REPORT

ON

THE PRELIMINARY SURVEY

OF

THE MODERNIZATION OF THE RAILWAY

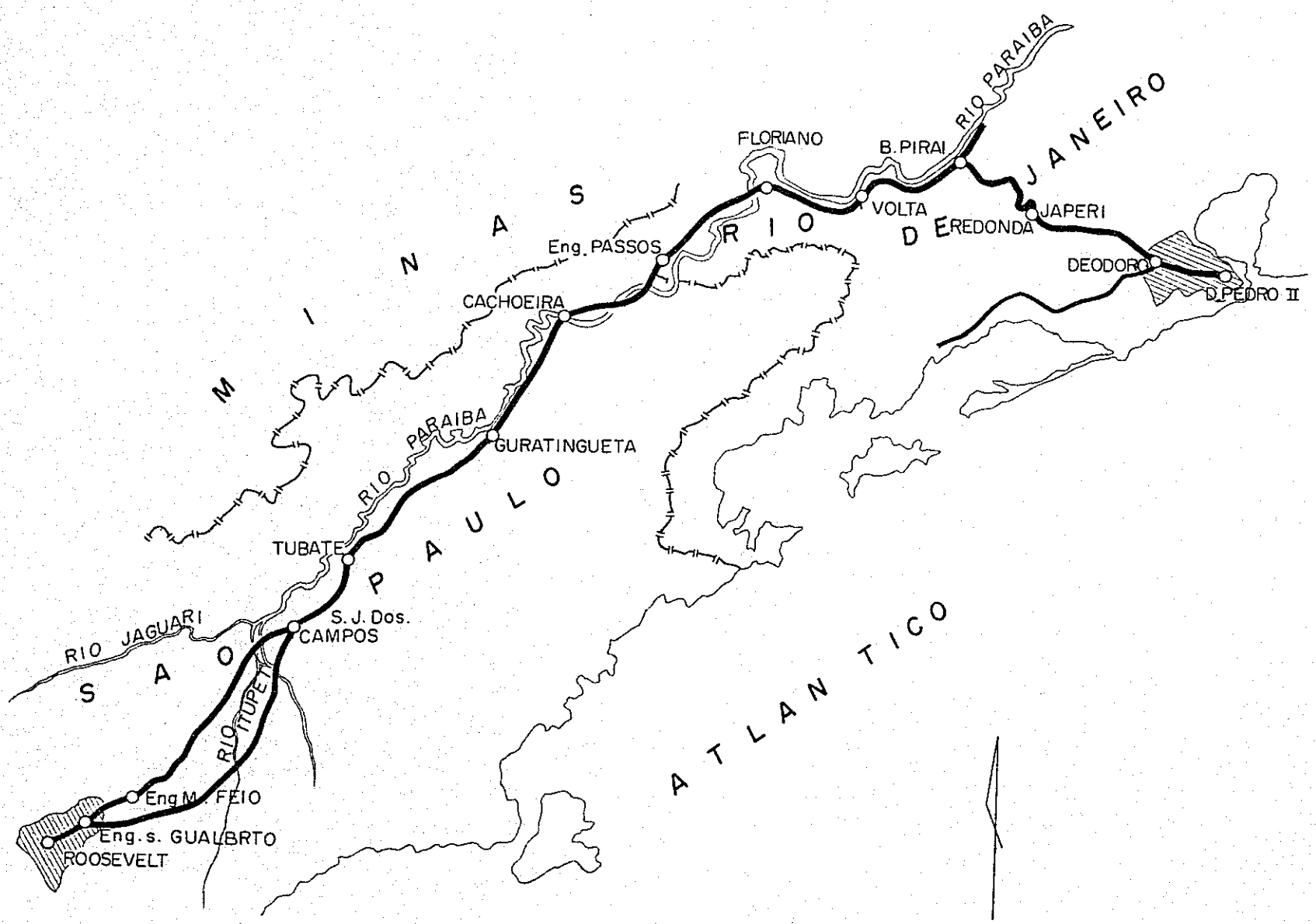
BETWEEN

RIO DE JANEIRO AND SÃO PAULO

BRAZIL

1968

OVERSEAS TECHNICAL COOPERATION AGENCY


MINAS
RIO DE JANEIRO
SAO PAULO
ATLANTICO
FLORIANO
B. PIRAI
RIO PARAIBA
VOLTA REDONDA
JAPERI
DEODORO
D. PEDRO II
Eng. PASSOS
CACHOEIRA
RIO PARAIBA
GURATINGUETA
TUBATE
RIO JAGUARI
S. J. Dos. CAMPOS
RIO ITUPET
Eng M. FEIO
Eng. s. GUALBRTO
ROOSEVELT

PREFACE

The survey for the modernization of the railway line between Rio de Janeiro and Sao Paulo, Brazil by Japanese experts was carried out under the direction of Japanese Government according to the request of the Ministry of Transport of Government of Brazil.

The request was offered officially to the Japanese Government through the Japanese Embassy in Rio de Janeiro by the Ministry of Transport of the Government of Brazil through the Department of National Railway of Brazil (Departamento Nacional do Estradas de Ferro) (DNEF) in December of 1967.

Answering the request, the Government of Japan decided to dispatch a survey team to Brazil, and in accordance of such decision the scope, the schedule and the terms of the survey works were agreed upon between the DNEF and the Japanese Embassy in Rio de Janeiro in March of 1968.

Under the above agreement, the Japan Overseas Technical Cooperation Agency (OTCA) arranged the schedule and nominated the experts for this purpose as follows:

Time of Survey :	One month of on-the-spot survey, starting in April 1968.
Experts of team :	
Consulting Engineer	Syuitiro Satoh Project Manager
Consulting Engineer	Hiroshi Yoshimura in charge of Safety Engineering and Electricfication
Consulting Engineer	Eiichi Tawara in charge of Train Operation and Workshops
Consulting Engineer	Sankichi Odai in charge of Track Maintenance
Consulting Engineer	Shoichi Kitahara in charge of Railway Location and Construction

In compliance with above mentioned agreement, it is instructed that the mission of the survey team is to carry out the preliminary survey of the existing railway line between Rio de Janeiro and Sao Paulo and that the extent bf the survey is confined to the technical matters and others closely related thereto. Consequently, it is understood that the main object of this survey is to render the relevant suggestions for the main detail survey, which shall be done by the Government of Brazil for the purpose of planning, designing and execution of the modernization program of the existing railway line between Rio de Janeiro and Sao Paulo, taking the construction of new line therebetween into considerations.

Upon the arrival of the survey team at Rio de Janeiro, the actual working schedule were determined, agreed upon between DNEF and the survey team.

The survey works carried out are chronologically shown as follows:

Date	Location and Member	Survey and Study
4/1 (Monday)	At Rio de Janeiro, by all members.	Visit to Ministerio dos Transportes of Brazil Government, Col. Rodrigo Ajace de Morira Barbosa (Sectretario Geral). Visit to Departamento Nacional de Estradas de Ferro (DNEF), and meeting under the attendance of Eng. Eduaro Rios Ellics (chairman of Conselho Ferroviario Nacional), Eng. Alvaro Gomes Barbosa (Chefe do Cabinete de DNEF), Dr. Manuel Alves do Vale (Procurador Geral do DNEF), Eng. Desio Teixeira Brandos (DNEF), Eng. Murillo Nunes de Azevedo (DNEF) and other staffs of DNEF. Arrangement of the schedule of the survey works in Brazil. Visit to the Embassy of Japan in Rio de Janeiro.
4/2 (Tuesday)	At Rio de Janeiro, by all members.	Hearing of the outline of the railway between Rio de Janeiro and Sao Paulo explained by the staffs of DNEF. Hearing of the outline of the railway of Brazil in general, explained by Eng. Murrillo.

		Discussion on materials and data requested by the team.
4/3 (Wednesday)	At Rio de Janeiro, by all members.	Visit to Estrada de Ferro Central Brazil (EFCB). Meeting Mr. Francisco Cruz (Superintendents do EFCB). Hearing of the general view of the railway between Rio de Janeiro and Sao Paulo presented by him. Hearing of the outline of the railway, explained by Eng. Guilherme Campos. (Assistente Central de Engenharia do EFCB). Inspection of Estacio Pedro II, Freight Terminal MARITIMA and Classifying Yard ARARA.
4/4 (Thursday)	At Rio de Janeiro, by all members.	Inspection of Workshop DENTRO and Rolling Stock Repairing Factory EMAFFA.
4/5 (Friday)	At Rio de Janeiro, By all members.	Collection and Orientation of materials and data on the railway, provided by EFCB. Inspection of the Operation Dispatching Office of EFCB.
4/6 (Saturday)	At Rio de Janeiro,	Orientation and studies of the materials, informations and data collected during the week.
4/7 (Sunday)	At Rio de Janeiro.	Holiday.
4/8 (Monday)	From Rio de Janeiro to Sao Paulo on the special train, by all members.	On the way, inspection of the general conditions of the railway and of the CTC center in Barra do Pirai.
4/9 (Tuesday)	At Sao Paulo, by all members.	Inspection of Factory FRESINBRA and Rolling Stock Manufacturing factory COBRASMA. Visit to the Consulate General of Japan, The Mayor of Sao Paulo and the Transportation Department of Sao Paulo State, where Eng. Firwino Rocha de Freitas (Chief of the Department) explained the outline of the ur urgan transit system of the city zone of

		Sao Paulo.
4/10 (We nesday)	From Sao Paulo to Santos on the train of Santos Jundiai Railway and from Santos to Campinas on the highway and returned back to Sao Paulo, by all members.	Inspection of the conditions of the railway between Sao Paulo and Santos and the highway traffic between Santos and Campinas via Sao Paulo, and visit to the G.E. Factory in Campinas.
4/11 (Thursday)	From Sao Paulo to Rio de Janeiro on the special train, by all members.	Inspection of the conditions of the railway. On the way, inspection of the Wheel Manufacturing Factory MAFERSA in Cacapaba.
4/12 (Friday)	At Rio de Janeiro.	Holiday (Easter)
4/13 (Saturday)	At Rio de Janeiro, by all members.	Orientation and Studies of materials, informations and data collected during the week.
4/14 (Sunday)	At Rio de Janeiro	Holiday
4/15 (Monday)	At Rio de Janeiro, by all members.	Had the honour of meeting Col Mario David Andreazza (Minstro, Ministerio dos Transportes) and Eng. Haracio Madreirra (Director Geral do DNEF). Discussion with staffs of DNEF on the materials and data provided by DNEF.
4/16 (Tuesday)	At Rio de Janeiro, By Eng. Satoh.	Visit to the President of RFFSA. Visit to the Chief Engineer of CVRD in the head office. Visit to the Vice President and the transportation engineer of MBR in the head office.
	At Dentro, by Engs. Yoshimura, Tawara and Odai.	Inspection of the states of track maintenance rolling stock, signal and repair of electric cars at Dentro. Inspection of electric welding of rails in Barra do Pirai.

