARS 1970	CARS 1975	CARS 1979	CARS Compound Annual Growth 70-79	BUSES 1970	BUSES 1975	BUSES 1979	BUSES Compound Annual Growth 70-79	TAXIS 1975	TAXIS 1979	TAXIS Compound Annual Growth 70-79	MOTORCYCLES 1970	MOTORCYCLES 1979	MOTORCYCLES Compound Annual Growth 70-79	TRUCKS 1970	TRUCKS 1975	TRUCKS 1979	TRUCKS Compound Annual Growth 70-79	TOTAL 1970	TOTAL 1975	TOTAL 1979	TOTAL Compound Annual Growth 70-79
Alvorada	383	1,056	2,475	22.0	52	110	140	14.0	60	60	0.0	36	106	14.4	123	455	900	17.1	714	2,403	3,395	20.0
Carbonatrinho	415	2,112	3,199	29.0	12	26	28	9.6	72	96	7.4	15	115	29.0	60	423	600	30.0	504	2,633	3,904	20.0
Canoas	681	1,263	2,468	17.6	5	16	23	21.0	36	-	-	104	104	7.2	105	102	107	7.5	895	1,606	2,630	15.0
Gravaí	5,663	8,211	14,660	13.3	150	149	271	7.0	176	177	0.4	319	380	0.3	1,087	2,006	2,630	12.7	7,395	10,542	18,475	12.5
Estancia Velha	365	630	1,386	18.0	3	4	4	3.7	9	9	0.0	21	40	10.9	80	108	136	5.5	478	971	1,562	16.0
Esteio	1,236	2,519	3,883	15.5	31	75	95	15.0	45	45	0.0	76	116	5.5	528	640	770	4.0	1,878	3,886	4,900	12.0
Gravataí	1,885	2,564	6,436	11.7	101	132	184	7.0	140	183	1.2	76	106	4.5	410	525	640	5.0	2,470	3,380	5,580	16.4
Guaíba	1,504	2,428	3,380	11.2	53	71	106	9.1	45	55	0.9	56	206	17.5	400	566	660	3.8	2,104	3,190	4,692	10.0
Novo Hamburgo	3,197	10,511	15,073	22.0	75	125	138	7.0	111	131	5.7	700	977	4.2	581	1,023	1,199	9.5	4,561	11,770	18,300	19.0
Porto Alegre	81,061	132,496	176,036	10.6	1,250	1,510	1,905	5.4	3,917	3,917	0.0	1,650	4,040	15.6	6,307	7,475	8,030	3.0	90,167	145,388	195,468	10.2
Sao Leopoldo	2,924	7,661	12,366	19.9	80	121	180	10.7	116	118	0.0	88	400	26.0	400	919	1,130	11.4	3,572	8,819	14,202	16.9
Sapiranga	662	1,556	2,395	17.1	6	7	10	6.6	20	18	-	60	241	13.4	119	164	213	7.5	865	1,967	2,877	15.7
Sapucaia do Sul	750	892	3,109	19.5	20	10	40	9.1	36	-	-	25	127	22.0	111	138	305	13.5	906	1,116	3,581	18.7
Viamão	1,970	2,360	5,063	11.4	123	163	281	7.0	119	126	1.3	117	166	2.9	668	386	711	0.7	2,878	3,377	5,807	9.2
TOTAL	102,716	177,470	251,320	12.1	1,960	2,549	3,330	6.0	4,930	4,933	-	3,366	8,066	11.5	11,366	15,069	17,802	6.0	110,337	110,077	205,519	11.5

Source: GEIPOT, Porto Alegre

January 1980

TABLE 2.1

TABLE 2.10

BRAZIL

SECOND URBAN TRANSPORT PROJECT

The Availability and Cost of Parking in the Porto Alegre Central Business District (CBD)[a/]
(1979)

Type of Parking	Street	Parking Lot	Garage
Number of Spaces	3,240	1,587	10,000
Tariff	-	Cr$ 10/4 hrs.	Cr$ 25/4 hrs.

[a/] Includes first ring road circling the CBD

Source: GEIPOT, Porto Alegre

January 1980

TABLE 2.11

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Private Automobile Owner/User Charges in the MRPA
1979

Sales Tax	
State of Rio Grande do Sul (Consumer's Tax)	14%
Federal (Manufacture's Tax)	27%
Property Tax	
50-60 horsepower	Cr$ 3,450
69-100 horsepower	Cr$ 5,000
User Tax (Gasoline)	22%
Compulsory Insurance (Average Vehicle)	Cr$ 435.10

Source: GEIPOT, Porto Alegre

January 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Modal, Purpose and Time Distribution of Passenger Trips in the MRPA
(1979)

Mode of Transport[a/]	Purpose[e/]	Number of Daily Trips	Hours (% of Total Daily Trips) 6-7	7-8	12-13	13-14	17-18	18-19	0-24
Total[b/]	Total	1,951,600	13.59	11.43	18.03	6.47	11.75	11.22	100
	Residence	950,039	0.47	0.35	9.62	0.70	10.12	8.14	48.68
	Work	662,763	10.7	7.36	5.61	4.10	0.54	0.41	33.96
	Study	267,955	2.19	3.28	2.40	1.09	0.83	2.52	13.73
	Others	70,843	0.21	0.45	0.40	0.58	0.26	0.16	3.63
Public (Bus and Taxi)[c/]	Total	1,338,798	10.67	6.96	11.48	3.89	8.64	7.92	68.60
	Residence	656,713	0.40	0.20	5.97	0.51	7.51	5.82	33.65
	Work	446,331	8.33	4.43	3.43	2.19	0.39	0.26	22.87
	Study	192,818	1.80	2.08	1.87	0.75	0.63	1.77	9.88
	Others	43,130	0.14	0.25	0.20	0.45	0.11	0.07	2.21
Private[d/] (Cars and others)	Total	586,456	2.86	4.40	6.29	2.53	2.83	3.05	30.05
	Residence	280,445	0.07	0.15	3.49	0.18	2.43	2.26	14.37
	Work	211,358	2.35	2.89	2.12	1.89	0.13	0.13	10.83
	Study	67,915	0.38	1.17	0.50	0.33	0.13	0.56	3.48
	Others	26,737	0.07	0.20	0.18	0.13	0.14	0.09	1.37

a/ Train trips at present, under the practically non-existent service of two trains daily in each direction, are negligible; approximately 700 passengers daily.

b/ Includes trips on foot which account for about 1.4% of total daily trips.

c/ Of which about 1.6% of total daily trips or about 2.4% of total trips in public vehicles are made in taxis.

d/ Of which 27.5% of total daily trips or 92% of all trips in private vehicles are made in cars.

e/ Defined with respect to destination.

Source: Based on unpublished computer printout from the Plano Diretor de Transportes Urbanos de Regiao Metropolitana de Porto Alegre-1976, and adjusted for a larger estimated absolute number of trips in 1979.

January 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Municipal Shares in Trip Generation in the MRPA
(1979)

MUNICIPALITIES	Population 1979		Daily Trips by Origin						Trips/inhabitants/day		
	Number	%	Intra	%	Inter	%	Total	%	Intra	Inter	Total
Porto Alegre - CBD	62,692	2.63	15,046	0.77	251,395	12.88	266,441	13.65	0.24	4.01	4.25
Rest of Porto Alegre	1,154,308	48.49	727,214	37.26	323,206	16.56	1,050,420	53.82	0.63	0.28	0.91
Alvorada	101,000	4.24	7,070	0.36	29,290	1.50	36,360	1.86	0.07	0.29	0.36
Cachoeirinha	78,000	3.28	11,700	0.60	21,840	1.12	33,540	1.72	0.15	0.28	0.43
Campo Bom	34,000	1.43	12,580	0.64	3,740	0.19	16,320	0.84	0.37	0.11	0.48
Canoas	241,000	10.13	79,530	4.08	62,660	3.21	142,190	7.29	0.33	0.26	0.59
Estancia Velha	15,000	0.63	3,750	0.19	2,400	0.12	6,150	0.32	0.25	0.16	0.41
Esteio	53,000	2.23	11,660	0.60	15,900	0.81	27,560	1.41	0.22	0.30	0.52
Gravatai	118,000	4.96	27,140	1.39	17,700	0.91	44,840	2.30	0.23	0.15	0.38
Guaiba	69,000	2.90	20,700	1.06	5,520	0.28	26,220	1.34	0.30	0.08	0.38
Novo Hamburgo	39,000	5.84	77,840	3.99	13,900	0.71	91,740	4.70	0.56	0.10	0.66
Sao Leopoldo	94,000	3.95	47,000	2.41	23,500	1.20	70,500	3.61	0.50	0.25	0.75
Sapiranga	30,000	1.26	9,300	0.48	9,000	0.46	18,300	0.94	0.31	0.03	0.34
Sapucaia do Sul	89,000	3.74	12,460	0.64	22,250	1.14	34,710	1.78	0.14	0.25	0.39
Viamao	102,000	4.29	11,220	0.57	20,400	1.05	31,620	1.62	0.11	0.20	0.31
TOTAL	2,380,000	100.00	1,118,600	55.04	833,000	42.14	1,951,600	97.20	0.47	0.35	0.82

Source: GEIPOT, Porto Alegre

January 1980

TABLE 2.13

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Daily and Peak-Hour Vehicle Traffic Levels and Growth Rates on BR-116 in the MRPA
(1975 and 1979)

YEAR	SECTIONS	Daily Vehicle Traffic (both directions)					Peak-Hour (6:00-7:00) Vehicle Traffic (One direction/ Offroute direction)				
					Total					Total	
		Car	Bus	Truck	Vehicles	Pcu's[a]	Car	Bus	Truck	Vehicles	Pcu's[a]
1975	Porto Alegre-Canoas	42041	4214	9789	56044	74261	1919/1387	145/152	230/269	229/1808	2814/2381
	Canoas-Esteio	23999	2569	7691	34259	47088	1080/1008	109/106	182/253	1371/1367	1771/1832
	Esteio-Sao Leopoldo	18181	1028	5084	24293	31433	706/696	36/35	103/205	845/936	1020/1211
	Sao Leopoldo-Novo Hamburgo	14067	907	2372	17346	21532	691/475	99/35	57/122	847/632	1102/824
1979	Porto Alegre-Canoas	50201	4898	12716	67815	90327	2291/1656	168/177	299/349	2758/2188	3393/2885
	Canoas-Esteio	26964	3745	11305	42014	60812	1213/1133	159/154	267/372	1639/1676	2224/2339
	Esteio-Sao Leopoldo	20427	1498	7473	29398	39867	793/782	52/51	151/301	996/1134	1251/1537
	Sao Leopoldo-Novo Hamburgo	15805	1322	3486	20613	26743	776/534	144/51	84/179	1004/764	1376/1045
Compound Annual Growth Rates 1975-1979 (%)	Porto Alegre-Canoas	4.5	3.8	7.0	4.9	5.0	4.5/4.5	3.7/3.9	6.8/6.8	4.7/4.9	4.8/4.9
	Canoas-Esteio	3.0	9.9	10.1	5.2	6.6	3.0/3.0	9.9/9.8	10.1/10.1	4.6/5.2	5.9/5.6
	Esteio-Sao Leopoldo	3.0	9.9	10.1	4.9	6.1	3.0/3.0	9.6/9.9	10.1/10.1	4.2/4.9	5.3/6.1
	Sao Leopoldo-Novo Hamburgo	3.0	9.9	10.1	4.4	5.6	3.0/3.0	9.8/9.9	10.2/10.1	4.4/4.9	5.7/6.1

a/ Passenger Car Equivalent (PCU); 1 bus = 3 cars and 1 truck = 2 cars

Source: 1975 data are from the Plano Diretor de Transportes Urbanos da Regiao Metropolitana de Porto Alegre - 1976; 1979 daily figures are based on a one day survey by local DNER personnel. Peak-hour figures are derived on the assumption of a constant peak to daily ratio.