	At Rio de Janeiro, by Eng. Kitahara.	Discussion on the materials and data provided by EFCB.
4/17 (Wednesday)	From Japeri to Barra do Pirai, by Engs. Satoh and Kitahara, and by Engs. Yoshimura, Tawara and Odai.	Inspection of the conditions of the proposed route between Japeri and Barra do Pirai. Inspection of the conditions of the Service Compartment in Pedro II. Inspection of the Diesel Locomotives Repair Shop at Dentro. Hearing of the outline of the Organization and Administration of workmen explained by Eng. Arbste Ibre. Inspection of the Track Maintenance Section Office at Dentro.
4/18 (Thursday)	At Rio de Janeiro, by Eng. Satoh.	Visit to the GEIPOT. Visit to the BNDE.
	From Rio de Janeiro to Sao Paulo on the Highway, by Eng. Kitahara.	Inspection of the traffic conditions of the Highway between Rio de Janeiro and Sao Paulo. Inspection of the progress of the improvement works of the railway line.
	At Rio de Janeiro, by Engs. Yoshimura, Tawara and Odai.	Discussions with staffs of DNEF on the data provided by DNEF. Inspection of Section Office of Signals, Telecommunication and Converter Substation. Discussion on the data with staffs of EFCB.
4/19 (Friday)	From Rio de Janeiro to Volta Redonada on the Highway, by all members.	Inspection of the traffic conditions of the Highway. Inspection of the facilities and the operation of C.S.N.
4/20 (Saturday)	At Rio de Janeiro, by all members.	Studies on the railway in details. Arrangement of the working schedule of the following days with Dr. Vale, DNEF.
4/21 (Sunday)	At Rio de Janeiro, by all members.	Studies on the railway in details. Preparation of the Interim Report.

4/22 (Monday)	At Rio de Janeiro, by all members.	Discussion with staffs of DNEF on the railway. Preparation of the Interim Repo t.
4/23 (Tuesday)	At Rio de Janeiro, by all members.	Discussion with staffs of DNEF and of EFCB on the railway. Preparation of the Interim Report.
4/24 (Wednesday)	To Vitoria, by Engs. Satoh and Yoshimura.	Inspection of the Transportation facilities of CVRD and the loading facilities and equipments at Tubarao.
	At Rio de Janeiro, by Engs. Odai, Tawara and Kitahara.	Studies on the railway. Preparation of Interim Report.
4/25 (Thursday)	At Rio de Janeiro, by all members.	Discussion with staffs of DNEF on the railway. Preparation of Interim Report. Explanation of the Interim Report to the Ambassador of Japan. Lecture of Eng. Satoh at the Engineering University on the perspective of the railway traffic.
4/26 (Friday)	At Rio de Janeiro, by all members.	Explanation of the Interim Report in the meeting held in the hall of DNEF with attendance of staffs of DNEF and EFCB and the offical of Japanese Embassy, under the charge of Chefe Geral do DNEF.
4/27 (Saturday)	At Rio de Janeiro, by all members.	Explanation of the Interim Report at the Japanese Embassy.
4/28 (Sunday)	At Rio de Janeiro.	Holiday.
4/29 (Monday)	From Rio de Janeiro to Brasilia and return.	Visit to Brasilia under the guide of DNEF.
4/30 (Tuesday)	At Rio de Janeiro.	Presentation of the Interim Report to DNEF.

Prior to preparation of this report, the Interim Report was submitted to the director general of DNEF on the 30th day of April, 1968 outline of which was explained to the staffs of DNEF and of other entities concerned by the survey team on the 26th day of April, under the attendance of a official of the Japanese Embassy. On the occasion, the Japanese Embassy expressed that Japanese Government is willing to cooperate with all entities of Brazil concerned, who will carry out the main detail survey in the future.

It is expected that the main detail survey will be carried out autonomously by the Brazil Government and the modernization project will be materialized in the near future and that this report will contribute to such materialization process; this report is focussed on this effect though it is set forth qualitatively.

It is acknowledged that this survey works was materially and mentally aided by the conveniences and materials rendered by the Department of National Railways of Brazil and other Government Organizations, namely that this survey works was carried through effectively and smoothly with the competent and able assistance of the staffs of DNEF and EFCB.

It is appreciated that the appropriate preparation for the survey was arranged by Eng. Alvaro Gomes Barbosa, Chefe do Cabinet do DNEF and Dr. Manuel Albes do Vale, Procurador Geral do DNEF with their assistants who were nominated to the counter part for the survey team.

It is appriciated that the sound guide was rendered by the Japanese Embassy in Rio de Janeiro for on-the-spot survey and that competent help for the orientation of materials, informations and data as well as for the preparation of the report was rendered by Japanese National Railways, Japan Railway Construction Coordination, Japan Railway Technical Service and other organizations of railway business.

This report is respectfully presented by

Eng. Syuitiro Satoh
Eng. Hiroshi Yoshimura
Eng. Eiichi Tawara
Eng. Sankichi Odai
Eng. Shoichi Kitahara

On the th day of , 1968, Tokyo, Japan.

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CHAPTER 1.

SKETCH OF THE BACKGROUND STANDING ON ECONOMICAL AND TECHNICAL POINTS OF VIEW

Article 1. General.

In case of framing up the project of construction and or improvement of railways, it is deemed necessary to review the background relating to the subject railway. It may be considered that as this survey is aimed at the modernization project of the railway line between Rio de Janeiro and Sao Paulo, the extent of the review shall be limited to the area along this line. However, it may be reasonable to expand the extent of the review to the area sourrounded by four big cities, Rio de Janeiro, Belo Horizonte, Sao Paulo and Santos because this railway line is the main artery of transportatio system of the region surrounded by these four cities.

This region is the megapolis of Brazil because the major part of industrial products and supplies of Brazil are concentrated in this region and the large part of agricultural products are consumed by the rehabilitants in this region which is estimated as large as about thirty five percent of total population of Brazil.

On the other hand, it is estimated that not only the growth of such production and consumption but also of the population will be higher and higher every year in the future.

Therefore, it is observed that the railway line, connecting these cities and running through this region, is and will be the most important traffic way of Brazil in the present and in the future.

It is generally recognized that the transport growth depends upon (i) the growth in production and consumption, (ii) the change in the structure of the economy and (iii) the specialization of economic activities.

The growth of production and consumption generally depend upon (i) the growth of population, (ii) the growth of income per capita and of employment, (iii) the growth of agricultural products, (iv) the growth of industrial products and (v) the expansion of service activities, traffic and commercial activities included.

On the other hand, it is noticed that such different sectors of economy as above mentioned are inter-related and the growth in one sector may not

only raise the level of resources available generally but also more directly promote the growth in other sectors in a long run.

The figures in the following Table 1. will suggest the above notice:

,Table 1.

Average annual growth rate of economy in values from 1950 to 1960 in Brazil.

Annual growth rate of economy,

(i)	for total real products	5.7%
(ii)	for industrial products	9.0%
(iii)	for agricultural products	4.6%
(iv)	for transport	7.1%
(v)	for other services	4.3%

Source: The National Account of Brazil, 1964.

Article 2. Physical Conditions Relating to Economical Development.

(A) Geological States.

Geological state of this area covering the route of railway between Rio de Janeiro and Sao Paulo is observed as follows:

(i) Geology covering the area between Rio de Janeiro and Cochoeira is, as a whole, Precambrian Strata with intrusive rocks erupted through in laces, except the area between Barra do Pirai and Volta Redonda where silty clay soil is found which is, it is observed, the deposit of the River Paraiba. All the exporsed surface of the Precambrian Strata of this area is heavily weathered out and decomposed and, subsequently, almost all area is covered by red, yellow and/or grey colored soil of decomposed strata accompanied with undecomposed intrusive rocks exposed in places.

(ii) Geology covering the area between Cochoeira and Sao Paulo is Tertiary strata, which is called "Tanbate System", except the area between Pao and Magi da Cruzes where these is found decomposed Precambrian strata of the same quality as in the area above mentioned.

(iii) Surface soil of the Precambrian strata is, in itself, technically unstable and of swelling properties and, consequently,

the exposed slope surface of a cutting and untreated bed of such soils are very unstable when saturated with water.

(iv) The sound rocks of the Precambrian Era may occur in deep tunnels and foundations in deep valleys and, subsequently, the stability of tunnels constructed in the deep and foundation of bridges will be secured.

(B) Mateorogical States relating to Economical Development.

This area is situated between from 20 to 30 south latitude and from 42 30' to 44 30' west longitude.
The altitude of each city is as follows :

Rio de Janeiro	0m
Bara do Pirai	350m
Belo Horizonte	840m
Sao Paulo	740m

The River Paraiba runs eastward along the subject railway line between southern and northern mountain ranges starting from the east of Sao Paulo and flowing out near at S. Joao da Barra to the Atlantic Ocean.