January 1980

BRAZIL
SECOND URBAN TRANSPORT PROJECT

Station-to-Station Daily Passenger Traffic
Year: 1985

Origin \ Destination	Mercado Central	Rodoviaria	Farrapos	Aeroporto	Ceasa	Niteroi	Fatima	Canoas	Mathias Velho	Sao Luis	Petrobras	Esteio	Luiz Pasteur	Sapucaia	TOTAL
Mercado Central	0	617	309	925	309	9125	2934	6421	5726	5301	2380	1475	3199	25754	64474
Rodoviaria	515	0	309	617	617	2046	655	1405	1217	1099	513	320	675	4648	14635
Farrapos	309	206	0	411	1029	5969	1694	3011	3000	2266	1039	817	1169	11676	32597
Aeroporto	1029	617	412	0	103	411	127	130	147	42	20	28	55	253	3373
Ceasa	206	617	1029	103	0	1038	283	324	344	107	60	103	90	596	4903
Niteroi	10603	2409	6469	493	1203	0	0	254	0	0	0	165	266	1764	23630
Fatima	3486	789	1887	162	343	0	0	103	0	0	0	64	116	775	7719
Canoas	10409	2323	4361	219	587	333	136	0	430	485	149	593	695	5470	26184
Mathias Velho	5162	1150	2626	169	419	0	0	198	0	0	0	273	280	1341	11624
Sao Luis	1832	406	771	28	88	0	0	74	0	0	0	220	463	881	4769
Petrobras	2362	526	961	35	111	0	0	68	0	0	0	174	357	1009	5596
Esteio	2481	551	1177	51	167	193	82	577	334	505	361	0	611	558	7646
Luiz Pasteur	5161	1139	1920	108	232	298	127	643	405	808	523	618	0	474	12459
Sapucaia	20063	3895	7173	404	1039	1015	518	2355	1286	1641	873	541	363	0	41170
TOTAL:	63613	15245	29404	3725	6247	20425	6556	16563	12889	12253	5918	5400	8338	55199	260779

Source: Mission estimates
January 1980

TABLE 2.2

BRAZIL
SECOND URBAN TRANSPORT PROJECT

Station-to-Station Daily Passenger Traffic
Year: 1990

Origin \ Destination	Mercado Central	Rodoviaria	Farrapos	Aeroporto	Ceasa	Niteroi	Fatima	Canoas	Mathias Velho	Sao Luis	Petrobras	Esteio	Luiz Pasteur	Sapucaia	TOTAL
Mercado Central	0	1046	524	1571	524	10859	3723	10264	7691	7149	4153	2226	4968	40753	95454
Rodoviaria	872	0	524	1047	1047	2397	814	2166	1606	1469	896	462	1006	8130	22434
Farrapos	524	349	0	699	1745	6859	2049	4631	3758	2941	1792	1204	1883	20753	49188
Aeroporto	1744	1046	698	0	175	439	142	166	150	45	29	38	64	344	5087
Ceasa	349	1046	1744	175	0	1103	306	362	355	112	71	113	100	713	6550
Niteroi	12333	2767	7903	722	1405	0	0	408	0	0	0	214	374	2034	28160
Fatima	4267	951	2459	262	425	0	0	166	0	0	0	91	164	887	9672
Canoas	14653	3189	7569	816	1002	498	208	0	623	660	229	811	1073	9655	40991
Mathias Velho	6602	1438	3736	380	564	0	0	338	0	0	0	325	390	2120	15891
Sao Luis	2434	528	1244	113	147	0	0	133	0	0	0	272	520	909	6298
Petrobras	3313	722	1711	176	207	0	0	119	0	0	0	208	423	1740	8614
Esteio	3196	695	1732	146	236	240	105	751	393	582	405	0	625	630	9801
Luiz Pasteur	7207	1542	3571	397	431	417	184	1001	564	967	702	719	0	561	18260
Sapucaia	29758	6589	16429	1450	1568	1536	861	4549	1951	2216	1833	619	421	0	69780
TOTAL:	87255	21909	49840	7951	9475	24345	8390	25054	17100	16141	10107	7302	12080	89229	386180

Source: Mission estimates
January 1980

TABLE 2.16

TABLE 2.17

BRAZIL
SECOND URBAN TRANSPORT PROJECT

Station-to-Station Daily Train Passengers
Year: 2000

Origin \ Destination	Mercado Central	Rodoviaria	Farrapos	Aeroporto	Ceasa	Niteroi	Fatima	Canoas	Mathias Velho	Sao Luis	Petrobras	Esteio	Luiz Pasteur	Sapucaia	TOTAL
Mercado Central	0	1616	809	2425	809	13385	5289	21188	11929	12367	9106	3348	7106	76098	165476
Rodoviaria	1347	0	809	1616	1616	2910	1128	4360	2451	2507	1970	683	1423	15255	38079
Farrapos	809	538	0	1078	2694	8083	2769	9533	5667	5260	4009	1786	2842	42267	87336
Aeroporto	2694	1616	1078	0	269	470	155	244	182	68	55	44	76	537	7468
Ceasa	538	1616	2694	269	0	1159	324	401	379	126	86	120	109	825	8648
Niteroi	14173	3113	9916	878	1626	0	0	685	0	0	0	277	488	3394	34546
Fatima	4905	1070	3144	315	497	0	0	264	0	0	0	114	206	1648	12164
Canoas	19535	4082	13516	1266	1573	915	490	0	1415	1652	648	1154	1563	23082	70891
Mathias Velho	8357	1755	5798	536	766	0	0	652	0	0	0	401	519	4300	23085
Sao Luis	3294	679	2275	189	245	0	0	292	0	0	0	303	591	1871	9742
Petrobras	4715	983	3494	311	378	0	0	265	0	0	0	234	511	3836	14727
Esteio	3797	803	2440	196	301	289	136	1065	483	699	464	0	740	681	12093
Luiz Pasteur	8378	1754	4902	495	551	505	240	1433	721	1175	886	766	0	645	22450
Sapucaia	36917	3066	3156	2368	2802	2331	1149	9762	3524	4122	4067	653	445	0	79364
TOTAL:	109461	27695	54033	11944	14124	30047	11681	50124	26751	27976	21291	9883	16619	174441	586069

Source: Mission estimates
January 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Train Operations and Operating Costs

I. Train Operations

A. General Information

Origin:	Mercado Station (Central Business District, CBD)
Destination:	Sapucaia
Route Length:	26.7 km
Average train speed:	42 km/hr
Average train trip:	
Peak:	22 km
Off-peak:	16 km
Operating day:	18 hours
Peak:	4 hours (2 hours in the morning, 2 hours in the evening)
Mid-peak:	2 hours (mid-day)
Off-peak:	12 hours
Average operating days per year:	300 days equivalent
Unit train:	4 cars (2 motorized cars, 2 cars without motor)
Unit train passenger capacity:	1,200 passengers (300 passengers per car)
Unit train weight:	204 metric tons (58 metric tons each motorized car and 44 metric tons each car without motor)
Average passenger weight:	70 kilograms
Unit train energy consumption:	62.4 watt/hour per gross ton km (GTK)

	Forecast Initial Operation Daily Passenger Traffic	At Different Levels of Traffic Daily Passenger Traffic				
	260,000	100,000	200,000	300,000	400,000	500,000
B. Distribution of Traffic						
(i) Daily Distribution of Traffic						
Peak-Mid-peak (6 hours) 72% of daily passenger traffic	187,200	72,000	144,000	216,000	288,000	360,000
Off-peak (12 hours) 28% of daily passenger traffic	72,800	28,000	56,000	84,000	112,000	140,000
(ii) Directional Split of Traffic per Hour						
Peak - both directions	31,200	12,000	24,000	36,000	48,000	60,000
- one way (80%)	24,960	9,600	19,200	28,800	38,400	48,000
- opposite direction (20%)	6,240	2,400	4,800	7,200	9,600	12,000
Mid-peak - both directions	31,200	12,000	24,000	36,000	48,000	60,000
- one way (65%)	20,280	7,800	15,600	23,400	31,200	39,000
- opposite direction (35%)	10,920	4,200	8,400	12,600	16,800	21,000
Off-peak - both directions	6,066	2,334	4,666	7,000	9,334	11,666
- one way (50%)	3,033	1,167	2,333	3,500	4,667	5,833
- opposite direction (50%)	3,033	1,167	2,333	3,500	4,667	5,833
C. Number of Trains						
Peak hour						
No. of trains	11	8	8	12	16	20
No. of unit trains	22	8	16	24	32	40
Mid-peak hour						
No. of trains	9	7	7	10	13	16
No. of unit trains	18	7	14	20	26	32
Off-peak hour						
No. of trains	4	4	4	4	4	4
No. of unit trains	4	4	4	4	4	8
D. Head-way Between Trains (minutes)						
Peak hour	5.5	7.5	7.5	5.2	3.75	3.0
Mid-peak hour	6.6	8.5	8.5	6.0	4.6	3.75
Off-peak hour	15.0	15.0	15.0	15.0	15.0	15.0
E. Fleet Requirements (unit-trains)						
Average peak hour	22	8	16	24	32	40
In repair/maintenance	3	2	3	4	6	7
Total (based on an 85% availability)	25	10	19	28	38	47
F. Personnel Requirements (staff numbers)						
Top management	9	9	9	9	9	9
Middle management	10	10	10	10	10	10
Supervisors	12	10	12	12	12	14
Drivers	33	25	25	35	41	50
Clerks	60	50	60	60	60	70
Stations	366	180	294	409	523	638
Workshops	58	40	47	62	79	94
Permanent way	86	65	75	90	105	120
Total	634	389	532	687	839	1,005
G. Operating Statistics						
Number of daily train trips	220	188	188	232	276	320
Number of daily unit train trips	344	188	280	368	456	640
Daily train-km	4,264	3,560	3,560	4,528	5,496	6,464
Daily unit train-km	6,992	3,560	5,584	7,520	9,456	12,928
Daily gross ton-km	2,165,998	1,010,738	1,708,078	2,387,520	3,066,962	2,165,998

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Train Operations and Operating Costs

	Forecast Initial Operation Daily Passenger Traffic 260,000	At Different Levels of Traffic Daily Passenger Traffic 100,000	200,000	300,000	400,000	500,000
Operating Costs (in mid-1979 Cr$)						
Working Costs						
A. Driver Cost						
Monthly salary plus benefits per driver = Cr$ 20,500						
Total cost per day (Cr$)	27,060	20,500	20,500	28,700	33,620	41,000
Total cost per year (in thousand of Cr$)	8,118.0	6,150.0	6,150.0	8,610.0	10,086.0	12,300.0
Total cost per passenger (Cr$)	0.1040	0.2050	0.1025	0.0957	0.0841	0.0820
B. Energy Cost						
Consumption of energy per day of operation (kilowatt-hour)kwh	135,158	63,070	106,584	148,981	191,378	253,325
Total cost per day @ Cr$ 0.78 per kwh (Cr$)	105,423	49,195	83,136	116,205	149,275	197,593
Total cost per year (in thousand of Cr$)	31,626.9	14,758.4	24,940.7	34,861.6	44,782.5	59,278.0
Total cost per passenger (Cr$)	0.4054	0.4919	0.4157	0.3874	0.3732	0.3952
C. Lubricant Cost						
Estimated at 1.5% of energy cost						
Total cost per day (Cr$)	1,575	735	1,242	1,736	2,230	2,951
Total cost per year (in thousand of Cr$)	472.5	220.5	372.6	520.8	669.0	885.3
Total cost per passenger (Cr$)	0.0060	0.0074	0.0062	0.0058	0.0056	0.0059
D. Train Maintenance Cost						
Average monthly salary plus benefits per worker = Cr$ 16,080						
Personnel cost per day (Cr$)	37,305	25,728	30,230	39,878	50,813	60,461
Personnel cost per year (in thousand of Cr$)	11,191.7	7,718.4	9,069.1	11,963.5	15,243.8	18,138.2
Material cost per day - 25% of personnel cost (Cr$)	9,326	6,432	7,558	9,970	12,703	15,115
Material cost per year (in thousand of Cr$)	2,798.0	1,929.6	2,267.3	2,990.9	3,810.9	4,534.6
Total cost per day (Cr$)	46,631	32,160	37,788	49,848	63,516	75,576
Total cost per year (in thousand of Cr$)	13,989.7	9,648.0	11,336.4	14,954.4	19,054.7	22,672.8
Total cost per passenger (Cr$)	0.1793	0.3216	0.1889	0.1662	0.1588	0.1512
E. Permanent Way Maintenance Cost						
Average monthly salary plus benefits per worker = Cr$ 16,080						
Personnel cost per day (Cr$)	55,315	41,808	48,240	57,888	67,536	77,184
Personnel cost per year (in thousand of Cr$)	16,594.6	12,542.4	14,472.0	17,366.4	20,260.8	23,155.2
Material cost per day - 25% of personnel cost (Cr$)	13,829	10,452	12,060	14,472	16,884	19,296
Material cost per year (in thousand of Cr$)	4,148.6	3,135.6	3,618.0	4,341.6	5,065.2	5,788.8
Total cost per day (Cr$)	69,144	52,260	60,300	72,360	84,420	96,480
Total cost per year (in thousand of Cr$)	20,743.2	15,678.0	18,090.0	21,708.0	25,326.0	28,944.0
Total cost per passenger (Cr$)	0.2659	0.5226	0.3015	0.2412	0.2111	0.1930
F. Other Administrative Cost						
Average monthly salary plus benefits per employee:						
Top management Cr$ 96,480						
Middle management Cr$ 87,100						
Supervisors Cr$ 20,648						
Clerks and stations Cr$ 16,080						
Personnel cost per day (Cr$)	353,355	225,688	307,081	381,048	454,373	536,409
Personnel cost per year (in thousand of Cr$)	106,006.5	67,706.4	92,124.3	114,314.4	136,311.9	160,922.7
Office supply and equipment cost per day - 25% of personnel cost (Cr$)	88,339	56,422	76,770	95,262	113,593	134,102
Office supply and equipment cost per year (in thousand of Cr$)	26,501.6	16,926.6	23,031.1	28,578.6	34,078.0	40,230.8
Total cost per day (Cr$)	441,694	282,110	383,851	476,310	567,966	670,511
Total cost per year (in thousand of Cr$)	132,508.1	84,633	115,155.4	142,893.0	170,389.9	201,153.5
Total cost per passenger (Cr$)	1.6988	2.8211	1.9193	1.5877	1.4199	1.3410
Total Working Cost						
Daily (Cr$)	691,527	436,960	586,817	743,159	901,027	1,084,111
Yearly (in thousand of Cr$)	207,458.4	131,087.9	176,045.1	223,347.8	270,308.1	325,233.6
Per passenger (Cr$)	2.6594	4.3696	2.9341	2.4840	2.2527	2.1683
Depreciation						
G. Unit Trains						
Estimated price of a unit train US$3,200,000 or Cr$ 83,200,000						
Total investment cost (in thousand of Cr$)	2,080,000	832,000	1,580,800	2,329,600	3,161,600	3,910,400
Total investment cost to be depreciated, after allowing for a 5% residual value (in thousand of Cr$)	1,976,000	790,400	1,501,760	2,213,120	3,003,520	3,714,880
Total daily depreciation, based on 25 years of useful life (Cr$)	263,467	105,387	200,233	295,083	400,467	495,317
Total annual depreciation (in thousand of Cr$)	79,040.0	31,616.0	60,070.0	88,525.0	120,140.0	148,595.0
Total depreciation per passenger	1.0133	1.0538	1.0011	0.9836	1.0011	0.9906
H. Permanent Way						
Infrastructure						
Total investment cost Cr$ 281,927,000						
Total daily depreciation, based on 40 years of useful life (Cr$)	23,493	23,493	23,493	23,493	23,493	23,493
Total annual depreciation (in thousand of Cr$)	7,048.0	7,048.0	7,048.0	7,048.0	7,048.0	7,048.0
Total depreciation per passenger (Cr$)	0.0904	0.2349	0.1174	0.0783	0.0587	0.0469
Superstructure						
Total investment cost Cr$ 635,024,000						
Total investment cost to be depreciated after allowing for a residual value of rails Cr$ 508,019,000						
Total daily depreciation, based on 25 years of useful life (Cr$)	67,733	67,733	67,733	67,733	67,733	67,733
Total annual depreciation (in thousand of Cr$)	20,320.0	20,320.0	20,320.0	20,320.0	20,320.0	20,320.0
Total depreciation per passenger (Cr$)	0.2605	0.6773	0.3386	0.2257	0.1693	0.1354