Provided that it is well regulated and appropriately arranged with necessary facilities and equipments, this river will serve not only the sufficient source of irrigational, industrial and domestic water supply but also the disposal in the region along the railway line.
Climatic states of this area is shown in the following Table 2:

Table 2

The Table of climatic state in 1966.

City	Items	Jan.	Feb.	Mar.	Apr.	May	June.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Highest, Lowest and total in the year
Rio de Janeiro	Highest Temperature in C	38.4	39.7	37.6	32.6	32.0	32.0	32.8	32.6	36.0	36.4	35.0	39.8	39.8
	Lowest Temperature in C	20.4	21.8	20.0	18.0	14.8	14.2	13.0	13.6	11.2	16.4	18.2	18.8	11.2
	Water fall during a month in mm	570.2	140.8	299.8	107.8	107.1	10.7	38.5	92.9	41.6	147.6	166.2	150.9	1874.4
	Highest intensity of Waterfall during 24 hours.	219.2	71.1	140.6	47.7	30.2	7.8	19.0	46.1	9.0	22.8	34.5	40.6	219.2
Sao Paulo	Highest temperature in C	33.0	32.6	31.3	29.2	29.2	27.1	27.0	29.0	32.7	31. 4	31.3	32.5	33.0
	Lowest temperature inCC	15.0	18.2	15.0	13.3	7.8	9.2	9.8	5.2	7.0	10.6	12.7	12.6	5.2
	Water fall during a month in mm	198.3	184.7	257.9	35.6	24.8	5.1	20.0	52.1	121.5	166.6	69.5	338.2	1474.3
	Highest intensity of Waterfall during 24 hours.	44.0	40.6	87.7	13.1	18.0	3.1	14.8	17.6	55.7	61.8	28.5	86.5	87.7

Article 3. Population.

(A) General View

The population of Brazil was growing normally from 1940 to 1950, annual growth rate during this period was recorded at 2.5%; the total population in 1950 was recorded at 51,944,000 and from 1950 to 1960 the annual growth rate was increased to 3.1% and the total population was recorded at 81,393,000 in 1965.

It is noticed that the concentration of the population into urban region is conspicuous.

Annual growth rate classified into urban and rural regions is recorded in the latest Population Census of Brazil as follows:

Urban Region	5.4%
Rural Region	1.5%
Total in Brazil	3.1%

On the other hand, the growth rate is estimated to be continued in the equal amount or more as above recorded.

The percentage share of the total population is recorded by Economic Division, Coverdale & Colpitts, New York, New York U.S.A. as shown in the Table 3.

Table 3

Urban, Rural and Total Population, by Regions of Brazil, and Annual Growth Rates.

Region	1950	1960	1965	Percentage Share of Population 1950	Percentage Share of Population 1960	Average Annual Growth Rate 1940-50	Average Annual Growth Rate 1950-60
	(in thousands)			(in %)		(in %)	
North							
Rural	1,264	1,584	1,733				
Urban	581	963	1,205				
Total	1,845	2,547	2,938	3.55	3.63	2.4	3.3
Northeast							
Rural	9,205	10,277	10,879				
Urban	3,289	5,248	6,603				
Total	12,494	15,525	17,482	24.05	22.14	2.3	2.2
East							
Rural	11,515	12,705	13,500				
Urban	7,378	11,954	14,889				
Total	18,893	24,659	28,389	36.38	35.17	1.9	2.7

South							
Rural	9,858	12,033	13,050				
Urban	7,117	12,413	15,770				
Total	16,975	24,446	28,820	32.68	34.86	2.8	3.9
Centralwest							
Rural	1,313	1,860	2,229				
Urban	424	1,082	1,535				
Total	1,737	2,943	3,764	3.34	4.20	3.3	5.4
Brazil							
Rural	33,155	38,459	41,391	63.80	54.80		1.5
Urban	18,789	31,660	40,002	36.20	45.20		5.4
Total	51,944	70,119	81,393	100.00	100.00	2.5	3.1

As is suggested by the above review, it is forecasted that in the region along the railway line the population will grow at the rate of 5 - 6% annually.

(B) Peculiarity in this Area.

The following table arranged by the Economic Division, Coverdale & Copitts shows the population states of the region along the route of railway line between Rio de Janeiro and Sao Paulo:

Table 4.

Urban, Rural and Total Population, by States of East Region.

Region and State	Population (in thousand)			Share of Total Population (percent)		Annual Growth Rate (Percent)	
	1950	1960	1965	1950	1960	1940-50	1950-60
East							
Rural	11,515	12,705	13,500				
Urban	7,378	11,954	14,889				
Total	18,893	24,659	28,389	100.00	100.00	1.9	2.7
Sergipe							
Rural	439	460	490				
Urban	205	294	351				
Total	644	754	841	3.41	3.06	1.7	1.6
Bahia							
Rural	3,584	3,879	4,028				
Urban	1,251	2,069	2,603				
Total	4,835	5,948	6,631	25.59	24.12	2.1	2.1
Minas Gerais							
Rural	5,519	5,992	6,311				
Urban	2,343	3,931	4,970				
Total	7,862	9,923	11,281	41.61	40.24	1.5	2.4

Espirito Santo							
Rural	693	973	1,121				
Urban	185	393	494				
Total	878	1,366	1,615	4.65	5.54	1.5	4.5
Rio de Janeiro							
Rural	1,206	1,318	1,490				
Urban	1,091	2,065	2,686				
Total	2,297	3,383	4,176	12.16	13.72	2.2	3.9
Guanabara							
Rural	74	83	60				
Urban	2,303	3,202	3,785				
Total	2,377	3,285	3,845	12.58	13.32	3.0	3.3

This indicates that the population of these regions amounts to about 30 millions, percentage share of which is about 35% of total population of Brazil.

It also suggests that the concentration of the population to this regions is very conspicuous.

It is noticed that the concentration of the population to the urban region of this regions is specially remarkable as shown in the following Table 5 :

Table 5

City	Population in 1960	Average annual growth rate estimated
Niteroi U.C.	1,076,000	5.6%
Barra do Pirai	29,000	3.8%
Barra Mansa	47,000	6.2%
Volta Redonda	84,000	6.2%
Urban of Guanabara	3,202,000	3.4%
Sao Paulo U.C	3,916,000	4.8%
Santos U.C	361,000	4.0%
Cruzeiro	27,000	5.5%
Guaratinguета	29,000	4.8%
Lorena	26,000	4.6%
Mogi das Cruzes	64,000	5.5%
San Jose do Campos	55,000	6.0%
Taubate	65,000	5.3%
Belo Horizonte U.C	715,000	5.4%

It is observed on the latest Population Census of Brazil that the domestic income per capita in rural region grew at the annual rate of 3.6% and that of urban region was continuing the same amount, while, in total, it grew a little at the annual rate of 1.8% during the past 15 years from 1950 to 1964.

On the other hand, it is observed that the income per person employed grew in the agricultural sector and in the industrial sector at the annual rate of 7.5% and 7.6% respectively, while, in services sector, it grew at 3.7% and, in total, it grew at 6.4% in the same period. It will indicate that the unemployed percentage was increasing in total, and that it was higher in the industrial region than in the agricultural region.

The following table will suggest this tendency:

Table 6.

Name of state	Average income growth rate per person employed	Average income growth rate per capita
Minas Gerais	3.7%	1.1%
Rio de Janeiro	5.3%	1.4%
Guanabara	4.0%	0.7%
Sao Paulo	4.9%	1.5%

Article 4. Economic Structure.

It is servicable, as a whole, for the review of the economic structure to pick up the following fundamental tendencies which are, it is deemed, closely related to the economic structure :

(i) Increasing urbanization

(ii) Shift from agricultural employment to industrial employment, and

(iii) Higher rate of growth of industrial production compared with agricultural production, which is shown in the Table 1 in Article 1 of this Chapter.

It may be concluded that the economic structure of Brazil is summarized as follows :

(i) In general, both industrial and agricultural production will increase and expand in the region of high economic potential.

(ii) The production of heavy industry will continue to concentrate heavily in the states of Sao Paulo, Rio de Janeiro, Minas Gerais and Guanabara ; i.e. the industrial center of Brazil.

(iii) Increasing manufactured products, supplies for industries, and provisions for increasing inhabitants, concentrated in the industrial center, will require sufficient transportation facilities parallel with the increase of industrial and agricultural products.

(iv) Reduction in transport cost, especially in medium and long distance transport, will accelerate the economic integration of the rural economy with urban economy, in other words, it will promote the integration of agricultural area with the industrial center.

Article 5. Industrial Activities.

As is set forth in the preceding Articles, the growth of the industrial production is remarkable in Brazil in a latest few years.

The state of industrial production is qualitatively summarized as follows :

(i) Machineries, electrical equipments and transport equipments industries are heavily concentrated in a few centers of industrial production mainly the industrial areas around Sao Paulo, Rio de Janeiro, and Belo Horizonte from where their products are distributed throughout the country.

(ii) Rapid growth industries, such as the metal-using and chemical industries, create the increase of the demand of industrial products in an increasing wealthy, urbanized and industrialized region.

(iii) Production of iron ores in the State of Minas Gerais remarkably increases and is being transported to ports for exportation and to Volta Redonda for domestic use.

(iv) Growth of such industrial production creates increased demand for transportation services.

(v) Percentage share of industrial production in 1962 is shown in the following Table 7 and Table 8 that indicate the heavy concentration to the industrial center.

Table 7.

Production share in Values in 1962

Region	Percentage share of industrial products of Rapid Growth	of Slow Growth	Total
North	0.4%	0.6%	0.6%
Northeast	4.0%	9.5%	6.8%
East	89.6%	70.3%	79.6%
South	5.8%	18.5%	12.4%
Centralwest	0.2%	1.0%	0.6%
Total	100.0%	100.0%	100.0%

Source: Industrial Register, 1962, IBGE.

Table 8

Percentage share of Industrial products in value of Rapid growth industries	of Slow growth industries
48.3%	51.7%

Source: Industrial Register, 1962, IBGE.

Following Table 9 shows the latest annual growth rate of industrial products in 1964-1965 classified into the kinds of products :

Table 9

Annual Growth Rate of Production

Kind of Products	Annual Growth Rate (in percent)
Iron ore	16.5
Steel ingot	7.8
Aluminium ingot	10.5
Metaric lead	1.4
Petroleum products	6.1
Natural phosphate	7.4
Nitrogeneous ferterizer	10.6
Caustic soda	8.6
Soda ash	5.0
Salt	1.0
Sulphuric acid	10.0
Cement	7.0
Limestone	6.0
Gypsum	7.9
Newsprint	6.2
Rubber	8.8

Source: Report of Economic Division, Coverdale & Colpitts.

(vi) Total amount of industrial products and supplies moved medium and long distance in transport was estimated about 50 million tons annually in 1965 as shown in the following Table 10.

Table 10

Kind of Commodities	Annual Transportation in tons
Iron ore	15,000,000
Petrium Products	15,000,000
Cement	5,000,000
Steel Products	2,000,000
Pine	2,000,000
Coal	2,000,000
Ferterizer	1,000,000
Charcoal	1,000,000
Salt	1,000,000
Paper	1,000,000
Limestone	1,000,000
Others	3,500,000
Total	50,000,000

Major part of the amount listed up in this Table was handled in this region.

(vii) Commodities to be transported medium and long distance, listed up in the Table 10 will be estimated to increase at the annual growth rate of not less than that shown in the Table 9. And adding the amount of miscellaneous manufactured products it is estimated that total amount of industrial commodities requiring transport is estimated to increase at an average annual rate of about 9 percent, referring to Table 1.

Article 6. Agricultural Activities

The wide area northwest of this railway line is a land of fertile soil and it produces the good amount of coffee, cereals, suger cane and cotton. The area along this railway line parallel to the River Paraiba is a land of production of rice and corn and is surrounded by the pasture plantation which creates the livestock production.

This area covering these area above mentioned is called "Zone of Laticinos", through the southern part of which this railway runs. It is observed that such good agricultural potential will be able to supply the provisions for inhabitants in the industrial center including Sao Paulo, Rio de Janeiro and Belo Horizonte, provided that the transportation system will be appropriately facilitated and administrated. On the other hand it is expected that

such a good agricultural potential will accelerate the progress of industrial development of this region.

The following Table 11 will supply the suggestion for the future prospects of agricultural activities of this region:

Table 11

Annual Growth Rate of Crop Production

Region	Average Growth Rate (1950 - 1962)
North	5.4%
Northeast	7.2%
East	2.9%
South	5.1%
Centralwest	9.5%
Total	5.2%

Source: Report by Economic Division, Coverdale & Colpitts.

It is noticed that the demand of agricultural products increases at the same growth rate of population, and, consequently, will increase at the annual rate of more than 6% as the annual growth rate of population is 6% in the present and will be more than 6% in the future in the city zones of Sao Paulo and Rio de Janeiro as well as other urban centres in the region along this railway line.

Coffee and cotton and the principal export agricultural products of Brazil and they are expected to increase in the future; therefore, it is necessary to increase the capacity of transportation and to reduce the transportation cost of these products from farms to ports. Therefore, it may be required that the development as well as the coordination of all transportation modes shall be facilitated as far as the agricultural activities is concerned.

The following Table 12 will suggest such concept.

Table 12

Crop Production for Export in 1964.

Commodities	Annual production (in tons)
Caster beans	257,000
Cocoa	146,000
Coffee	1,753,000
Cotton	1,877,000
Sisal	200,000
Total	4,233,000

It is selfexplanatory that such increase of crop products for export is to be added to agricultural products for domestic use which was amounted to 29,000,000 tons in 1964 and will increase at the same growth rate of population.

Consequently, it is clear that the transportation of agricultural products shall be considered not only for the promotion of the welfare of the people domestically which will contribute to the development of industrial activities but also for the expansion of export.

It is observed that the transportation of agricultural products both for domestic use and export are destined to this region from all the country through.

Consequently, it is expected that while the total transportation of agricultural products is estimated more than 35,000,000 tons annually in the present, it will increase year by year in the future.

It is noticed that the planning of transportation system in this region shall be contemplated standing on the view points of agricultural development of entire Brazil, and it is advisable that the installation of special facilities and the special regulation shall be arranged for lowering down the cost for transportation of agricultural products.

Article 7. *Highway Transportation between Rio de Janeiro and Sao Paulo.*

There exists four-lane paved highway between Rio de Janeiro and Sao Paulo. This highway runs parallel with the railway line and passing the same cities and towns as on the railway line, the distance of which is about 410 kilometers, a little less than railway line by about 80 kilometers.

Urban sections of this highway both in Rio de Janeiro and Sao Paulo are not separated from urban streets and a few solid crossing are installed.

On this highway, there runs express bus at 10 minutes head and stopping over Barra do Pirai, Barra Mansa and Sao Jose do Campos only, and taking 6 - 7 hours. The average speed of the bus is estimated about 60 kilometers per hour and, at maximum speed more than 100 kilometer per hour. Adding to these bux traffic, many trucks and passenger cars are running, the average speed of which ma may be 40 kilometer per hour and 80 kilometer per hour respectively.

It is informed that the fee for a passenger between Rio de Janeiro and Sao Paulo is about the same as that on the ordinal day train of railway line. It is observed that the present transportation on this highway is in normal state, however, the increase of motor vehicles will create the apprehension of traffic congestion in the urban section which will bring about the lower

average speed and more accidents and consequently it may be impossible to shorten the travelling time and to enhance the transportation capacity in the future.

As it is generally recognized, the maximum speed of motor vehicles on highway shall be limited to 100 kilometer per hour in order to maintain the safety, even when it is installed with satisfactory solid crossings and separating zone. There is a proposition that the increase of passenger traffic may be able to be born by buses. However, it may be apprehended that it may not be able to be done without any cost of longer travelling time and poorer safety unless the improvement of the existing highway or the construction of new one as well as the construction of the separated or elevated highway connecting thereto in urban sections will be implemented, which will cost very high.

On the other hand, it is observed that cutting slope surface and bed of the way are in unstable conditions in some places and that such sections shall be improved in order to secure safe and reliable running of motor vehicles for the purpose of answering for the increase of motor vehicles in the future.

Article 8. Relation between and Percentage Share of Railway and Highway Transportation.

In 1937, it is recorded, the freight transportation in Brazil was born by the railways at almost 100 percent. Due to the negligence of the improvement and the poor maintenance of railways facilities, and, on the other hand, due to the rapid development of highways and motor vehicles, the share of railway transport decreased to 50 percent in 1945 while the real products and the total freight transport had increased during these years. And it is noticed that the passenger traffic had decreased year by year and continued to decrease due to the same causes.

The following Tables 13 and 14 show such changes:

Table 13

Ton-Kilometer of Freight, and
Average Annual Growth Rate of Transport by Transport Modes
1950 - 1960 and 1961 - 1965

Mode of Transport	Ton-Kilometers(billions)			Percentage Share			Average Annual Growth Rate	
	1950	1961	1965	1950	1961	1965	1950-61	1961-65
High way	17.3	46.8	71.6	49.7%	62.5%	68.6%	9.5%	14.6%
Railways	9.1	14.1	18.7	16.1	18.8	17.9	4.1	14.4

Source: World Bank Report

Table 14

Passenger Kilometers, Percentage Share and
Average Annual Growth Rate, by Mode of Transport

Mode of Transport	Passenger-Kilometers (billions)			Percentage Share			Average Annual Growth Rate	
	1950	1961	1965	1950	1961	1965	1950-61	1961-65
Highway	21.1	59.5	102.3	57.5%	73.5%	83.3%	9.9%	14.5%
Railways	13.6	18.0	17.6	37.0%	22.4%	14.3%	2.6%	-0.6%

Source : World Bank Report

It is noticed that the investment in transport did not change in total amount during last six years from 1960 to 1965 and that the percentage share of investment in railways is one ninth of that in highways, while the percentage share of freight transport on railways is about one fifth of that on highways, and passenger traffic about one sixth.

The following Table 15 shows the figures of the amount of investments both to railways and highways:

Table 15

Investment in Transports by Modes of Transport

Mode	Item						
	Year	1960	1961	1962	1963	1964	1965
Rail	Replace and Improvement	134.6	138.8	103.2	119.6	105.7	149.7
	New Line	21.5	24.7	62.9	57.0	33.6	46.5
	Total	156.1	163.5	166.1	176.6	139.3	196.2
	Percentage Share in Total investment in Transport	7.8%	9.7%	9.7%	9.0%	7.0%	9.5%
High-way	Construction (i)	565.7	381.2	521.8	383.1	434.6	711.8
	Vehicles (ii)	1,030.9	974.9	1,301.2	1,250.1	1,236.2	1,013.6
	Total	1,596.6	1,356.1	1,823.0	1,633.2	1,670.8	1,725.4
	Percentage Share in Total investment in Transport	79.5%	80.8%	83.8%	82.7%	84.2%	84.0%

(i) Cost for construction of urban roads and for highway construction equipment were excluded.

(ii) Investment in passenger cars was taken as 50% of total cost.

Source: GEIPOT, DNEF, RFFSA, EFESP.

Those facts above mentioned indicate that investment allotment in railways is approximately half of that in highways per unit work done, standing on the hypothetic proposition that the investment is to be allocated in proportion with the work done.

It may be understood that such an unreasonable investment allotment has made the main railway line effete, and consequently, has impeded the development of economical activities in this region, while there is a critique that uncomfortability, unrealizbility and incompetency of this railway line has brought about such a policy of investment in transport.

It is an endless argument which is the cause or the result. However, it is noticed that this area between Rio de Janeiro and Sao Paulo included is the civic, economical and political center of Brazil , and, consequently, it is absolutely necessary to have the most reliable, capable, and comfortable transportation facilities in this region beyond such arguments as above mentioned.