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Train Operations and Operating Costs

	Forecast Initial Operation Daily Passenger Traffic 260,000	At Different Levels of Traffic Daily Passenger Traffic 100,000	200,000	300,000	400,000	500,000
I. Signaling and Telecommunication						
Total investment cost Cr$ 336,630,000						
Total daily depreciation, based on 25 years of useful life (Cr$)	44,883	44,883	44,883	44,883	44,883	44,883
Total annual depreciation (in thousand of Cr$)	13,465.0	13,465.0	13,465.0	13,465.0	13,465.0	13,465.0
Total depreciation per passenger (Cr$)	0.1726	0.4488	0.2244	0.1496	0.1122	0.0897
J. Electrification - Catenary/Substations						
Total investment cost Cr$ 318,432,000						
Total daily depreciation, based on 25 years of useful life (Cr$)	42,456	42,456	42,456	42,456	42,456	42,456
Total annual depreciation (in thousand of Cr$)	12,737.0	12,737.0	12,737.0	12,737.0	12,737.0	12,737.0
Total depreciation per passenger (Cr$)	0.1633	0.4245	0.2122	0.1415	0.1061	0.0849
K. Other Investments - Bridges/Under-Over Passes						
Total investment cost Cr$ 661,325,000						
Total daily depreciation, based on 40 years of useful life (Cr$)	55,110	55,110	55,110	55,110	55,110	55,110
Total annual depreciation (in thousand of Cr$)	16,533.0	16,533.0	16,533.0	16,533.0	16,533.0	16,533.0
Total depreciation per passenger (Cr$)	0.2119	0.5511	0.2755	0.1837	0.1377	0.1102
L. Stations						
Total investment cost Cr$ 430,729,000						
Total daily depreciation, based on 40 years of useful life (Cr$)	35,893	35,893	35,893	35,893	35,893	35,893
Total annual depreciation (in thousand of Cr$)	10,768.0	10,768.0	10,768.0	10,768.0	10,768.0	10,768.0
Total depreciation per passenger (Cr$)	0.1380	0.3589	0.1794	0.1196	0.0897	0.0717
M. Workshops						
Depot						
Total investment Cr$ 73,300,000						
Total daily depreciation, based on 40 years of useful life (Cr$)	6,110	6,110	6,110	6,110	6,110	6,110
Total annual depreciation (in thousand of Cr$)	1,833.0	1,833.0	1,833.0	1,883.0	1,833.0	1,833.0
Total depreciation per passenger (Cr$)	0.0235	0.0611	0.0305	0.0203	0.0152	0.0122
Yard						
Total investment cost Cr$ 71,212,000						
Total investment cost to be depreciated, after allowing for a residual value of rails Cr$ 64,091,000						
Total daily depreciation, based on 25 years of useful life (Cr$)	8,545	8,545	8,545	8,545	8,545	8,545
Total annual depreciation (in thousand of Cr$)	2,564.0	2,564.0	2,564.0	2,564.0	2,564.0	2,564.0
Total depreciation per passenger (Cr$)	0.0329	0.0854	0.0427	0.0284	0.0213	0.0171
Equipment						
Total investment cost Cr$ 57,705,000						
Total investment cost to be depreciated, after allowing for a 5% residual value Cr$ 54,820,000						
Total daily depreciation, based on 18 years of useful life (Cr$)	10,150	10,150	10,150	10,150	10,150	10,150
Total annual depreciation (in thousand of Cr$)	3,045.0	3,045.0	3,045.0	3,045.0	3,045.0	3,045.0
Total depreciation per passenger (Cr$)	0.0390	0.1015	0.0507	0.0338	0.0253	0.0203
N. Administration and Other Buildings						
Total investment cost Cr$ 57,477,000						
Total daily depreciation, based on 40 years of useful life (Cr$)	4,790	4,790	4,790	4,790	4,790	4,790
Total annual depreciation (in thousand of Cr$)	1,437.0	1,437.0	1,437.0	1,437.0	1,437.0	1,437.0
Total depreciation per passenger (Cr$)	0.0184	0.0479	0.0239	0.0159	0.0119	0.0095
Total Depreciation						
Daily (Cr$)	362,630	404,550	499,396	594,246	699,530	794,480
Yearly (in thousand of Cr$)	168,790.0	121,366.0	149,820.0	178,275.0	209,390.0	238,345.0
Per passenger (Cr$)	2.1635	4.0452	2.4964	1.9804	1.7485	1.5885
Total Operating Cost						
Daily (Cr$)	1,254,157	841,510	1,086,213	1,339,405	1,600,657	1,878,591
Yearly (in thousand of Cr$)	376,248.4	252,453.9	325,865.1	401,822.8	480,198.1	563,578.6
Per passenger (Cr$)	4.8229	8.4148	5.4305	4.4644	4.0012	3.7568

Note: The investment costs shown herein include the physical contingencies. Price contingencies were not included since the costs shown in the table are in mid-1979 Cr$.

Source: Mission estimates.

November 1979

TABLE 3.2

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Permanent Way Maintenance Equipment

Items	Quantity	Estimated Cost (US$)
1. Transportation Equipment		
Road truck	1	31,000
Road/rail truck	2	122,000
Motor trolley with 4 trolleys	1	9,000
Trolley with collapsible platform	2	4,000
Subtotal		166,000
2. Light Equipment		
Portable tampers	5	58,000
Rail drill	3	2,000
Rail saw	3	2,000
Rail grinder	1	1,000
Sleeper adzing machine	1	8,000
Sleeper drilling machine	2	3,000
Sleeper banding machine	1	1,000
Screwing machine	5	8,000
Joint rectifier machine	1	2,000
Rail switch grinder	1	1,000
Subtotal		86,000
3. Tools and Other Equipment		
Track jacks 15 tons	4	1,000
Track jacks 10 tons	8	1,000
Track gauges	4	500
Portable telephone UHF	4	8,000
VHF (FM) equipment	2	5,000
Portable motor generator set	4	26,000
Aluminothermic welding equipment	2	5,500
Normal maintenance tools set and miscellaneous	1	29,000
Subtotal		76,000
Total		328,000

Source: GEIPOT, Porto Alegre

January 1980

BRAZIL

TABLE 3.3
Page 1 of

SECOND URBAN TRANSPORT PROJECT

Depot Maintenance Equipment

Item	Quantity	Estimated Cost (US$)
1. Depot Equipment		
Overhead traveling crane 5/15 ton (14 meter span)	1	234,000
Overhead traveling cranes 5 ton (11.6 and 18.6 meter span)	2	327,000
Washing machine for train set	1	116,000
Pit wheel lathe	1	536,000
High pressure cold water cleaning machine for unit train parts	1	4,700
Hydraulic hoisting machine for unit train trucks	1	233,000
Jacks 15 ton	4	58,300
Sub-total		1,509,000
2. Electric and Mechanical Equipment		
Lathe 1,500 mm	1	21,000
Horizontal shaping machine 500 mm	1	7,000
Column drilling machine up to 50 mm diam.	1	9,000
Bench drilling machine up to 25 mm diam.	1	1,500
Column grinding machine	1	1,800
Hydraulic saw	1	2,500
Electric welding TIG machine	1	1,500
Oxy-acetilene welding and cutting equipment	1	800
Electric cutting machine with graphite electrodes	1	1,900

TABLE 3.3
Page

Item	Quantity	Estimated Cost (US$)
Fork lift	1	26,000
Various instrument and tool sets	-	53,000
Sub-total		126,000
3. Workshop equipment to be installed in the depot to be transferred to the workshop in Phase II		
Hydraulic press 100 ton	1	7,000
Armature lathe and commuter bar undercutting machine	1	33,000
Stoving oven (to dry traction motor windings)	1	4,600
Shot blasting machine with glass microsphere (to clean electric sets)	1	3,700
Rectifier to recharge batteries	1	1,800
Rectifier for welding machine	1	1,300
Deionizer set for battery water treatment	1	1,200
Hydraulic pump (to remove bearings and pinions)	1	7,000
Gas tempering furnace	1	2,300
Dynamic rotor balancing machine	1	70,000
Universal tool sharpening machine	1	29,000
Miscellaneous (shelves, tool cabinets, lockers, etc.)	-	33,100
Sub-total		194,000
TOTAL		1,829,000

Source: GEIPOT, Porto Alegre

January 1980

TABLE 3.4

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Technical Assistance Program

	1981	1982	1983	1984	1985	1986	Man-Months Local	Man-Months Foreign	Man-Months Total	Cost (Cr$ Million) Local a/	Cost (Cr$ Million) Foreign b/	Cost (Cr$ Million) Total
Technical Assistance												
A. TRENSURB/P.A.												
1. Setting Up TRENSURB/P.A.							66	66	132	17.03	28.38	45.41
(a) Organization and Management (b) Training and Staffing (c) Accounts (d) Financial Management (e) Operations (f) Implementation												
2. Phase II Economic and Financial Feasibility Study							24	-	24	6.19	-	6.19
B. Other Complementary Policies and Programs												
1. Satellite Automobile Parks, Auto Restraint Policy and Monitoring							44	40	84	11.35	17.20	28.55
2. Bus Routes							36	9	45	9.29	3.87	13.16
3. Tariff Policy							-	24	24	-	10.32	10.32
C. Urban Impact												
1. Commercial Center Development and Master Plan Assistance							18	24	42	4.64	10.32	14.96
							188	163	351	48.50	70.09	118.59

a/ US$6,000/man month.
b/ US$10,000/man month.

Source: GEIPOT, Porto Alegre; EBTU and Mission

March 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Project Cost Estimates

Item	1981 Local	1981 Foreign	1981 Total	1982 Local	1982 Foreign	1982 Total	1983 Local	1983 Foreign	1983 Total	1984 Local	1984 Foreign	1984 Total	Total Expenditures 1981 - 1984 Local	Total Expenditures 1981 - 1984 Foreign	Total Expenditures 1981 - 1984 Total	Total Expenditures 1981 - 1984 Local	Total Expenditures 1981 - 1984 Foreign	Total Expenditures 1981 - 1984 Total
	Cr$ '000												Cr$ '000			US$ '000		
1 Track Infrastructure	77,811	19,261	97,072	172,395	28,822	201,217	134,131	11,159	145,290	39,547	1,598	41,145	423,884	60,840	484,724	9,858	1,415	11,273
2. Track Superstructure	62,986	41,949	104,935	216,314	156,695	373,009	259,685	181,280	440,965	106,357	66,534	172,891	645,342	446,458	1,091,800	15,008	10,383	25,391
3. Pedestrian and Road Vehicle, etc.	139,361	21,081	160,442	349,563	52,682	402,245	354,027	54,042	408,069	143,826	22,401	166,227	986,777	150,206	1,136,983	22,948	3,494	26,442
4. Stations	79,270	7,880	87,150	178,691	29,300	207,991	173,930	109,202	283,132	74,508	87,782	162,290	506,398	234,164	740,562	11,777	5,446	17,223
5. Administration and Depot Buildings	61,326	3,647	64,973	142,275	9,957	152,232	99,557	9,110	108,667	18,608	2,799	21,407	321,766	25,513	347,279	7,483	593	8,076
6. Maintenance Depot Equipment	-	-	-	1,611	19,574	21,185	3,237	39,328	42,556	1,625	19,754	21,379	6,473	78,656	85,129	151	1,829	1,980
7. Permanent Way Equipment	-	-	-	-	-	-	-	7,043	7,043	-	7,042	7,042	-	14,085	14,085	-	328	328
8. Telecommunications	-	9,266	9,266	27,400	45,684	73,084	32,957	54,950	87,907	5,557	-	5,557	65,914	109,900	175,814	1,533	2,556	4,089
9. Signalling	-	38,429	38,429	45,312	126,395	171,707	47,247	131,795	179,042	13,776	-	13,776	106,335	296,619	402,954	2,473	6,898	9,371
10. Electrification	-	40,357	40,357	45,125	151,374	196,499	65,977	211,801	277,778	32,792	-	32,792	143,894	403,532	547,426	3,347	9,385	12,732
11. Satellite Car Parking	-	-	-	-	-	-	81,258	19,263	100,521	27,089	6,482	33,571	108,347	25,745	134,092	2,520	598	3,118
12. Expropriation	824,122	-	824,122	-	-	-	-	-	-	-	-	-	824,122	-	824,122	19,166	-	19,166
Subtotal	1,244,876	181,870	1,426,746	1,178,686	620,483	1,799,169	1,252,006	828,973	2,080,979	463,685	214,392	678,077	4,139,252	1,845,718	5,984,970	96,261	42,927	139,188
13. Unit-trains	108,358	433,430	541,788	180,596	722,384	902,980	252,834	1,011,338	1,264,172	180,596	722,384	902,980	722,384	2,889,536	3,611,920	16,800	67,198	83,998
14. Train Spare Parts	-	-	-	-	-	-	28,895	115,581	144,476	28,895	115,582	144,477	57,790	231,163	288,953	1,344	5,376	6,720
15. Technical Assistance a/	5,484	7,337	12,821	26,273	25,057	51,330	9,080	18,737	27,817	10,094	22,462	32,556	50,931	73,593	124,524	1,184	1,711	2,895
Subtotal	1,358,718	622,637	1,981,355	1,385,555	1,367,924	2,753,479	1,542,815	1,974,629	3,517,444	683,270	1,074,820	1,758,090	4,970,357	5,040,010	10,010,367	115,589	117,212	232,801
16. Physical Contingencies (5% for cement items, 3% for steel items, 5% for cables and 5% for spare parts for substations)	12,448	1,818	14,266	11,787	6,205	17,992	12,520	8,289	20,809	4,636	2,145	6,781	41,392	18,458	59,850	962	429	1,392
17. Price Contingencies (10.5% in 1980, 9% in 1981, 8% in 1982, 7% in 1983 and 3.5% for the six first months of 1984)	277,780	137,944	415,724	416,971	403,641	820,612	604,580	763,551	1,368,131	300,957	473,301	774,258	1,600,288	1,778,406	3,378,694	37,216	41,359	78,575
GRAND TOTAL	1,648,946	762,399	2,411,345	1,814,313	1,777,770	3,592,083	2,159,915	2,746,469	4,906,384	988,863	1,550,266	2,539,129	6,612,037	6,836,874	13,448,911	153,768	159,000	312,768

a/ The amount shown for 1984 includes provision for the monitoring and operational assistance programmed for 1985 and 1986 (See Table 3.4).