CHAPTER II.

PERSPECTIVE OF RAILWAY LINE BETWEEN RIO DE JANEIRO AND SAO PAULO

Article 1. General.

This perspective is induced from the review of the background, described in the Chapter I, the present states of existing railway between Rio de Janeiro and Sao Paulo and the progressive techniques of railway in the developed countries. It is observed that transport of both passengers and freights in this region is important sector of the economical activities in Brazil in the present, and that it will be forcasted that the demand of transportation will continue to grow at high grade in the future. And it may be understood that the fulfillment of such demand will be fatal sector for not only the future development of industrial activities but also the prosperity of the economy of Brazil.

On the other hand, it is recognized that this region is the megapolis of Brazil. It is the common sense of the modern civilization that the railway system in such a place as above mentioned shall be modernized in its facilities and operation.

The basic grounds, on which the perspective of this railway will stand are summarized as follows:

(i) The demand of the transport of the industrial supplies and products will increase at the annual growth rate of nine (9) percent or more.

(ii) The demand of the transport of passengers will increase at the annual growth rate of six (6) percent at least, and, as far as railway is concerned, rapid passenger trains in this region, especially between Rio de Janeiro and Sao Paulo, will be required.

(iii) Safety and accuracy on schedule of train running and especially comfortable running of passenger trains shall be secured and the frequent services for passengers and freights will be required in conformity with the progress of economical activities in this region, and, furthermore, it will be desired that the trains shall be run in the favourable time-zone of departure and arrival in big cities in corspondence to the kinds of trains.

(iv) Special trains for containers, which will answer for the requirement of door-to-door transportation of fresh vegitables, manufactured commodities and other provisions, shall be set up in conformity with the growth of population and industrial supplies and products in this region.

(v) Maintenance and operation of the railway shall be modernized for the purpose of satisfying these requirements above mentioned as well as reducing the operation cost.

(vi) Coordination between railway and highway transportation systems shall be reasonably established.

(vii) The modernization program shall be planned and materialized step by step on the most reasonable process.

Article 2. Coordination of Railway and Highway Transport Systems.

The following Table 16 of comparison between railway and highway transportation is generally acknowledged :

Table 16

Types of Traffic hauled by Transportation Modes, according to Unit Value and Distance hauled.

Unit Value of Commodity	Distance hauled Short Distance	Intermediate Distance	Long Distance
Low Unit Value	Rail	Rail	Rail
Medium Unit Value	Motor	Moter Rail	Rail
High Unit Value	Motor	Motor	Rail Motor

The railway shall carry basically low unit value commodities and shall have a competitive advantage in this category over motor freight carriers at all distances. Motor carriers shall basically haul medium and high unit value commodities at short and intermediate distances.

These two modes of transportation come into competition with one another principally for medium unit value commodities of intermediate distance haul. The concepts of unit value of the commodity and the distance hauled are referred to only for comparison.

An understanding of not only varying proportions of constant and variable cost in the modes of transportation but also the regulation or coordination of the modes of transportation, a framework within which carrier management must operate, is important.

For the references, there are given the following tables:

Transportation Amount in 1960 in various countries

Country	Ton-Kilometers of freight transported per one kilometer of highway (average)	Ton-Kilometers of Freight transported per one kilometer of railway (average)
U.S.A	58,000	2,417,000
Great Britain	139,000	1,027,000
France	25,000	1,570,000
West Germany	99,000	1,840,000
Italy	183,000	1,021,000
Japan	22,000	2,680,000

This table indicates that the utility index of transportation system.

In comparison with these figures, the statistics of the railway line of this region shows the following figures:

	Sections	Annual Transport of freight (in ton-kilometers)	Annual Transport of freight per one kilometer of the railway (in tons)	Distance with branch lines (in kilometer)
(1)	D.PEDRO II -BARRA DO PIRAI	456,299,354	2,700,000	170
(2)	BARRA DO PIRAI -VOLTA REDONDA	123,047,559	3,000,000	36
(3)	VOLTA REDONDA -SAN JOSE DOS CAMPOS	113,647,187	520,000	244
(4)	SAN JOSE DOS CAMPOS - ROOSE-VELT	52,663,607	250,000	219
	TOTAL	745,657,707	1,310,000	569

It is observed that section (1) and (2) each has the average value of utility, but section (3) and (4) very low value.

Observation of the commodities to be transported in this region suggests that major portion of freights will be heavy bulky and low-unit-value commodities and haulage of which will be medium or long distance.

As for industrial products both the unit value and the haulage distance will be medium. Therefore, the transportation of such commodities shall be regulated in well coordinated manner with each other. However, it is very hard to regulate the transportation of each commodity individually.

It is categorically recommended as follows :

(i) Heavy bulky low-unit-value commodities such as iron ore, steel or pig iron ingots, coal, etc. shall be transported on rail.

(ii) Industrial products shall be transported on rail from the factory to the consumption places, provided that the spur tracks and appropriate siding tracks are installed in the factory and in consumption places respectively. And they shall be transported by motor carriers directly from production places to consumption places in case that the spur tracks are not installed when the amount of one lot transportation is less than carload and the haulage distance is less than 200 kilometers.

(iii) When haulage distance more than 200 kilometers and no spur tracks are installed in the factory, the industrial products shall be transported by motor carriers from the factory to the nearest freight station.

(iv) Agricultural products shall be transported by motor carriers from the center of farm to the freight station, from where it shall be transported on rail to the consumption places, and in such case, the container special trains shall be used for this purpose and the container terminal equipment shall be installed in freight station above indicated.

It is recommended that such a freight station for vegetable products shall be located less than 200 kilometers from the center of farm.

According to such concept for mode of freight transportation, the fundamental coordination between railway and highway transportation system shall be established on the principles as shown in the following items:

(i) In large factory, the spur track shall be installed from the freight station where appropriate side tracks shall be installed.

(ii) Container terminal station shall be constructed within 200 kilometers from the center of agricultural productions.

(iii) Highway for motor carriers shall be constructed from the center of farm to the nearest container terminal station.

(iv) Small size factory shall be established near the station or in the place from where highway for motor carrier runs to a freight station nearby.

As for passenger transportation services, it is, as a rule, not recommendable to regulate the transportation mode. It is estimated that the growth rate of passenger transport will be 1.5 times the growth rate of populations, and that the speed for buses, in the other hand, will be limited to a definite amount, and furthermore it will be understood that the allowable maximum speed of the buses will be lowered down when number of buses will exceed a certain limit. Therefore, it is observed that the capacity of passenger transport by busses will be lowered down, that the time required will be prolonged and that accidents will increase in case that the passengers by buses will exceed a certain limit, in other words, when the population exceeds a certain limit.

In comunity with such progress, the coordination measures shall be set up to the effect that a certain volume of passengers shall be transferred to the railway for the purpose of maintain the safe and rapid travell when they will exceed a certain limit. Consequently it is expected that the passenger transport on railway will increase more than that induced from the past record.

In other words, it is expected that a certain amount of passengers who might have been carried by motor vehicles will be transferred to the railway. Furthermore, due to the increase of the establishment of industrial enterprises along the railway line, the increase of passengers will be created over and above that induced from the past records.

There is a proposition that the major portion of the increase of transportation both of passengers and freight shall be born by highway transportation system. However, it may be considered on the contrary due to the following reason reasons:

(i) The lowering of the average speed of motor vehicles in the case that the number of motor vehicles will exceed a certain limit.

(ii) The increase of accidents in running of motor vehicles in the case that the number of motor vehicles will exceed a certain limit.

(iii) Requirement of reduction of transportation cost for agricultural products and raw materials of industrial use.

Article 3. Relation between the Interior Travel and Suburban Travel on this Railway

The Table 17 shows the summary of travelling passengers on EFCB railway line in 1966:

Table 17

	Number of Passengers (in 1000)	Average Number per day	Average Haulage Distance
Interior	10,795	30,000	119 kilometer
Suburban	165,101	450,000	27 kilometer
Total	175,896	480,000	

This is the total amount of interior passengers on all EFCB lines, the major portion of which may be on the railway between Rio de Janeiro, Sao Paulo and Belo Horizonte. Suburban travellers are on the suburban lines both of Rio de Janeiro and Sao Paulo. The population in these cities and their suburban area are increasing at high rate and, consequently, an appropriate measure shall be contemplated to satisfy the demand of such increasing suburban travellers.

Considering such states as above mentioned, the subject railway line shall be improved or modernized without disturbing the program of the improvement of suburban lines; in other words, the improvement program of this railway line shall be planned and implimented on the principle that any measure to be taken up for this purpose shall be on the line of improvement measure for such suburban lines and, furthermore, appropriate facilities for easy transferring of passengers from suburban line to this main line shall be constructed.

Article 4. Summary

The perspective of the railway line between Rio de Janeiro and Sao Paulo, including the region of Santos and Belo Horizonte are qualitatively summarized as follows:

(i) The railway in this region shall be modernized both in facilities and operation.

(ii) The transportation demand in this region will increase in high grade

both on passenger and freight services.

(iii) Rapid transit service for passengers between Rio de Janeiro and Sao Paulo as well as the frequent interurban services for passengers of cities along the line will be demanded in the future.

(iv) Safe, reliable and comfortable running of passenger trains shall be secured as early as possible.

(v) Reliable and sufficient freight transport shall be secured.

(vi) Cost for freight transport on this railway shall be reduced as much as possible.

(vii) Door-to-door transport of agricultural and manufactured products shall be secured, i.e. the containers, container trans and container terminals shall be appropriately established.

For the purpose of understanding the perspective of the railway line in this region it is helpful to review the records of the investment for transport in the past.

As indicated in the Table 15, Article 8, Chapter I, the investment in Highway Transport was amounted to as much as about nine times that in Railway Transport in the past. Such policy of investment as in the past will be reasonably adjusted according to the requirement or necessity of the modernization of this railway for the purpose of promoting most effectively economic and industrial development and welfare of the people in Brazil.