NOTE: US$1.00 = 43 Cruzeiros (January 1980)

Source: GEIPOT, Porto Alegre and Mission

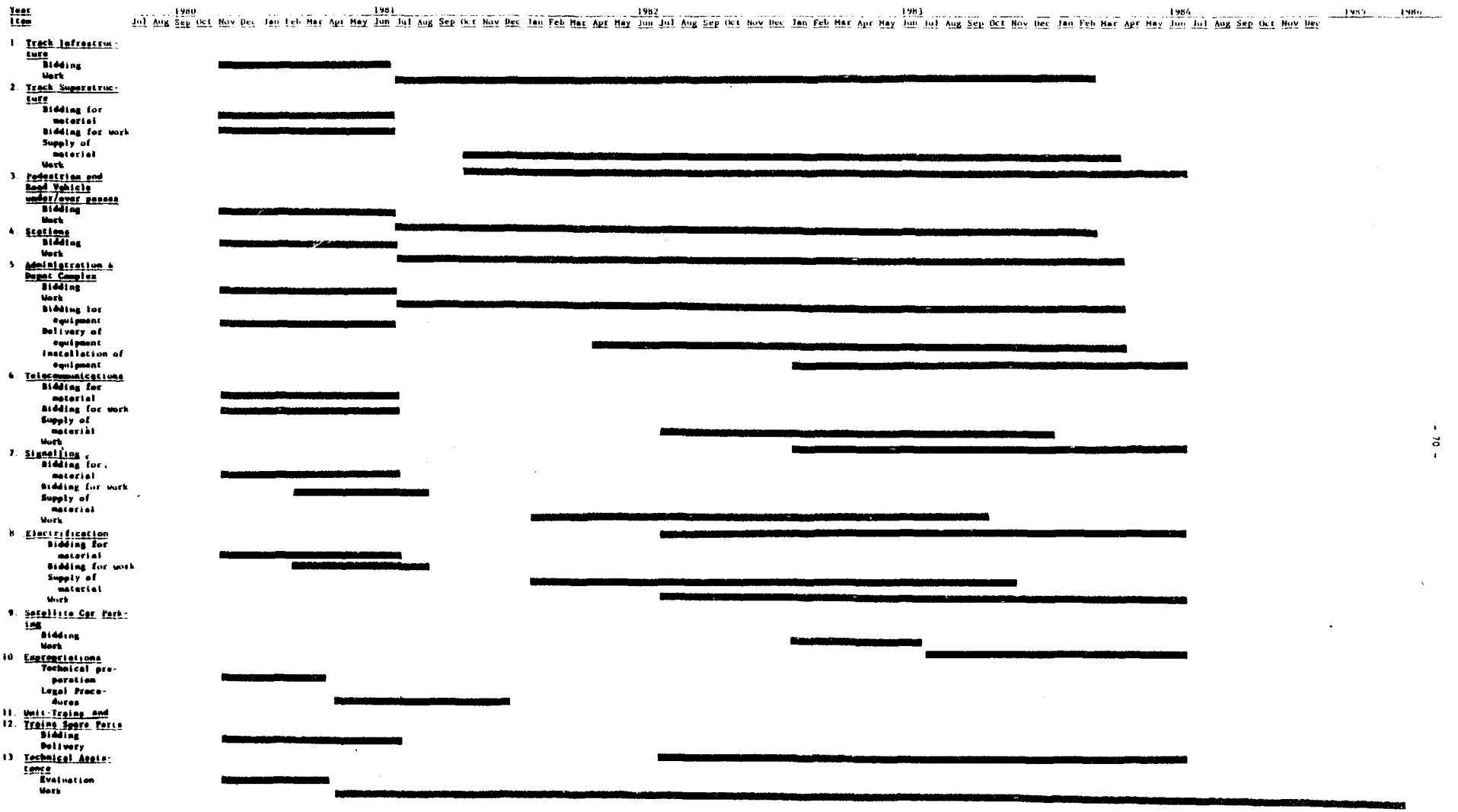
March 1980

TABLE 3.5

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Project Implementation Schedule



Source: GEIPOT, Porto Alegre and Mission

March 1980

TABLE 3.1

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Items to be Financed by the Proposed Loan

Category I		Cost (US$ Million)
Track Superstructure		
(i)	8,202 tons of 57 kg rails for 26.7 km of double track main line	3,300
(ii)	1,596 tons of 45 kg rails for sidings and yards	650
(iii)	93,000 concrete sleepers and rail fittings for 26.7 km of double track main line	2,870
(iv)	126 switches for sidings and yards	2,520
	Total Category I	9,340
Category II		
Unit trains and related spare parts		
(i)	25 electric unit trains of two motor coaches and two trailers	83,998
(ii)	spare parts for the 25 electric unit trains	5,372
	Total Category II	89,370
Category III		
Signalling and Electrification		
(i)	Centralized traffic control system (CTC) and operational center for signalization	6,200
(ii)	Electrical equipment such as transformers, rectifiers, switches and catenary	7,990
	Total Category III	14,190

Category IV	Cost (US$ Million)
Maintenance equipment (Tables 3.2, 3.3)	
(i) Machine tools and other equipment for maintenance depot	1,890
(ii) Track maintenance equipment	330
Total Category IV	2,220
Category V	
Technical assistance (Table 3.4)	
(i) The establishment of TRENSURB/P.A. (66 man-months)	
(ii) Satellite automobile parks, auto restraint policy and monitoring (40 man-months)	
(iii) Bus routes (9 man-months)	
(iv) Commercial center development and master plan assistance (24 man-months)	
(v) Tariff policy in MRPA (24 man-months)	
Total Category V	1,710
GRAND TOTAL	116,830
Physical Contingencies (3.67%)	4,290
Price Contingencies (Table 3.5)	37,880
Amount of Loan	159,000

March 1980

TABLE 4.3

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Estimated Disbursement Schedule

IBRD Fiscal Year and Quarter	US$ Million Quarter	Cumulative
1981		
To September 30, 1980	-	-
To December 31, 1980	-	-
To March 31, 1981	-	-
To June 30, 1981	0.1	0.1
1982		
To September 30, 1981	19.4	19.5
To December 31, 1981	0.6	20.1
To March 31, 1982	3.2	23.3
To June 30, 1982	3.4	26.7
1983		
To September 30, 1982	17.7	44.4
To December 31, 1982	17.7	62.1
To March 31, 1983	14.0	76.1
To June 30, 1983	14.0	90.1
1984		
To September 30, 1983	14.2	104.3
To December 31, 1983	16.7	121.0
To March 31, 1984	19.4	140.4
To June 30, 1984	18.2	158.6
1985		
To September 30, 1984	0.1	158.7
To December 31, 1984	0.3	159.0

Principal Assumptions

1. Effective date of loan not later than November 1, 1980
2. Bid invitation for Track Materials and Rolling Stock not later than November 1, 1980.

Source: Mission estimates

March 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Forecast of TRENSURB/P.A.'s Financial Statements (1985-1990)

Income Accounts and Balance Sheet

(In millions of mid-1979 Cr$)

	1985	1986	1987	1988	1989	1990
I INCOME ACCOUNTS						
Revenues						
Passenger Fares	471.6	516.6	561.6	608.4	653.4	698.4
Expenses						
Personnel	142.9	149.4	156.4	164.8	172.2	178.9
Energy/Lubricants	32.1	34.7	36.6	39.3	41.8	44.3
Materials/Other	33.7	35.3	36.9	38.9	40.6	42.3
Total Working Expenses	208.7	219.4	229.9	243.0	254.6	265.5
Depreciation	170.0	175.8	182.7	191.9	199.8	206.8
Total Operating Expenses	378.7	395.2	412.6	434.9	454.4	472.3
Operating Profit	92.9	121.4	149.0	173.5	199.0	226.1
Financial Revenues	6.1	20.9	37.6	41.5	36.7	32.6
Financial Expenses	--	--	--	206.7	189.5	172.1
Net Surplus	99.0	142.3	186.6	8.3	46.2	86.5
Working ratio	44	42	41	40	39	38
Operating ratio	80	77	73	71	70	68
Return on Estimated Project Costs (%)	1.6	2.1	2.5	3.0	3.4	3.9
Return on Net Fixed Assets (%)	1.5	2.0	2.5	3.1	3.7	4.3
II CASH ON HAND						
Beginning of Year	--	269.0	587.1	956.4	812.1	713.6
Plus						
Operating Surplus	92.9	121.4	149.0	173.5	199.0	226.1
Depreciation of fixed assets	170.0	175.8	182.7	191.9	199.8	206.8
Financial Revenues	6.1	20.9	37.6	41.5	36.7	32.6
Less						
Repayment of EBTU Loan-principal	--	--	--	344.5	344.5	344.5
-interest	--	--	--	206.7	189.5	172.1
End of Year	269.0	587.1	956.4	812.1	713.6	662.5
III. BALANCE SHEET						
Assets						
Current Assets	43.4	47.4	51.3	55.5	59.5	63.5
Investments	247.1	562.3	928.8	781.6	680.4	626.3
Inventories	166.4	166.4	166.4	166.4	166.4	166.4
Fixed Assets (net)	6,202.4	6,026.6	5,843.9	5,652.0	5,452.2	5,245.4
Total Assets	6,659.3	6,802.7	6,990.4	6,655.5	6,358.5	6,101.6
Liabilities and Equity						
Current Liabilities	21.5	22.6	23.7	25.0	26.3	27.4
Long Term Borrowings						
Loan from EBTU	4,134.0	4,134.0	4,134.0	3,789.5	3,445.0	3,100.5
Equity						
Share Capital	2,404.8	2,404.8	2,404.8	2,404.8	2,404.8	2,404.8
Reserves	99.0	241.3	427.9	436.2	482.4	568.9
	2,503.8	2,646.1	2,832.7	2,841.0	2,887.2	2,973.7
Total Liabilities and Equity	6,659.3	6,802.7	6,990.4	6,655.5	6,358.5	6,101.6

A) NOTES

1) The income statement is based on the following passenger traffic forecast:

	Daily	Yearly (in thousands)
1985	262,000	78,600
1986	287,000	86,100
1987	312,000	93,600
1988	338,000	101,400
1989	363,000	108,900
1990	388,000	116,400

2) Estimated project cost excluding price contingencies in mid-1979 Cr$ is Cr$ 5,808.8 million.

B) ASSUMPTIONS

Income Accounts:

- Revenues: Based on a tariff of Cr$ 6.00 per passenger through the period 1985-1990.

Operating Expenses

- Labor, energy, material and depreciation costs are based on mid-1979 Cr$ prices and were derived from the unit operating cost analysis given in Table 3.1.

Financial Revenues:

Represent interest earned on investments.

Financial Expenses:

Represent interest paid on long-term borrowings.

Balance Sheets

- Current assets represent 1/12 of the yearly cash generation which is maintained in Bank accounts. It also includes other cash available to pay for current liabilities.
- Investments represent 11/12 of the surplus cash generation which is maintained in interest bearing bank accounts.
- Inventories represent a minimum stock of spare parts and other materials equivalent to 8% of the unit train costs.
- Fixed assets represent the original project costs, in mid-1979 Cr$, (excluding price contingencies) after considering the depreciation charges. It also includes Cr$ 730 million which represents the estimated value of land holdings presently owned by the Federal Railway, the State of Rio Grande do Sul and Porto Alegre Municipality and which would be transferred to TRENSURB/P.A. in exchange of share capital ownership.
- Current liabilities represent accounts payable and refer to about 9% and 13% of the yearly personnel (Social Security) and energy/material costs.
- Long-Term borrowings represent the loan obtained from EBTU; i.e.US$ 159 million or Cr$ 4,134 million.
- Share Capital represents land and/or cash contributions from TRENSURB/P.A.'s shareholders.
- Reserves represent the accumulation of TRENSURB/P.A.'s yearly net surplus.