It is forecasted that much more amount than ever of the investment will be allocated to the modernization project of this railway, taking into consideration the facts that the annual investment per unit volume of transport on the highway was much more than on railways in the past and the future development of this region is resonably expected.

CHAPTER III

OUTLINE OF THE PRESENT STATES AND THE SUBJECTS TO BE STUDIED

Article 1. Route.

The route of the existing railway line between Rio de Janeiro and Sao Paulo is shown in the Figure 1, attached; the total distance is about 478 kilometers with curves and gradient shown in the Chart 1, attached, and the details in regard to the route are summarized as follows:

(A) Section between D. Pedro II and Japeri.
Distance: 62 kilometers
The route in this section is the suburban railway of double tracks, all electrified, and in the subsection of 22 kilometers between D. Pedro II and Deodoro 4 tracks are laid and in the subsection of 11 kilometers between Deodoro and Madureira 6 tracks. In this section there are about 10 curve sections of small radius less than 400 meters, minimum radius being 311 meters. Due to such small radius of curvature,, the irregular use of these tracks and the train passing on turnout, train running in this section is limited to rather low speed. The gradient of this section is gentle as the topography of this section is flat, and, consequently, there is no speed regulation due to gradient in this section.

(B) Section between Japeri and Barra do Pirai.
Distance: 46 kilometers
The route in this section runs through so-called mountainous district, climbing from the flat area to the mountain range and descending from the summit to the valley of the River Paraiba. The gradient in this subsection, climbing from 29 m to 447 m altitude, is 18.7 o/oo continued (max. grade being 23.8 o/oo). And in the subsection from the summit (447 m altitude) to Barra do Pirai (357 m altitude) the gradient is 15.2 o/oo continued. The route runs hillside with many successive sharp curves, some of them being reverse curves. There are 78 sharp curves of less than 300 m radius (minimum radius being 125 m), and many tunnels, the longest of which is 2 kilometers long. There are laid double tracks and electrified all through the section.

(C) Section between Barra do Pirai and Eg. M. Feio.
Distance: about 340 kilometers.
Route in this section runs in the broad valley along the River

Paraiba, climbing on gentle slope from east to west with gentle gradient (max. gradient being 5 o/oo). In the subsection of about 152 kilometers between Barra do Pirai and Cachoeira Paulista there are 3 curve sections of less than 300 meter radius. The subsection of 48 kilometers, where such 3 curve sections as above mentioned exist, are now under improvement for eliminating such sharp curves. After the improvement will have been completed, radius of all curves in this section will be larger than 688 meters except in the yard of Barra do Pirai and the total distance will be shortened by 5 kilometers.

The comparison of existing and improved route is tabulated in the Chart 2., attached.

The route of the subsection of 188 kilometers between Cachoeira and Eg. M. Feio is of pretty good alignment with only 2 curve sections of 699 meter radius and 9 curve sections of 700's meters radius. This section of 340 kilometers is of single track except the subsection of 48 kilometers between Barra do Pirai and Sandade where double tracks are laid and electrified. After the 3 subsections now under improvement will have been completed all the route of this section will be of good alignment.

However, it is observed that through entire section there are not constructed side drains and other drainage works for stabilizing the cutting slope surface such as surface protecting w works, retaining wall etc. and there exist unstable road bed in some places. Due to such poor conditions, there are found fall-down of cutting slope, breaking of embankments, mud ejection on road bed, etc., in some places.

(D) Section between Eg. M. Feio and Roosevelt.

Distance : about 30 kilometers.

This section is the suburban railway line for commuters of Sao Paulo where double tracks are laid and electrified. The gradient of the route of this section is gentle, the max. gradient being 5 o/oo. There are 24 curve sections of 300's meters radius (min. curvature being 300 meter radius.). It is recommended that such sharp curves shall be eliminated in the near future when the improvement works of suburban railway of Sao Paulo will be carried out and that in such improvement works the radius of curvature shall be large enough for high speed running.

(E) Transition Curve and Vertical Curve.

In the entire route through, there are installed neither transition curve nor vertical curve. Such condition is one of the causes of the pitch and roll of the high speed train. It is recommended that such poor condition shall be eliminated; appropriate transition and vertical curves shall be installed as early as possible.

Article 2. Road Bed.

In general, it is observed that the work for stabilization of embankment, such as side drain, drainage culvert, cross ditch for drainage, other water disposal works and the surface stabilization works for cutting such as protection works for the surface of cutting slope, retaining wall, strengthening works at the bottom of cutting, are not satisfactory.

In the section of about 70% of entire route between Barra do Pirai and Eg. M. Feio, there are found unstable road bed of poor soil in many places and no drainage works in such places, due to which there are found fall-down of the cutting slope and mud-ejection.

According to the record of DNEF, the highwater level of the River Pirai is much lower than the formation level of the railway, and therefore, it is surmised that the unstable conditions of road bed and damages of road bed in this section are due to not overflow of the high water or the penetration of the river water but the negligence of drainage works such as the lack of cross culvert and/or side drains and that the lack of side drains in the hillside and of the cross drainage culvert create the overflow over the formation from the hillside in case of heavy local rainfall.

Article 3. Track Structure.

(A) General.

The standards and existing conditions of track structure are as follows :

(1) Gauge : 1.6 meter

(2) Rail :

57 kg/m rail of 12 meter long is used through the entire route. In several sections, the electric welded long-rail (120 meters at maximum) is used and the total distance of long-rail sections is about 75 kilometers.

(3) Rail Fastening and the Accessaries.

Ordinary screw spikes are used on all rails for fastening. Steel tie-plates and anticreefers are installed through entire route.

(4) Cross Ties.

Wooden cross ties are used on almost all route and, in some subsections, reinforced concrete ties of RC type are used with special rail fastening apparatus.

On the main track, 1,800 pieces of ties per kilometer are laid.

(5) Ballast.

While the standard depth of ballast is 40 cm from the bottom of cross ties to the road bed and the ballast is of crushed stone, the existing condition of ballast, it is observed, is so poor that sides of almost all cross ties are exposed and the depth of ballast is very thin in almost all route and no ballast in some places.

(6) Joint of Rails.

Rails of normal length (12 meter) are jointed in taggered joint type with normal fish plate. The depression of rail joint is very heavy as a whole. It is to be noticed that such depression is progressive due to the unstable road bed, poor ballast filling and the wear of rail end and fish plate. It is understood that such condition creates heavily the pitch and roll of train.

(7) Superelevation.

While the standard of the superelevation is stipulated, the regulation of superelevation is not regulary secured. Such negligence in adjustment of superelevation creates heave pitch and roll of train in case of high speed running.

(B) Review on the Track Structure.

Renewals of weared rail, its accessaries and cross-ties as well as satisfactory ballast filling are not appropriately carried out. Such condition creates the heavy pitch and roll of train, and the weak and unstable road bed creates the pitch and roll of the train and, subsequently, the abnormal wear of track materials due to the train running under such pitch and roll.

In other words, it is understood that the heavy pitch and roll of train makes the wear of track materials and vice versa. Such

vicious cycle is found in the present and will continue unless the determined measures will be implemented.

On the other hand, it is understood that unreliability of the passengers to the railway was raised in the past and is rising in the present due to uncomfortablity of travel by railway, and, consequently, increasing passengers is and will be transfered to other transport means.

Such facts as above mentioned being realized, welding of rail joint, replacement of concrete cross-ties and the improvement works in some sections between Barra do Pirai and Roosevelt where the road bed is unstable and the sharp curves exist, are now in progress. It is recommended that such reasonable works shall be completed as early as possible.

Article 4. Maintenance of Track and Road Bed.

The present states of maintenance of track and road bed in every respects, such as field works, organization, administration, standarization of maintenance works etc., are observed as follows:

(A) Administration and Organization.

Maintenance of track and road bed shall be carried out in parallel with other performances of railway business. However, it is observed that the track maintenance works is somewhat neglected in comparison with other works. It is recommended that this works shall be empowered prior to other works, namely, the empowering of the maintenance of track and road bed shall be carried out prior to other works.

It is observed that number of workmen engaged in field works is very small, compared with that in the office, in other words, allocation of workers is in the state of top heavy, which shall be avoided especially in maintenance works.

(B) Inspection and Studies of the States of Track and Road Bed,

As the states of track structure varies day by day due to the operation features and the weathers, it is desired to catch the actual states of track structure and investigate and study the causes of changes of the state thereof, if any. It is desired that the field works shall be arranged in accordance with the degree of importance, for instance, the skilled labourers shall be allocated to the maintenance works of main tracks prior to

side tracks, adn the other works such as clearing the side ditch and weeding shall be assigned to the appropriate outside contractors by contract, employing the weeding cars. It is desired that the fundamental data of climates, such as temperature, run off, intensity and amount of rainfall etc. shall be surveyed and recorded constantly whole through the year for the purpose of supplying the necessary data for arrangement of maintenance works and for the planning of maintenance techniques. It is observed that such fundamental survey and study on this railway line are somewhat rough and unsatisfactory.

(C) Standarization and Regulation.

It is desired that the practical maintenance standard of tracks structure such as allowable limit of destortion of gauge, level, surface of rails and fall of rails as well as the wear limit of track materials, shall be established according to the results of investigation and study of the local conditions and the economy of the line, taking the importance of the line into account.

Article 5. Electrification, Singnal and Telecommunication Systems.

(A) General view.

The outline of the present states of electrification, signal and telecommunication is shown in the Chart 3, attached. It is observed that the field works of electrical devices of EFCB is well performed in respects of planning, organization, administration and measures for emmergency. The control center of CTC are all well located and operated appropriately; for instance, the control center located at D. Pedro II operates the train-control of the section between H. Gurgei and Foo Sa of Araia.

(B) Electrification.

Electrification system is constructed under the following standards:

(i) Direct Current.

(ii) 3,000 Volts.

(iii) Single messenger of 152 $\frac{2}{mm}$.

(iv) Double trally wires of 107 $\frac{2}{mm}$ each.