Source: Mission estimate
January 1980

TABLE 5.1

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Financial Sensitivity Analysis *

	Tariff per Passenger				
	Cr$ 6	Cr$ 5	Cr$ 4	Cr$ 3	Cr$ 2
Total Revenues	471.6	393.0	314.4	235.8	157.2
Base Case Operating Costs					
Working expenses	208.7	208.7	208.7	208.7	208.7
Operating expenses	378.7	378.7	378.7	378.7	378.7
Working ratio	44	53	66	88	133
Operating ratio	80	96	120	161	241
Operating Costs (30% Higher Personnel Costs)					
Working expenses	251.5	251.5	251.5	251.5	251.5
Operating expenses	421.5	421.5	421.5	421.5	421.5
Working ratio	53	64	80	107	160
Operating ratio	89	107	134	179	268
Operating Costs (60% Higher Personnel Costs)					
Working expenses	294.4	294.4	294.4	294.4	294.4
Operating expenses	464.4	464.4	464.4	464.4	464.4
Working ratio	62	75	94	125	187
Operating ratio	98	118	148	197	295
Operating Costs (100% Higher Personnel Costs)					
Working expenses	351.6	351.6	351.6	351.6	351.6
Operating expenses	521.6	521.6	521.6	521.6	521.6
Working ratio	75	89	112	149	224
Operating ratio	111	133	166	221	332

Note: Revenues and expenses are shown in millions of mid-1979 Cr$.
Operating expenses is the sum of working expenses and depreciation.

* Pertains to first year of operation.

Source: Mission estimates

TABLE 6.1

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Analysis
Alternative I

(Cr$ million, mid-1979)

Year	Capital Costs	Road Maintenance Costs a/	Road Vehicle Operating Costs		Road Passenger Travel Time Costs		Total
			Car	Bus b/	Car	Bus c/	
1981	479.71						
1982	664.21						
1983	885.62						
1984		1.15	846	618	225	514	2,204
1985		1.15	906	657	241	546	2,351
1986		1.15	966	696	257	578	2,498
1987		1.15	1,030	737	274	612	2,654
1988		49.15	1,098	780	292	648	2,867
1989		1.15	1,170	826	311	686	2,994
1990		1.15	1,239	873	330	725	3,168
1991		1.15	1,296	917	351	768	3,333
1992		1.15	1,356	963	373	813	3,506
1993		49.15	1,418	1,011	397	861	3,736
1994		1.15	1,483	1,062	422	912	3,880
1995		1.15	1,551	1,115	449	966	4,082
1996		1.15	1,622	1,171	477	1,023	4,294
1997		1.15	1,697	1,230	507	1,083	4,518
1998		49.15	1,775	1,292	539	1,147	4,802
1999		1.15	1,857	1,357	573	1,215	5,003
2000		1.15	1,947	1,411	606	1,280	5,245
2001		1.15	2,037	1,482	644	1,356	5,520
2002		1.15	2,131	1,556	685	1,436	5,809
2003		49.15	2,229	1,634	728	1,521	6,161

a/ **Road maintenance costs on the new bus expressway.** Road maintenance costs on the existing road system are assumed to be the same under all the project alternatives including the base case and, therefore, it was not taken into account in the economic analysis, which explains their omission from Tables 6-1 through 6-6. Of course, theoretically, this assumption is a simplification since the traffic assigned to BR-116 is different under the various alternatives, and to the extent that road maintenance costs vary with traffic, the former would be different under each alternative. However, since the variable road maintenance component is relatively small for all the alternatives and the difference in variable maintenance between each of the alternatives and the base case is even smaller, the error from its omission is insignificant and surely would not change any of the conclusions.

b/ Buses on the bus expressway during peak hours are expected to have an average occupancy rate of 60 passengers/bus compared with 81 for intermunicipal buses at present.

c/ Includes estimated walk/wait time.

Source: Mission estimates
January 1980

TABLE 6.2

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Analysis
Alternative II

(Cr$ million, mid-1979)

Year	Capital Costs	Rail Right-of-Way Maintenance Costs	Vehicle Operating Costs			Passenger Travel Time Costs a/			Total
			Road			Road			
			Car	Bus	Rail	Car	Bus	Rail	
1981	532.74								
1982	737.65								
1983	778.63								
1984		30.39	840	383	118	217	341	192	2,121
1985		30.39	906	428	118	241	387	192	2,302
1986		30.39	972	473	118	265	433	192	2,483
1987		30.39	1,043	523	118	291	484	192	2,681
1988		30.39	1,119	578	118	320	541	192	2,898
1989		30.39	1,201	639	118	351	605	192	3,136
1990		30.39	1,289	705	118	384	673	192	3,391
1991		30.39	1,361	743	118	409	709	192	3,562
1992		30.39	1,437	783	118	436	747	192	3,743
1993		30.39	1,517	825	118	465	787	192	3,934
1994		30.39	1,602	870	118	496	830	192	4,138
1995		30.39	1,692	917	118	529	875	192	4,353
1996		30.39	1,787	967	118	564	922	192	4,580
1997		30.39	1,887	1,019	118	601	972	192	4,819
1998		30.39	1,993	1,074	118	641	1,024	192	5,072
1999		30.39	2,105	1,132	118	683	1,079	192	5,339
2000		30.39	2,214	1,188	118	725	1,138	192	5,605
2001		30.39	2,338	1,252	118	773	1,199	192	5,902
2002		30.39	2,469	1,320	118	824	1,264	192	6,217
2003		30.39	2,607	1,391	118	878	1,332	192	6,548

a/ Includes estimated walk/wait time.

Source: Mission estimates

January 1980

TABLE 6.3

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Analysis
Alternative III

(Cr$ million, mid-1979)

Year	Capital Cost	Rail Right-of-Way Maintenance Costs	Vehicle Operating Costs			Passenger Travel Time Costs b/			Total
			Road			Road			
			Car	Bus	Rail	Car	Bus	Rail	
1981	831.98								
1982	1,151.97								
1983	1,215.97								
1984		25.33	784	319	203	209	277	242	2,059
1985		25.33	797	337	214	212	304	271	2,160
1986		25.33	810	355	225	215	331	300	2,261
1987		25.33	823	374	237	218	360	332	2,369
1988	a/ 77.16	25.33	836	394	250	221	392	368	2,486
1989	a/ 25.72	25.33	849	415	263	225	427	407	2,611
1990		25.33	863	439	277	229	466	449	2,748
1991		25.33	904	462	289	240	485	468	2,873
1992		25.33	947	486	301	252	505	488	3,004
1993		25.33	992	511	314	264	526	509	3,141
1994		25.33	1,040	538	328	277	548	531	3,287
1995		25.33	1,090	566	342	291	570	554	3,438
1996		25.33	1,142	595	357	305	593	578	3,595
1997		25.33	1,197	626	372	320	617	603	3,760
1998		25.33	1,254	659	388	336	642	629	3,933
1999		25.33	1,314	693	405	352	668	656	4,113
2000		25.33	1,374	730	422	365	695	683	4,294
2001		25.33	1,440	768	440	383	724	712	4,492
2002		25.33	1,509	808	459	402	754	743	4,700
2003		25.33	1,581	850	479	422	785	775	4,917

a/ Workshop facilities for general overhauls required after the first five years of operation.
b/ Includes estimated walk/wait time.

Source: Mission estimates

January 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Analysis
Alternative IV

(Cr$ million, mid-1979)

Year	Capital Cost	Rail Right-of-Way Maintenance Costs	Vehicle Operating Costs			Passenger Travel Time Costs a/			Total
			Road			Road			
			Car	Bus	Rail	Car	Bus	Rail	
1981	780.35								
1982	1,080.49								
1983	1,140.51								
1984		23.76	790	421	116	210	379	146	2,086
1985		23.76	849	492	116	226	446	146	2,298
1986		23.76	908	563	116	242	513	146	2,511
1987		23.76	972	645	116	259	590	146	2,751
1988		23.76	1,040	739	116	277	679	146	3,020
1989		23.76	1,113	846	116	296	781	146	3,321
1990		23.76	1,187	961	116	316	921	146	3,670
1991		23.76	1,262	998	116	343	963	146	3,851
1992		23.76	1,342	1,037	116	372	1,007	146	4,043
1993		23.76	1,427	1,077	116	404	1,053	146	4,246
1994		23.76	1,517	1,119	116	438	1,101	146	4,460
1995		23.76	1,613	1,163	116	475	1,152	146	4,688
1996		23.76	1,615	1,208	116	515	1,205	146	4,928
1997		23.76	1,823	1,255	116	559	1,260	146	5,182
1998		23.76	1,938	1,304	116	607	1,318	146	5,452
1999		23.76	2,060	1,355	116	659	1,379	146	5,738
2000		23.76	2,180	1,405	116	714	1,439	146	6,023
2001		23.76	2,317	1,460	116	775	1,505	146	6,342
2002		23.76	2,463	1,517	116	841	1,574	146	6,680
2003		23.76	2,618	1,576	116	912	1,646	146	7,037

a/ Includes estimated walk/wait time.

Source: Mission estimates

January 1980

TABLE 6.5

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Analysis
Alternative V

(Cr$ million, mid-1979)

Year	Capital Costs	Rail Right-of-Way Maintenance Costs		Vehicle Operating Costs			Passenger Travel Time Costs c/			
				Road			Road			
		Road a/	Rail	Car	Bus b/	Rail	Car	Bus	Rail	Total
1981	801.94									
1982	1,110.38									
1983	1,172.07									
1984		1.53	14.3	842	609	2.79	227	571	0.64	2,268
1985		1.53	14.3	921	640	2.79	250	599	0.64	2,429
1986		1.53	14.3	1,000	671	2.79	273	627	0.64	2,590
1987		1.53	14.3	1,086	703	2.79	298	656	0.64	2,762
1988		65.37	14.3	1,179	737	2.79	326	687	0.64	3,012
1989		1.53	14.3	1,280	772	2.79	356	719	0.64	3,146
1990		1.53	14.3	1,395	809	2.79	389	754	0.64	3,366
1991		1.53	14.3	1,477	835	2.79	417	795	0.64	3,543
1992		1.53	14.3	1,564	862	2.79	447	838	0.64	3,730
1993		65.37	14.3	1,656	890	2.79	479	883	0.64	3,991
1994		1.53	14.3	1,754	918	2.79	513	931	0.64	4,135
1995		1.53	14.3	1,857	947	2.79	549	981	0.64	4,353
1996		1.53	14.3	1,967	977	2.79	588	1,034	0.64	4,585
1997		1.53	14.3	2,083	1,008	2.79	630	1,090	0.64	4,830
1998		65.37	14.3	2,206	1,040	2.79	675	1,149	0.64	5,153
1999		1.53	14.3	2,336	1,073	2.79	723	1,211	0.64	5,362
2000		1.53	14.3	2,486	1,110	2.79	772	1,277	0.64	5,664
2001		1.53	14.3	2,630	1,145	2.79	827	1,346	0.64	5,967
2002		1.53	14.3	2,783	1,181	2.79	886	1,419	0.64	6,288
2003		65.37	14.3	2,944	1,219	2.79	949	1,496	0.64	6,691

a/ Specifically associated with the new highway under the present alternative.

b/ Buses in the express bus lanes of the new highway are expected to have an average occupancy rate of 60 passengers/bus during the peak hours compared with 81 for intermunicipal buses at present.

c/ Includes estimated walk/wait time.

Source: Mission estimates

January 1980

TABLE 6.6

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Analysis

Base Case

(Cr$ million, mid-1979)

Year	Capital Costs	Rail Right-of-Way Maintenance Costs	Vehicle Operating Costs			Passenger Travel Time Costs[a]			TOTAL
			Road			Road			
			Car	Bus	Rail	Car	Bus	Rail	
1981	-								
1982	-								
1983	-								
1984		14.3	840	688	2.79	217	651	0.64	2,414
1985		14.3	906	746	2.79	241	716	0.64	2,627
1986		14.3	972	804	2.79	265	781	0.64	2.840
1987		14.3	1,043	867	2.79	291	852	0.64	3,071
1988		14.3	1,119	935	2.79	320	930	0.64	3,322
1989		14.3	1,201	1,008	2.79	352	1,014	0.64	3,593
1990		14.3	1,289	1,079	2.79	385	1,106	0.64	3,877
1991		14.3	1,372	1,162	2.79	420	1,228	0.64	4,200
1992		14.3	1,460	1,251	2.79	458	1,363	0.64	4,550
1993		14.3	1,553	1,347	2.79	499	1,513	0.64	4,930
1994		14.3	1,652	1,451	2.79	544	1,679	0.64	5,344
1995		14.3	1,758	1,563	2.79	593	1,864	0.64	5,796
1996		14.3	1,871	1,683	2.79	646	2,069	0.64	6,287
1997		14.3	1,991	1,813	2.79	704	2,297	0.64	2,823
1998		14.3	2,118	1,953	2.79	767	2,550	0.64	7,406
1999		14.3	2,254	2,103	2.79	836	2,831	0.64	8,042
2000		14.3	2,400	2,259	2.79	906	3,227	0.64	8,810
2001		14.3	2,554	2,433	2.79	988	3,582	0.64	9,575
2002		14.3	2,717	2,620	2.79	1,077	3,976	0.64	10,408
2003		14.3	2,891	2,822	2.79	1,174	4,413	0.64	11,318

[a] Includes estimated walk/wait time

Source: Mission estimates

January 1980

TABLE 6.7

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Road Vehicle Operating Costs

(Cr$/vehicle-km) (mid-1979)

Item \ Vehicle	Car a/	%	Bus b/	%
Fuel	0.552	23	0.992	12
Lubricants and Washing	0.222	9	0.792	9
Maintenance	0.516	22	2.234	27
Tires	0.054	2	0.562	7
Salaries	-	-	0.556	7
Depreciation	0.542	23	1.602	19
Interest	0.246	10	0.688	8
Administration	0.264	11	0.960	11
Total	2.396	100	8.386	100

Speed Adjustment Factors

Speed km/hr	Car	Bus
60	1.0	-
50	1.01	1.024
40	1.05	1.05
30	1.14	1.15
20	1.35	1.41
10	1.98	2.26

a/ VW-1300 at 60 km/hr.
b/ MB-OM-362 Diesel at 55 km/hr.

Source: Dados Basicos: Manual de Custos de Operaçao de Vehiculos do DNER - 1976, vol. 1.

Road Vehicle Speed and Traffic Relationship (2 lanes in one direction)

(PCU's in one direction/hr)

Vehicle \ Speed (km/hr)	13	15	18	19	22	24	28	30	33	36	38
Car							2,109	1,513	1,500	1,397	1,088
Bus	2,914	2,819	2,773	2,231	2,450	1,515					

Source: Project Implementation Office, First Urban Transport Project, Porto Alegre.

January 1980

TABLE 6.3

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Economic Rail Operating Costs

Cost a/ / Item	Improved Diesel Service b/ (Cr$/train (7 cars)-km)	Rail Mass Transit System (Proposed Project) c/ (Cr$/unit(4 car)train-km)	Light Rail d/ (Cr$/unit(4 car)train-km)
Crew	20.17	2.86	2.86
Energy (diesel)	7.53	7.78	7.15
Lubrication	0.35	0.18	0.18
Train Maintenance	9.81	5.10	4.59
Depreciation	16.77	31.61	26.87
Interest	25.48	45.76	38.89
Stations	57.32	34.18	30.76
Administration	25.74	13.03	13.03
Total	163.17	140.50	124.33
Average daily train occupancy (passengers)	1,166	800	693
Cr$/pass-km	0.14	0.175	0.18

a/ Concept of long-run marginal costs.
b/ Assumed to operate at the outset at full capacity during peak hours (12 trains/hr;locomotive plus 7 cars/train;250 pass/car or 21,000 passengers in one direction per hour).
c/ Average applicable over project's life where traffic ranges from about 300,000 to 500,000 passengers daily.
d/ Assumed to operate at the outset at full capacity during the peak hours (17 trains/hr; 4 cars/train; 250 pass/car or 17,000 passengers in one direction).

Source: Mission estimates

January 1980

TABLE 6.9

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Passenger Travel Time Costs

Monthly Income:	Cr$ (mid-1979)
Average bus and existing train passenger:	4,200
Average car passsenger:	14,700
Average train passenger (new service):	6,193 a/

Working hours: 200 hrs/month

a/ Based on average diversion of 19% from cars and 81% from buses.

Source: METROPLAN and GEIPOT, Porto Alegre
November 1979

Most of the empirical studies of the value of non-working travel time savings indicate that commuters value time savings somewhere between one-fourth and one-half of their hourly earnings. IBRD, Bank Staff Working Paper No. 199, February, 1975. A Survey of the Theories and Empirical Investigations of the Value of Travel Time Savings.

A figure of 25% of hourly earnings was used. Therefore:

Bus and existing train (Cr$ 4,200 : 200).25 = Cr$ 5.25/hr or Cr$ 0.087/min.

Car (Cr$ 14,700 : 200).25 = Cr$18.37/hr or Cr$ 0.306/min.

Train (Cr$ 6,193 : 200).25 = Cr$ 7.74/hr or Cr$ 0.129/min.

January 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Description and Status of First Urban Transport Project

A. Project Description

1. The principal objectives of the project are: (a) to finance investments for improving urban transport services, with emphasis on public transport; (b) to promote the application of appropriate urban transport policies; and, (c) to strengthen municipal, state, and federal capacity to prepare and execute urban transport projects.

2. The project's components are being implemented in five cities: Belo Horizonte, Curitiba, Porto Alegre, Recife, and Salvador. Municipal and metropolitan-level agencies are responsible for project execution. EBTU (Empresa Brasileira dos Transportes Urbanos) is coordinating the project at the federal level and is channeling the Brazilian Federal Government's share of project funds. The total project cost is US$248.9 million, of which the World Bank's contribution is US$88 million (35%). The Brazilian federal share is US$87 million, with the balance coming from states and municipalities.

3. Components being carried out in the five cities are as follows:

(a) Belo Horizonte: traffic engineering works to improve circulation in the central area; a central area signal system; construction of exclusive bus lanes in two major corridors; Traffic Operations Programs to Increase Capacity and Safety (TOPICS) for critical congestion points; construction of a portion of a major link in the city transport network (Avenida Cristiano Machado); paving of bus access roads in poor areas.

(b) Curitiba: construction of a new structural axis (Estructural/Conectora 5); construction of eight bus terminals; paving for bus access in poor areas.

(c) Porto Alegre: construction of exclusive bus lanes in five "pre-corridors"; construction of an overpass to complete a major portion of the first perimeter road; improvements to speed traffic flow on two other major arteries; paving in poor areas.

(d) Recife: Central Area Improvements consisting of exclusive bus facilities, bus terminals, and traffic engineering measures; TOPICS improvements on three major radial routes; construction of missing links in the second perimeter road; paving in poor areas; and technical assistance and equipment to create a bus maintenance facility.

(e) Salvador: construction of bus lanes in six central area corridors; construction of, or major improvements to, four large bus terminals; TOPICS improvements at critical points; provision of traffic enforcement equipment; paving and small terminals in poor areas.

4. In addition, EBTU and the cities will receive technical assistance to carry out the following: a project monitoring and evaluation program; studies of bus operations and transport regulation in Recife; a study of the development of metropolitan urban transport companies; a study of the relationships between employment, urban poverty, and transport; and a study on the potential for introducing urban road pricing in Brazil.

B. Project Status

5. Works are under way in all cities. Construction projects are being carried out in all cities. Recife and Salvador were slow to start executing physical works. Recife has recently made considerable progress and Salvador is expected to begin executing its components more efficiently in 1980. Paving in low-income areas is well advanced in all cities, and final designs for most other works are finished or nearing completion. Curitiba is the most advanced of the five cities.

6. The principal problems, so far, have been execution delays caused by the Government change in early 1979 and by weaknesses in managerial capacity in some cities. The situation is improving. World Bank disbursements, up to the end of March 1980, totaled US$12.0 million, about 34% of the amount programed to that date.

March 1980

BRAZIL

SECOND URBAN TRANSPORT PROJECT

EBTU's Organization, Resources and Finances

A. Organization

1. The Empresa Brasileira dos Transportes Urbanos (EBTU) was established by Law No. 6261 of November 14, 1975 and organized as shown on Chart 1. It is a fully Federal Government-owned company under the jurisdiction of the Ministry of Transport, but with administrative and financial autonomy, independent juridical status, and its own assets and liabilities. The governing body of EBTU is the Administrative Council, which is chaired by the Minister of Transport, and includes, in addition to EBTU's President, five members designated by the Minister of Transport. The financial execution of its policies is overseen by a Fiscal Council, and day-to-day management is the responsibility of the Board of Managing Directors. The Administrative Council's main responsibility is to define the steps required to formulate, implement and execute national urban transport policies in accordance with national transport and urban development plans. EBTU's assets, liabilities and accounts are monitored by the Fiscal Council, whose three members are also appointed by the Minister of Transport.

2. The Board of Managing Directors is chaired by EBTU's President, who is appointed to a four-year term by the President of the Republic from a list of nominees suggested by the Minister of Transport. The Board also includes four Directors who are appointed to a four-year term by the Minister of Transport from a list of nominees suggested by EBTU's President. Each director is in charge of one area, i.e., administration, finance, operations and technical. The main activity of the Board of Directors is to promote, at the national level, the implementation of national urban transport policies in accordance with the general policy guidelines elaborated by its administrative council in coordination with the National Urban Development Council (CNDU).

3. EBTU's staff presently numbers about 315, evenly distributed among the President's office and the other four Directorates; all staff are located in Brasilia. Salaries are at the level of any other Federal Government organization and compare well with those of the private sector.

B. Resources

4. Until 1980, EBTU's resources were principally derived from the Urban Transport Development Fund (FDTU), which accounted for over 90% of EBTU's resources. Other federal budget funds made up the balance. The FDTU funds came from: (a) 14% of the proceeds of the vehicle registration tax, (b) a 0.5% surtax on leisure vehicle registration and (c) 45% of the proceeds of the 12% surtax on lubricants and liquid and gaseous fuels.

5. As of January 1, 1980, EBTU will have an additional source of funds from the Energy Mobilization Program (PME) which was created by Law 1691 of August 2, 1979. EBTU is expected to receive about 65% of the PME. The PME funds will come from (a) a new surtax of 12.5% on the CIF value of crude oil imports and from (b) 26% of the proceeds of the vehicle registration tax. The sources of FDTU funds will also change: (a) 12% of the proceeds of the vehicle registration tax and (b) 45% of the proceeds of the 12% surtax on lubricants and liquid and gaseous fuel. The resources available to EBTU in the past and in the future as forecast by the Ministry of Transport, based on these new percentages and their forecast of total tax revenues, are shown below:

	(Constant mid-1979 Cr$ billion)				
	Actual			Estimated	
	1976	1977	1978	1979	1980/1982
FDTU					
Vehicle Registration Tax	1.4	2.2	2.0	1.9	11.2
Surtax on Vehicle Registration	1.1	1.6	1.5	1.5	-
Surtax on Lubricants and Liquid and Gaseous Fuels	2.2	3.1	3.2	4.2	12.6
Other Federal Budget Funds	-	1.2	2.2	2.1	2.5
PME	-	-	-	-	18.5
	5.7	8.1	8.9	9.7	44.8

C. Financial Position

6. Comparative balance sheets and income statements for the period 1976-1978 are shown in Tables 1 and 2 of this annex. For its services, EBTU receives a 3% administrative commission. In 1978, EBTU generated surplus administrative receipts of CR$ 37.4 million, which were distributed in the form of financial grants to support subsidiary companies.

7. EBTU's financial structure is generally sound. The company does not borrow on its own, and the administrative commission it receives is sufficient to enable it to perform its responsibilities efficiently.

D. Budgets

8. EBTU prepares annual administrative and operational budgets which must be approved by the Ministry of Transport and the Ministry of Planning. The operating/investment budget shows only general categories of items (e.g., suburban trains, metro (underground), trolly-bus, road paving, and passenger-bus terminals). Although the present system allows EBTU to be flexible in

the allocation or reallocation of funds, the budget does not indicate individual projects. EBTU agreed during negotiations that it would employ, by December 31, 1980, consultants, whose terms of reference would be satisfactory to the Bank, to help "projectize" the budget.

E. Accounts

9. The accounting system of EBTU is very cumbersome, and the financial statements, as well as other financial management information, are produced after considerable delay. Consequently, the management of EBTU relies mainly on budget data, which are updated in accordance with available cash flow data. EBTU agreed during negotiations that it would hire, by December 31, 1980, consultants, whose terms of reference would be satisfactory to the Bank, to streamline its accounting system.

F. Audit

10. EBTU's auditing arrangements are generally satisfactory. According to Article 42 of Decree-Law 199 of February 25, 1967, all Federal Government-owned companies under the jurisdiction of the Ministry of Transport are subject to the external audit of the Financial Directorate of the Ministry of Transport. Upon completion of this audit, the financial statements of EBTU and the audit report of the Ministry of Transport are sent to the Federal Accounting Office (Comptroller General of the Federal Union) for ratification. This audit is essentially an accounts verification function which determines if the funds disbursed and other financial transactions undertaken by EBTU are executed in accordance with its charter.

11. In addition, the Inspector General of Finance of the Ministry of Finance conducts the external audit for those projects being financed with foreign funds, which includes the Bank-financed First Urban Transport Project. Generally, the audits performed by the Inspector General of Finance are of high caliber. The Inspector General's audit report contains information on the existing internal control system of the federal and local agencies involved in project execution and provides, when applicable, comments for improving the accounting system and controls.

February 1980

ANNEX 2
Table 1

BRAZIL

SECOND URBAN TRANSPORT PROJECT

EBTU: Comparative Balance Sheets, December 31, 1976-1978

(Millions of current cruzeiros)

Assets	1976	1977	1978
Current Assets			
Cash Bank Balances - Administrative account	4.8	1.3	35.9
Cash Bank Balances - Operational account	197.3	336.9	180.5
Interest Earning Funds (Bank Deposits)	105.0	84.9	-
	307.1	423.1	216.4
Accounts Receivable	-	0.3	0.9
Deferred Debits	-	1.3	1.2
Investments			
Share ownership in other companies (Subsidiaries)	21.1	1,643.5	5,519.2
Fixed Assets (Net)			
Buildings and dwellings for staff	16.1	93.1	240.3
Other Assets 1/			
Undisbursed balance - First Urban Transport Project (Loan 1563-BR) - (US$86.7 million)	-	-	1,801.3
Disbursed portion - First Urban Transport Project (Loan 1563-BR) - (US$1.3 million)	-	-	26.2
Exchange rate adjustment on disbursed portion	-	-	1.1
	-	-	1,828.6
Advances for Project Work in Progress			
On account of First Urban Transport Project - Loan 1563-BR	-	-	90.1
Total Assets	344.3	2,161.3	7,896.7

Liabilities and Equity	1976	1977	1978
Current Liabilities	7.1	14.1	32.7
Long-Term Borrowings 1/			
First Urban Transport Project IBRD Loan 1563-BR (US$88.0 million)	-	-	1,827.5
Exchange rate adjustment on disbursed portion	-	-	1.1
	-	-	1,828.6
Other Liabilities			
Funds to be allocated for project work in progress	197.3	336.9	270.6
Equity			
Share capital	100.0	1,630.0	1,630.0
Reserves	39.9	180.2	4,134.8
	139.9	1,810.2	5,764.8
Total Liabilities and Equity	344.3	2,161.2	7,896.7

1/ Other assets and long-term borrowing accounts refer to in and out transactions whereby EBTU serves as a financial intermediary for the Federal Government. The amount shown in the liability column is a Federal Government debt which is matched by funds available to the Federal Government (IBRD Loan 1563-BR).