(v) Converter stations are located at seven places in Rio de Janeiro district and at 2 places in Sao Paulo district.

(vi) In each converter station there are installed three mercury rectifiers of 2,500 KW or 3,000 KW, supplying direct current of 3,000 V.

(C) Safety Devices.

(1) Blocking System.

The blocking in the section of about 300 kilometers between Volta Redonda and Eg. M. Feio is operated by electric staff system. In other sections, the blocking is operated by automatic block system, except the section between Japeri and Volta Redonda and the section between Eg. M. Feio and Roosevelt where ATC system is adopted for blocking. As for interlocking, in all stations there are installed electric interlocking devices or electromechanical interlocking devices, though almost all of them are of old pattern.

(2) Safety Devices in the Section between D. Pedro II and Deodoro.

In the section between D. Pedro II and Deodoro where 4 tracks are laid in the subsection between D. Pedro II and Dentro, 6 tracks between Dentro and Madoreira and 4 tracks between Madoreira and Deodoro, the trains are forced to run crossing the other main tracks in stations. Such complicated train running system shall be improved for the safety and smooth running. For this purpose there are proposed four alternatives in the Figure 4, attached. The final plan of train running shall be determined taking into consideration the transportation volume in this section, passenger handling method in each station, platform of each station, states of branching system of branch lines etc.

It is recommended that the alternative 4 is most preferable due to the following reasons :

(i) Not only the layout of the tracks, electrification facilities and patterns and systems of signalling and blocking, but also the maintenance method shall be arranged in conformity with the high speed through train, different from those applied on the suburban trains.

(ii) For the purpose of achieving such arrangement effectively, the tracks for through trains shall be preferably separated from tracks for suburban trains.

(3) Singalling System.

In the major part of the section of double tracks between Deodoro and Pirai, the signalling and blocking devices are available for both directions, except the subsection between Deodoro and Nova Iguchi where they are available only for one direction. Such an ununiformity of signals shall be avoided because signalling system shall be constructed in perfect unformity in order to avoid the confusion of handling.

(4) *Mechanical and Electric ATS.*

The mechanical automatic train stop (ATS) is used only in the rapid trains on suburban lines. Such device shall be used in all trains which will pass on the same tracks. Futhermore, it is recommended that as the existing mechanical ATS is of old pattern, it shall be considered to be replaced to the electric ATS in the electric cars on the suburban lines which has the faculty of speed check. It is recommended that the ATC shall be adopted with cab signal in all trains, in case where long distance through trains will run at high speed in the future, for the purpose of securing the safety of train running.

(D) Telecommunication.

The telecommunication circuit for train dispatching and the omnibus circuit are installed all through the railway line. As for radio communication there are installed HF of several meg megacycles per second all through the railway line and HF of 150 and 160 megacycles per second in the districts of Rio de Janeiro and Sao Paulo respectively.

Article 6. Traffic and Train Operation.

(A) Traffic.

It is observed that the traffic on the railway line between Rio de Janeiro and Sao Paulo may be classified into (i) long distance transport of passengers, (ii) Transport of commuters and (iii) freight transport of industrial products and supplies

such as iron ore, coal and manufactured goods and of other commodities. For answering for such demand, the following trains are now being operated:

(i) Four through trains between Rio de Janeiro and Sao Paulo for long distance passengers are in service.

(ii) Electric car trains for commuters in the suburban areas both of Rio de Janeiro and Sao Paulo are in service. 15 electric car trains per hour in the time zone of rush hours, 6 trains per hour in the other time zone, and 400 trains in total per day in the area of Rio de Janeiro are in service, 200 units of electric cars being used therefor. 180 electric car trains in total per day in the area of Sao Paulo are in service, 50 units of electric cars being used therefor.

(iii) For freight transport, 12 freight trains are in service transporting mainly iron ore from Bello Horizonte to Volta Redonda and Cosipa Iron Mill via Santos-Jundia Railway for domestic use and to Rio de Janeiro through Arara for export. Generally, each freight train carries 5,000 tons (including tare weight), tracted by four units of diesel locomotives. It is expected that the demand of transport of iron ore and coal for iron mills will increase due to the increase of export but that the demand of transport of other commodities has the tendency of decreasing due to the development of high-way transport if the railway facilities and operation will be left unimproved in the future.
It is emphasized that the freight transport by containers is increasing since it has been developed.

(B) Train Operation

(1) General.
The schedule of train operation of the railway is tabulated as shown in the Chart 4, attached. But, it is observed that there are recorded frequent delays and cancellations of trains. The causes are not identified clearly but, it is surmised, may be the poor conditions of track structure and the undue regulation of train running. Such poor state of train running, it is deemed, may be one of the causes of decreasing volume of transportation.

(2) Capacity in the Section of Single Track.
It is approximately calculated that the single track between

Barra do Pirai and Eg. M. Feio has the capacity of 56 - 54 trains per day under the assumption that the present running speed will be maintained.

(3) Plan of train running between D. Pedro II and Deodoro. In the somewhat complicated as explained in the preceding paragraph (2), (C), Article 5. While there is a plan to construct the new line, separated from the existing line, in this section, it is recommended that the special committee, consisting of staffs and experts of DNEF and EFCB shall be organized for the purpose of determing the final plan of train running arrangement in this section, taking into consideration the concept as mentioned in the preceding paragraph (2), (C), Article 5 of this Chapter.

(4) The Subjects to be studied in detail regarding Train Running in connection with Safety Device.
It is selfexplanatory that the train running shall be regulated in close connection with safety devices, and, therefore,it is proposed that the schedule of through trains between Rio de Janeiro and Sao Paulo shall be planned, taking the safety devices and the fixed facilities into consideration, as well as in compliance with the demand of transport of both freight and passenger. For this purpose, the detail survey regarding this subject shall be carried out.

Article 7. Rolling Stock

(A) Motive Power.
There are a little units of steam locomotives in service, but it is observed that they will be out of service in one year or so. As for tractive locomotives, therefore, major part of them will be diesel locomotives, while electric locomotives are in service between Rio de Janeiro and Barra do Pirai.
350 units of diesel locomotives are now in service. They are of 700 HP at smallest and of 3,000 HP at largest. 35 units of electric locomotives are now in service. In the suburban trains, 300 units of electric cars are used, in the formation of T.M.T. (trailer, motor car and trailer) in one integral train set. 200 units of them are of English made which are of small power. The other 100 units are of home made which are powerful, installed with 4 sets of 385 HP motors each.

(B) Passenger Car.

About 70 units of De Luxe passenger cars and about 200 units of ordinary passenger cars are now in service. Almost all of them are of old pattern and the dead weight per one theoritical passenger is very heavy. As for sleeping car, the dead weight is estimated at 2.5 tons per one theoritical passenger.

Half of De Luxe passenger cars are manufactured by Budo Co. of U.S.A. 10 units of diesel cars are now in service. They are in service for through express trains between Rio de Janeiro and Belo Horizonte.

(C) Freight Car.

All of freight cars are of large size, loaded weight of which is about 70 - 90 tons. Besides such cars the large size cars are in service for iron ore of M.B.R., the loaded weight of which is estimated at 115 tons each. All freight cars are of 2 bogie trucks of cast steel with 2 axles per each. Workmanship and maintenance of them are in good conditions.

Article 8. Workshop.

Workshops of EFCB are located at Eg. Dentro, Bello Horizonte and Barra do Pirai. Workshop in Eg. Dentro has two sections, one being assigned to the overhaul and the repair of diesel locomotives and passenger cars and other to the medium and light repair of electric cars.

Workshop in Belo Horizonte is assigned to the overhaul and the repair of diesel locomotives. Workshop in Barra do Pirai is assigned to the repair of electric locomotives. The light repair other than that above mentioned are being done in 10 deposits located in various spots. And the inspection of various kinds of cars are done in the deposits above mentioned. Among them the deposit in Sandiego is the largest one, to which the following cars are allocated for inspection:

Diesel locomotives:	48 units
Diesel cars:	10 units
Passenger cars:	263 units
Electric cars:	234 units.

As the capacity of repair in these workshops are not sufficient enough for all repairs required, a little portion of heavy repair of electric cars, passenger cars and freight cars are assigned to the outside workshops by contract.

CHAPTER IV

OUTLINE OF THE PROPOSED MODERNIZATION PROJECT

Article 1. General

Taking into accounts the background of the region, the perspective of the railway, the present states of the existing railway line and the progressing techniques of railways in developed countries, this plan of the modernization project of the railway line between Rio de Janeiro and Sao Paulo is made qualitatively. This plan is tentative and shall be modified in accordance with the results of detail quantitative survey which shall be carried out in the future because such a plan shall be materialized in compliance with the local conditions and along the line of general development program of Brazil.

This plan is made standing on the following basic principles:

(i) The plan shall be practical.

(α) The plan shall be made on the line of statisfying the demand of transport of both passengers and freights in the present and in the future.

(β) The plan shall be arranged in practical and reasonable schedule of works. In other words, the rehabilitation and the improvement shall precede the final modernization program.

(γ) The plan shall be made in the manner that entire program shall be arranged and scheduled in compliance with the financial arrangement, necessary working time, and in parallel with the increase of the demand of transport.

(ii) Safety, rapidity, authenticity and comfortability of train running shall be secured.

(iii) It is preferable that the high speed passenger train shall use the cars of light axle load, and that the freight trains shall run at rather low speed due to the heavier axle load.

(iv) It shall be deliberately considered not to disturb the commuter traffic.

Article 2. Modernization Program.

The modernization program is classified into four (4) steps in accordance with the principles above mentioned.

(A) The First Step.

(1) Maintenance of Track Structure and Road Bed.

The improvement of the maintenance works shall be carried out aiming at the security of safety and comfortability of train running. According to this aim the following programs are recommended:

(a) Organization and Working Method

(i) Number of trackmen in the field shall be increased. Inspectors in the field shall be enhanced in number and capability. It may be achieved by transfering the workers in the office to the trackmen and/or inspectors in the field.