Source: EBTU

November 1979

ANNEX
Table 2

BRAZIL

SECOND URBAN TRANSPORT PROJECT

EBTU: Comparative Income Statements, Years Ended December 31, 1976-1978

(Millions of current cruzeiros)

Expenses	1976	1977	1978
Administrative expenses	15.4	86.3	133.9
Financial and other general expenses	0.3	5.2	11.1
Grants - Financial support to subsidiary companies	-	32.7	37.4
	15.7	124.2	181.4
Other Expenses:			
Project work "Fond Perdu"	1,385.9	1,973.7	2,836.4
Interest and commissions on borrowings - First Urban Transport Project Loan 1563-BR	-	-	5.4
Interest and commissions on operational funds collection - Banco do Brasil and DNER	13.2	22.8	68.0
	1,399.1	1,996.5	2,909.8
Provision Fund for Income Taxes	6.0	6.4	8.1
Total Expenses	1,420.8	2,127.1	3,099.3
Net Profit	19.9	16.3	527.0
	1,440.7	2,143.4	3,626.3

Income	1976	1977	1978
Administrative receipts	41.6	108.5	158.9
Interest on Bank deposits	-	38.4	22.5
Monetary correction on investments	-	-	535.1
	41.6	146.9	716.5
Other Income:			
Operational funds - FDTU	1,399.1	1,996.5	2,909.8
	1,440.7	2,143.4	3,626.3

Source: EBTU

November 1979

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Assessment of the Development Master Plan for the MRPA

1. The essential objective of the Region's Development Master Plan, published in 1973, was to bring about a more efficient and equitable spatial distribution of urban activities and a more efficient utilization of available land, to be achieved primarily through the dispersal of population and employment growth to the north-south and east-west corridors. In order to serve the existing development more effectively and provide for the projected growth in the north-south corridor, a major increase in transport capacity was proposed. A specific recommendation for a suburban railway was subsequently proposed in a transport master plan for the region.

2. In assessing the Development Master plan, several points are relevant. First, actual metropolitan area growth has been much higher than assumed under the Plan, largely as a result of the high level of migration, which also implies a poorer, less skilled population structure. Second, while the Plan assumed a significant increase in the activity rate (registered jobs/person) from 28.38 in 1973 to 34.36 in 1985, the evidence to date suggests that this figure is unrealistic since population continues to increase more rapidly than employment. Moreover, the response of METROPLAN to this possibility has been to assume the realization of the desired activity rate by advancing the 1991 target employment projection to 1985. Third, the predicted shift in the structure of employment from the tertiary to the secondary sector is not being achieved. Thus, while the secondary sector is growing, it is growing less rapidly than the tertiary sector (Table 2.3 of the report). Fourth, this difference in the structure of employment has been accompanied by changes in its spatial distribution, with Porto Alegre retaining a far more dominant position than assumed by the Plan. Moreover, while population in the east-west corridor has grown rapidly, the Plan's objective of relocating industry there has been far less successful than anticipated. To date, only five planned industrial districts have been established (at Gravatai, Alvarado/Viomao Cochoerinha, Porto Alegre and Campo Bom) compared with the Plan's objective of creating 32 industrial districts providing over 200,000 jobs.

3. In examining the possible reasons for the differences between the projections of the Plan and subsequent events, the following comments can be made. The Porto Alegre Plan was primarily based on physical design principles and had a limited economic content. Thus, while a number of alternative spatial patterns were developed and evaluated, very little attention appears to have been given to the implications of, for example, migration on the region's future demographic and economic base and the consequences with regard to the distribution of land uses.

4. These technical weaknesses in the planning process would make it extremely difficult, if not impossible, for the adopted Master Plan to adjust to the types of structural and spatial variances described above. Furthermore, METROPLAN'S powers of implementation are limited. In the current situation, the main policy instruments (e.g., zoning) are in the hands of the individual municipalities.

5. In the light of the foregoing, it is important to consider the consistency of the suburban railway proposal, the original Master Plan and subsequent events. Although the suburban railway proposal is compatible with the primary objective of the Plan, notably the dispersal of population and employment growth from Porto Alegre and the consolidation of growth in a few large employment centers in the north-south corridor, it would not serve the secondary objective of increasing the relative growth of the east-west corridor. Of course, whether these two objectives could be achieved at the same time is doubtful in the first place, regardless of what is done. In any case, events subsequent to the Master Plan, particularly the increasing concentration of activities in the north-south corridor, have made the secondary objective even much less likely to be achieved and have brought planners to the realization that their attention should be focused on the north-south corridor, thus strengthening the case for providing additional transport capacity in that area.

November 1979

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SECOND URBAN TRANSPORT PROJECT

Land Use Alternatives and Travel Demand Forecasts

A. Land Use Alternatives

1. Land Use 1:

(a) continuation of the present rate of migration through 1990, resulting in an annual population growth rate of 5%;

(b) 1990-2000, annual average population growth of 4%;

(c) continuation of a constant activity rate of 27%; and

(d) the distribution of metropolitan area-wide population and employment forecasts to 46 traffic zones on the basis of each zone's existing share of metropolitan population and employment growth, making no allowance for any density constraints.

2. Land Use 2:

(a) continuation of present migration rates through 1990, resulting in an annual population growth of 5%;

(b) 1990-2000, annual average population growth of 4%;

(c) an increase in the activity rate as assumed under the Master Plan; and

(d) the distribution of population and employment to 46 traffic zones, assuming the achievement of the Master Plan's objectives in the east-west corridor and those of the individual municipal master plans in all other municipalities.

3. Land Use 3:

(a) continuation of present migration rates only through 1985, resulting in an annual population growth of 5%;

(b) 1985-1990, annual average population growth of 4%;

(c) 1990-2000, annual average population growth of 3%;

(d) the continuation of a constant activity rate of 27%; and

(e) the distribution of the metropolitan area-wide population and employment forecasts to 46 traffic zones on the basis of each zone's axisting share of metropolitan area population and employment growth, subject to that growth being capable of accommodation under maximum density assumptions. Growth that cannot be accommodated is reallocated to the next most rapidly growing zone.

4. Land Use 4:

this alternative is identical to land use 3, subject to the introduction of commercial centers along the suburban railway line at Canoas and Sao Leopoldo. These centers were introduced by assuming the redistribution of an equivalent amount of tertiary employment from Porto Alegre's CBD to each center.

5. On the basis of recent trends in the growth and spatial distribution of population and employment, it was concluded that land uses 3 and 4 were most representative of the future evolution of the metropolitan area. Consequently, land use 3 was adopted as the population and employment base for travel demand forecasts to be applied to all the project alternatives examined (Chapter IV) other than for the suburban railway (proposed project) and the light rail alternative. In these two latter cases, land use 4, incorporating the development of commercial centers along the line, was adopted. Tables 1 and 2 of this annex illustrate the distribution of population and employment associated with land use 3 for the forecast years of 1985, 1990 and 2000. Table 3 of this annex summarizes the amount of tertiary employment redistributed from the Porto Alegre CBD to each of the three commercial centers in each of the forecast years under land use 4.

B. Trip Generation

6. Total daily person trip rates for bus and car were projected forward from the 1974 survey base to 1985, 1990 and 2000 respectively. This was done for each of the 46 metropolitan area traffic zones. A series of regressions was run for person trip generation rates against socio-economic variables which included population density, employment and income changes. This analysis produced statistically insignificant and high autocorrelated results. Therefore, instead, total daily bus and car person trips were forecast forward by applying the 1974 trip rates to the 1985, 1990 and 2000 zonal population projections. The implication of this is two-fold: first, total demand is probably understated by failing to take account of increased trip-making as a result of increasing income levels, particularly with respect to automobile trips; and second, while the proportion of car to bus trips is held constant over time, the evidence suggests that car trips are increasing more rapidly. Both assumptions are consistent with the cautious approach adopted in estimating the demand for the train.

C. Trip Distribution

7. The resulting trip generation forecasts under the two alternative land uses were then distributed to destination zones on the following basis. For each

origin zone, the growth in total, bus and car person trip made over each forecast period was distributed to each of the 46 destination zones as a function of the proportion of the total metropolitan area employment growth experienced by that zone over the same period. The resulting 46 x 46 trip growth matrix was then added to the base year trip matrix to produce a total daily person, bus and car trip matrix for each forecast year and for land uses 3 and 4.

D. Modal Distribution

8. The demand for the suburban railway project was assessed under land use 4. First, all zonal pairs in the 46 x 46 matrix outside the area of influence of the suburban railway were eliminated. This included all intramunicipal zonal pairs (those relatively short trips were assumed to continue to be made by bus and car) and all those zonal pairs which do not involve essentially north-south trips. The remaining zonal pairs were considered to constitute a physically possible area of influence for the suburban train without yet taking account of probable modal choice behavior. From this physical area of influence were substracted all those zonal pairs for which it would be physically impossible to go by train without phase II (Sapacuia-Novo Hamburgo) of the railway project. The result is two matrices representing the physically possible area of influence of the suburban railway under phase I and phase II, respectively.

9. The phase I matrix was analyzed in detail regarding the question of modal choice. To do this, the travel time characteristics by different modes between zones were analyzed. The model used in this analysis related train trips as the dependent variable to the ratio of travel time in the north-south corridor (the railway or BR-116) to total travel time as the independent variable. This model was calibrated based on the experience of Bank consultants in other countries. The result of this zonal analysis is that, by 1985, approximately 10% of all intermunicipal car users in the corridor area of influence are forecast to divert to the railway, increasing to about 25% by 1990 and remaining constant at that percentage until 2000. The corresponding figure for intermunicipal bus diversion for the three forecast years was forecast to be about 50%.

10. The 46 x 46 train trip matrix was then collapsed into a 14 x 14 station matrix in phase I. Finally, the trips diverted to the train were deducted from the original 46 x 46 bus and car trip matrix to provide the bus and car travel demand forecast at 1985, 1990 and 2000, assuming the implementation of the suburban rail project.

BRAZIL

SECOND URBAN TRANSPORT PROJECT

ANNEX 4
Table I

Land Use 3
Population by Zone

Municipalities	Zones/Year	1974	1980	1985	1990	2000
Guaíba	1	43.740	64.246	88.011	110.000	172.000
	2	81.950	102.860	123.652	140.000	178.000
	3	585.920	722.586	852.668	953.000	1.186.000
	4	72.270	80.791	87.318	88.000	89.000
	5	153.290	189.267	223.667	251.000	312.000
	6	24.000	35.568	47.663	60.000	90.000
	7	5.160	6.110	7.032	8.000	9.000
	8	88.360	98.525	106.070	107.000	108.000
	9	4.760	5.714	6.642	7.000	8.000
Porto Alegre		1.015.710	1.241.421	1.454.322	1.614.000	1.980.000
Viamão	10	96.150	160.320	238.066	330.000	466.000
Alvorada	11	66.340	123.748	195.162	282.000	410.000
Cachoeirinha	12	46.370	79.633	120.321	169.000	287.000
Gravataí	13	71.570	111.685	159.392	214.000	342.000
	14	68.480	84.069	99.124	110.000	124.000
	15	4.830	7.350	10.253	13.000	20.000
	16	24.500	31.209	38.096	44.000	52.000
	17	990	1.308	1.600	1.900	2.000
	18	30.180	42.787	57.286	73.000	104.000
	19	7.200	14.396	23.422	35.000	62.000
	20	35.900	48.022	61.236	74.000	99.000
	21	5.960	7.900	10.000	13.000	18.000
	22	9.900	13.993	18.530	23.000	34.000
	23	140	3.271	7.431	13.100	28.000
Canoas		188.080	254.305	326.978	400.000	543.000
	24	20	28	40	50	100
	25	26.380	33.474	40.709	46.400	54.100
	26	13.070	16.301	19.500	21.450	24.600
	27	920	997	1.034	1.100	1.200
Esteio		40.390	50.800	61.283	69.000	80.000
	28	4.100	4.198	5.594	6.700	7.000
	29	28.790	46.660	68.243	94.000	108.000
	30	20.300	31.139	43.382	56.000	60.000
	31	5.500	12.690	20.759	31.300	45.000
Sapucaia do Sul		58.690	94.687	137.978	188.000	220.000
	32	3.090	3.168	3.328	3.400	3.500
	33	2.320	2.376	2.435	2.500	2.600
	34	44.810	53.142	60.313	64.100	72.900
	35	4.660	7.303	10.066	13.000	17.000
	36	10.960	11.834	12.339	12.000	13.000
	37	7.070	9.282	11.364	13.000	16.000
São Leopoldo		72.910	87.105	99.845	108.000	125.000
	38	4.980	6.737	7.000	8.000	11.000
	39	14.840	20.932	28.480	37.000	53.500
	40	130	172	214	300	400
	41	9.320	13.144	17.291	22.500	31.000
	42	73.260	99.310	128.743	156.000	212.000
	43	2.430	2.823	3.560	4.200	5.100
Novo Hamburgo		104.960	143.118	185.288	228.000	313.000
Estância Velha	44	11.890	18.108	25.434	34.000	52.000
Campo Bom	45	23.320	37.544	54.640	74.000	120.000
Sapiranga	46	23.380	38.280	56.280	78.000	128.000
MRPA		1.863.500	2.505.000	3.203.000	3.898.000	5.238.000

Source: METROPLAN

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SECOND URBAN TRANSPORT PROJECT

Land Use 3

Employment by Zone

		1985			1990			2000		
		SECONDARY	TERTIARY	TOTAL	SECONDARY	TERTIARY	TOTAL	SECONDARY	TERTIARY	TOTAL
Guaíba	1	19 900	8 000	27 900	28 100	10 800	38 900	51 900	18 000	69 900
	2	2 300	7 900	10 200	3 500	11 200	14 700	4 100	19 200	23 300
	3	36 300	173 100	209 400	35 600	210 500	246 100	38 700	276 000	314 700
	4	30 500	229 800	260 300	21 000	262 000	283 000	12 500	304 300	316 600
	5	22 700	37 200	59 900	23 900	52 700	76 600	26 200	81 500	107 700
	6	1 500	3 400	4 900	2 300	5 200	7 500	4 700	9 500	14 200
	7	-	500	500	-	600	600	-	800	800
	8	28 700	47 700	76 400	32 300	61 700	94 000	34 900	90 700	125 600
	9	5 500	2 500	8 000	14 800	2 700	17 500	21 200	3 000	24 200
Porto Alegre		127 500	502 100	629 600	133 400	606 600	740 000	142 300	785 000	927 300
Viamão	10	300	9 700	10 000	400	14 600	15 000	800	22 000	22 800
Alvorada	11	1 200	6 000	7 200	1 900	9 400	11 300	3 900	15 000	18 900
Cachoeirinha	12	7 700	6 100	13 800	10 500	9 400	19 900	15 500	17 000	32 500
Gravataí	13	8 900	7 700	16 600	12 700	11 300	24 000	25 600	20 000	45 600
	14	5 800	3 300	9 100	6 800	4 500	11 300	8 200	6 700	14 900
	15	1 900	1 700	3 600	2 500	1 800	4 300	3 700	2 000	5 700
	16	2 500	1 300	3 800	3 200	2 000	5 200	4 800	3 400	8 200
	17	-	200	200	-	200	200	-	200	200
	18	1 300	6 200	7 500	1 400	8 800	10 200	1 700	13 600	15 300
	19	1 400	500	1 900	2 000	800	2 800	2 300	2 000	4 300
	20	1 800	3 100	4 900	1 800	5 000	6 800	1 700	7 700	9 400
	21	11 300	5 800	17 100	14 300	6 200	20 500	27 800	6 800	34 600
	22	10 600	1 200	11 800	13 000	1 700	14 700	22 300	3 000	25 300
	23	1 000	200	1 200	4 300	300	4 600	11 700	600	12 300
Canoas		37 600	23 500	61 100	49 300	31 300	80 600	84 200	46 000	130 200
	24	-	-	-	-	-	-	-	-	-
	25	2 300	4 300	6 600	2 800	5 200	8 000	3 900	6 600	10 500
	26	3 700	2 800	6 500	4 300	3 400	7 700	5 600	4 200	9 800
	27	400	-	400	1 000	-	1 000	1 300	200	1 500
Esteio		6 400	7 100	13 500	8 100	8 600	16 700	10 800	11 000	21 800
	28	11 300	400	11 700	12 200	500	12 700	15 800	600	16 400
	29	1 200	3 600	4 800	1 600	5 400	7 000	2 300	7 000	9 300
	30	200	1 900	2 100	300	2 800	3 100	400	3 400	3 800
	31	-	500	500	100	700	800	100	1 000	1 100
Sapucaia do Sul		12 700	6 400	19 100	14 200	9 400	23 600	18 600	12 000	30 600
	32	600	100	700	600	100	700	700	200	900
	33	600	200	800	600	200	800	700	300	1 000
	34	8 500	12 500	21 000	8 800	13 900	22 700	8 800	17 200	26 000
	35	1 800	400	2 200	2 300	500	2 800	3 500	1 000	4 500
	36	900	900	1 800	1 100	1 000	2 100	1 500	1 100	2 600
	37	1 900	3 100	5 000	2 200	3 300	5 500	2 500	4 200	6 700
São Leopoldo		14 300	17 200	31 500	15 600	19 000	34 600	17 700	24 000	41 700
	38	200	3 000	3 200	300	4 100	4 400	500	6 100	6 600
	39	5 800	1 600	7 400	6 800	2 300	9 100	9 700	4 400	14 100
	40	800	100	900	1 200	100	1 300	4 000	200	4 200
	41	3 200	900	4 100	3 800	1 400	5 200	5 500	2 400	7 900
	42	28 500	16 400	44 900	30 000	21 500	51 500	32 000	30 600	62 600
	43	300	100	400	400	200	600	900	300	1 200
Novo Hamburgo		38 800	22 100	60 900	42 500	29 600	72 100	52 600	44 000	96 600
Estância Velha	44	6 200	2 100	8 300	8 400	3 000	11 400	14 500	5 000	19 500
Campo Bom	45	13 700	3 200	16 900	15 300	4 800	20 100	19 100	9 000	28 100
Sapiranga	46	12 600	4 300	16 900	15 300	6 500	21 800	22 500	12 000	34 500
MRPA		307 800	625 500	933 300	355 700	774 300	1 130 000	480 000	1 040 000	1 520 000

Source: METROPLAN .

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BRAZIL

SECOND URBAN TRANSPORT PROJECT

Land Use 4

Tertiary Employment Distributed from Porto Alegre, CBD to the Commercial Centers

Commercial Center	Year 1985	1990	2000
Canoas	5,000	10,000	30,000
Sao Leopoldo	-	5,000	15,000
Novo Hamburgo a/	-	8,000	30,000
Total by Year	5,000	23,000	75,000

a/ Based on the assumption that line is extended to Novo Hamburgo in Phase II.

Source: METROPLAN

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BRAZIL

SECOND URBAN TRANSPORT PROJECT

Selected Documents and Data Available in the Project File

A. Urban Transport Sector

A1. Plano Nacional de Transportes: Diagnostico and Prognostico, GEIPOT, 1978.

B. Selected Reports and Studies Relating to MRPA and the Project

B1. Regiao Metropolitana de Porto Alegre, Plano de Desenvolvimento Metropolitana, 1973.

B2. Estudo de Transporte Coletivo da Regiao Metropolitana de Porto Alegre, GEIPOT, 1976.

B3. Plano Diretor de Transportes Urbanos da Regiao Metropolitana de Porto Alegre, GEIPOT, 1976.

B4. Estudo de Tren Suburbano da Regiao Metropolitana de Porto Alegre. TRENSURB-P.A., GEIPOT, 1976.

B5. Transportes Urbanos, projeto EBTU-BIRD, Porto Alegre-1978.

B6. Porto Alegre Suburban Rail Project, Nathaniel Lichfield and Partners, September 1979.

B7. Computer Printout File on Passenger Trip Matrices.

B8. Human Resources Special Report, Annex I - Population, Brazil Country Programs Division, November, 1978.

C. Working Papers

C1. Detailed Staffing Analysis of PAMRAIL.

C2. Capital Cost Estimates for Project Alternatives in Economic Analysis.

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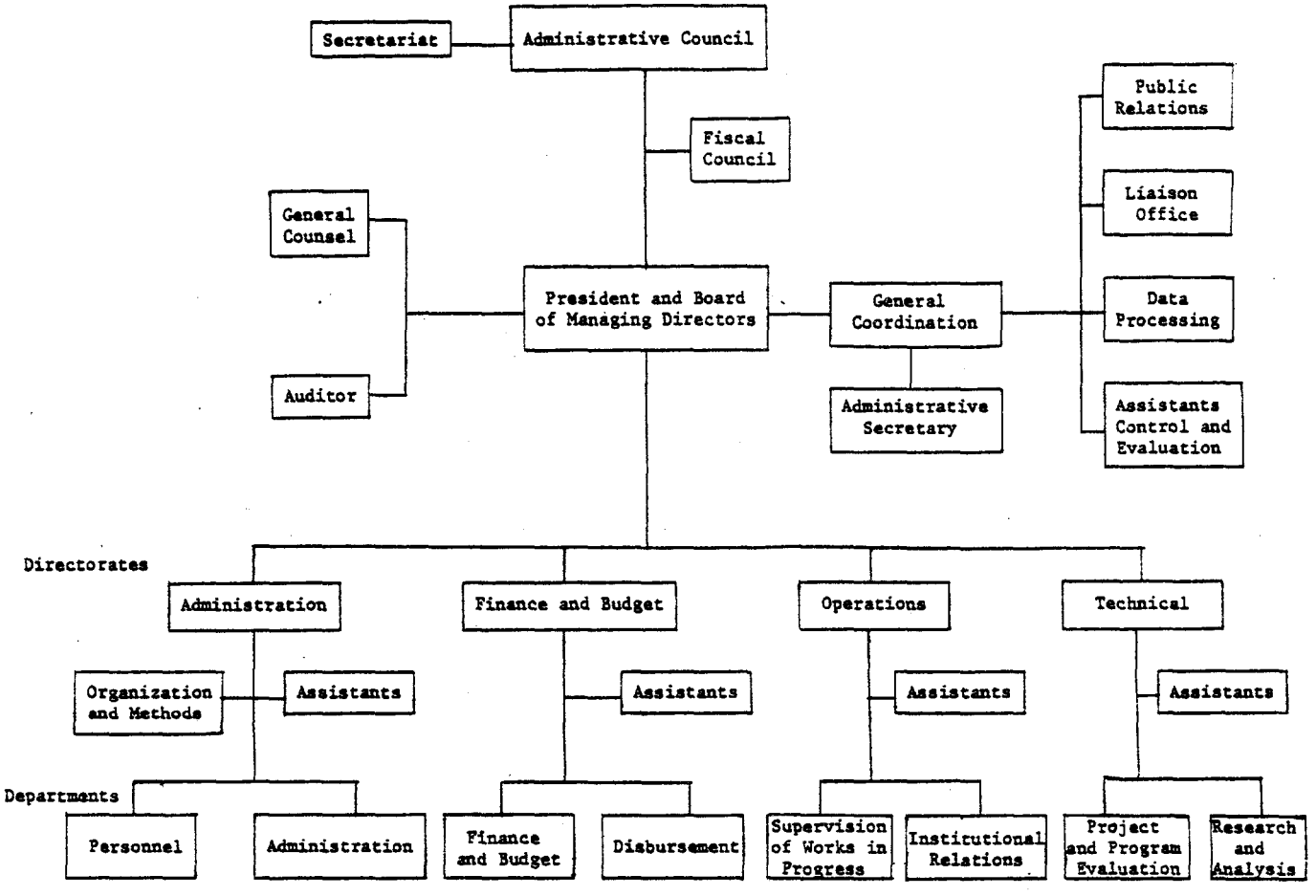
CHART 1

BRAZIL

SECOND URBAN TRANSPORT PROJECT

Empresa Brasileira dos Transportes (EBTU)

Organization Chart



Source: EBTU

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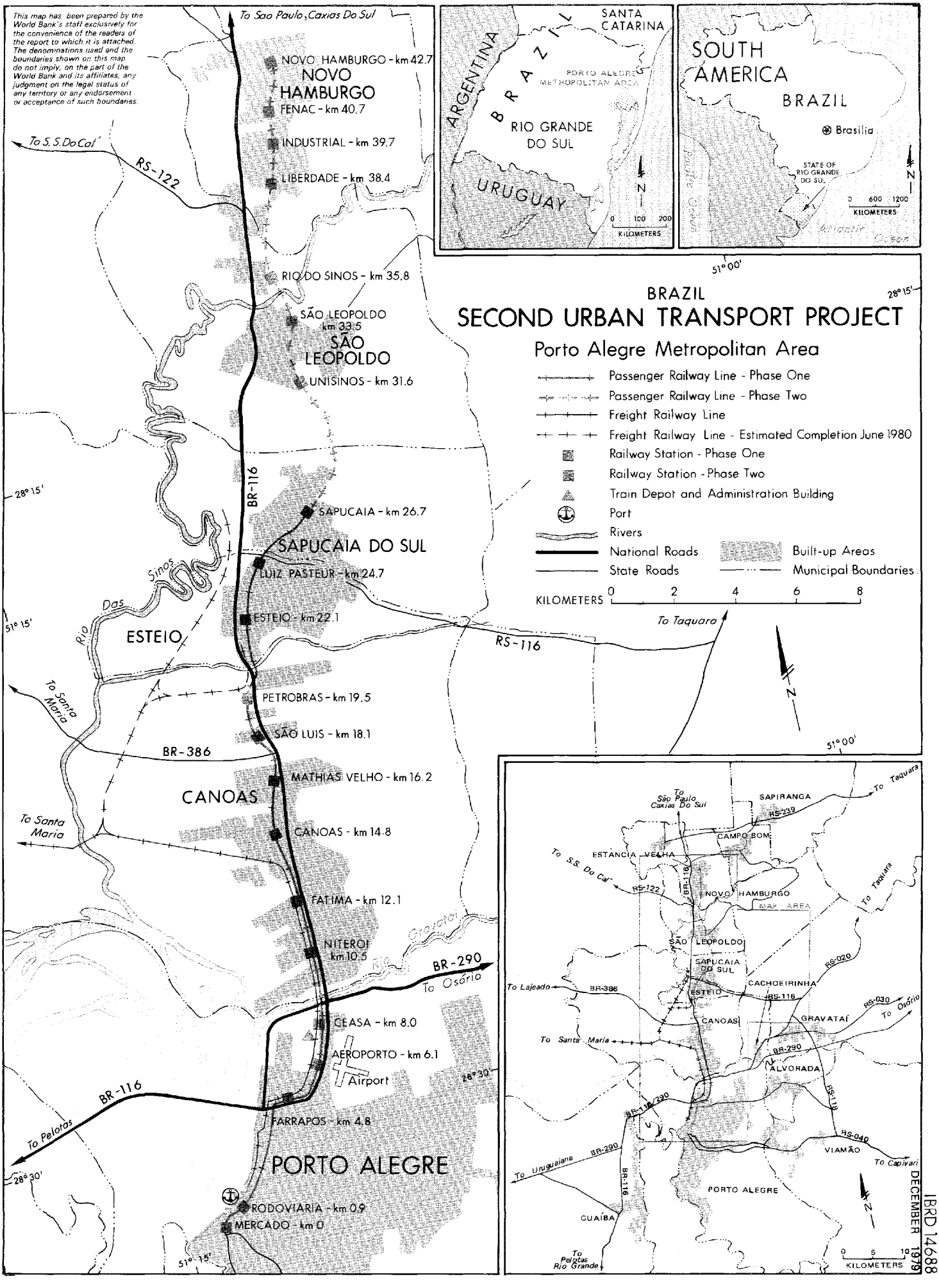

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