(ii) The scientific method shall be applied on the maintenance works. It may be achieved by the materialization of the scientific method of maintenance works, which shall be planned in accordance with the results of the scientific survey and findings of the causes of changes of the track conditions. The special track-recording couches and the efficient measuring meters shall be prepared for such survey and finding. The scientific method of maintenance work will be found out by the results measured and the findings of the causes of weakening of the track structure.

(iii) The standards of the allowance limit of the accuracy of maintenance, allowable wear limit of track materials shall be numerically established and they shall be secured in practice of maintenance works. The track-recording coaches and meters above mentioned will contribute to the establishment of such standards.

(iv) Management of repair and use of track machineries and materials shall be rationalized. There are one repair shop for the repair of track materials and machineries of all sections of EFCB, 7 shops in the section between Rio de Janeiro and Sao Paulo and one rail welding shop in Barra do Pirai. They are well operated. It is desirable to empower such shops in the future in parallel with the improvement of the maintenance works for the purpose of making the use of track materials and machineries more effective.

(v) Maintenance of road bed, structures and buildings shall be strengthened. For this purpose, it is desired that for the purpose of the orientation of the records, of climates and of the changes of the structure conditions, the continuous inspection of them shall be carried out and that the reasonable plan for maintenance method shall be

established and be brought into practice according to the results of such inspections.

(b) Renewal and Strengthening of the Track Structure.

In order to secure the safety and authenticity of train running, strengthening of track structure shall be carried out promptly. It is the way to regain the reliability of the passengers on the railway because such measures will bring about the travel on the railway more comfortable, safer and faster than the busses. The following measures shall be carried out:

(i) Replacement of Rail, its Accessaries, Turn-out, Cross-ties and sufficient filling of Ballasts. The volume of the works is approximately estimated as follows:

Rail:	10% of existing rails.
Rail accessaries:	8% of existing accessaries.
Cross-ties:	25% of existing ties.
Ballast:	30% of existing ballast.

And the cost and time for this program are estimated at 2,560 million yen (7 million U.S.$) and 2 years respectively.

(ii) Weld-jointing of Rails

The rails laid in the tangent section, where it is assumed that the trains run at high speed, shall be weld jointed. It is approximately estimated that the total distance of weld-jointed rails sections will be 150 kilometers. The cost for this program is approximately estimated at 1,000 million yen (3 million U.S.$).

(iii) Mechanization of Maintenance Works.

Track maintenance works shall be mechanized as much as possible. For this purpose, maintenance machineries, tools and high speed track-recording coach shall be procured and track maintenance bases for machineries, tools and materials shall be constructed. The high speed track-recording coach shall be designed on the following criteria: The gauge, level surface, alignment, vibration acceleration, lateral pressure, change of axle load, etc. can be measured and recordedautomatically on the coach during the running at high speed.

The cost for this program is approximately estimated at 740 million yen (2 million U.S.$).

(c) Drainage Devices.

Side drain, cross culvert for drainage and surface protecting works

for surface slope of cutting and embankment shall be constructed or rearranged. The cost for this program is approximately estimated at 1,500 million yen (4.2 million U.S.$).

(d) Safety Devices for Highway Crossing.

There exists no highway crossing in the section between D. Pedro II and Deodoro.

In other section, there exist some highway crossing. In some crossing spot the watchman is stationed who handles the crossing gate upon the notice from the adjacent station by telephone. However, in almost all crossing spots there is not any safety devices, no watchman is stationed and no planking and no guard rail is constructed.

It is desired that the solid crossing of highway or devices of automatic gate for crossing or alarming bell devices for approching train, etc. shall be constructed as the safety devices for crossing in order to secure the safety and to avoid the stopping or slowing down of train speed.

The cost for this program is approximately estimated at 1,500 million yen (4 million U.S.$).

(2) Improvement of the Route.

The improvement of the route in the section between Barra do Pirai and Cachoeira shall be facilitated. The following subsections of 42 kilometer long, in total, are now under planning:

(i) Subsection of 13 kilometers between Piniheiro and Volta Redonda.

(ii) Subsection of 17 kilometers between Queltz and Lavinihas.

(iii) Subsection of 12 kilometers between Crozeiro and Cochoeira Paulista.

After completion of above improvement the track distance will be shortened by 5 kilometers and the minimum radius of curvature will become larger than 668 m which allows the maximum speed of 118 kilometer per hour.

The cost for this program, including earth works, track laying and electrification, is approximately estimated at 2,800 million yen (7.8 million U.S.$).

Taking into account the future speed-up of train running, it is desirable to enlarge the radius of curvature up to 1,100 meters (or 1,500 meters, preferred) which allows the maximum speed of 150 kilometers per hour (or 175 kilometers per hour) in this section, in spite of the improvement design of setting up minimum radius at 688 meters.

The following Table 18 is given for reference :

Table 18

Allowable maximum speed at various radius of curvature.

Radius of curvature in meter	Allowable maximum speed in kilometers per hour
400	90
500	101
600	110
700	119
800	127
900	135
1,000	143
1,100	150
1,200	156
1,900	175
2,000	200

These figures in the Table are calculated by the formula

$V = C R$, where

V : allowable maximum speed in kilometer/hour

R : radius of curvature in meter

C : coefficient for standard gauge of track and assumed at

$C = 4.5$

This formula is generally recognized all over the world and this is adopted in New Tokaido Line of Japan. As the gauge of track of this railway line is 1.6 meter, wider than the standard gauge, it may be understood that these figures may be applied on this railway at the safer side.

The cost to be added for enlarging the radius to 1,100 meters is approximately estimated at 700 million yen (1.9 million U.S.$).

(3) Rearrangement of the Use of Tracks in the Section between D. Pedro II and Deodoro.

As above mentioned in the paragraph (2), (C), Article 5 and (A), (B), Article 6 of CHAPTER III, it is recommended that the final plan of the rearrangement of the use of tracks of

this section shall be decided according to the results of the study by the special committee. Taking into such considerations, it is recommended that some tentative rearrangement shall be carried out in the st step program along the line of the final plan.

The cost for this program is approximately estimated at 500 million yen (1.4 million U.S.$).

(4) Train Operation, Rolling Stock and Workshop.

After the completion of the improvement of track maintenance works and route as well as the enlargement of the radius of curvature as above mentioned, it will be possible to higher up the speed of all trains at more comfortable travelling conditions with less troubles, such as delay, cancellation, accidents etc. For the purpose of materialization of such speed-up as above mentioned, it is necessary to prepare the following programs :

(a) Preparation of the "Run Curve" of every train, closely related to the characteristics of cars to be used therefor.

(b) Preparation of running diagram of every train in 2 minutes interval pitch, based on the data prepared by the process (a) above mentioned.

(c) Planning of the improvement program of operation facilities based on the data prepared by the process (a) and (b) above mentioned.

(d) Preparation of the procedure for establishement of the transport system by special container trains and the technical studies of the train running system and the speed up of such special trains.

(e) Studies of the special locomotive and container wagon to be used in the special container train.

(f) Studies of the electric cars, the base for these electric cars, the necessary operation facilities, etc. under the consideration of the following second step programs of this modernization project.

(g) Studies for the enforcement of the capacity of repair of electric car.

(h) Studies for the establishment of the repair method by means of the replacement of finished spare parts.

(i) Disposal of the scraps in workshops.

The cost for this program (4) may be able to be born by the budget allocated to routine works of DNEF.

(5) The Cost and the Time for and the Effect of the First Step Program.

It is expected that all trains will be able to run on schedule in safer, more authentic and more comfortable conditions than ever, and, furthermore, the express passenger through train between Rio de Janeiro and Sao Paulo will be able to run within six hours and a half.

The cost and time for completion of the first step programs approximately estimated at 11,300 million yen (31.5 million U.S.$), and at 2 years respectively.

The expenses for education of staffs, training of technicians and studies with investigations are not included in the above estimated cost because they can be achieved by railway staffs in their routine works. The organization and schedule of such education, training and studies shall be established as early as possible.

(B) The Second Step.

(1) General.

The second step is the essential part of this modernization program. In other words, it is expected that this very program is the first step of the modernization. It is understood that the completion of this second program will create the modernized railway between Rio de Janeiro and Sao Paulo.

The followings are the recommended programs of the 2nd step:

(2) Strengthening of the Track Structure of Entire Line.

(a) Rails in the curve sections of larger than 1,000 meter radius shall be weld-jointed.

(b) All cross-ties shall be replaced by pre-stressed concrete ties with double elastic rail-fastening device.

(c) Perfect and reliable drainage works for road bed as well as protection works for slope surface of cutting and embankment shall be completed. It is desired that, on the other hand, the stabilization of the road bed by special measures, such as filling of sub-ballast, construction of cross drainage culvert

and other earth stabilization measures, shall be planned and executed.

(d) The cost for this program (2) is approximately estimated at 14,700 million yen (40.8 million U.S.$). All of these 3 sectors (a), (b), (c), of this program shall be executed section by section simultaneously. Such sections shall be divided as follows for the purpose of obtaining the immediate effect of completion of each section and for convenience of the excution :

(i) Subsection of track length 136 kilometers between D. Pedro II and Barra do Pirai.

(ii) Subsection of track length 293 kilometers between Barra do Pirai and Eg. M. Feio.

(iii) Subsection of track length 60 kilometers between Eg. M. Feio and Roosevelt.

(3) Procurement of Track Maintenance Machineries and Tools.
Following the same program in the 1st step, additional track maintenance machineries and tools shall be procured. The procurement of special track-recording coach is included in this program. It is desired that appropriate machinery shed for those machines, tools and coaches shall be constructed in this program. The cost for this program is approximately estimated at 1,500 million yen (4.2 million U.S.$).

(4) Construction of the new line between Japeri and Barra do Pirai.
The plan and profile of the proposed new line are shown in the Figures 2 and 3 respectively. It is the improvement of the existing line. The proposed line is designed on the following standards :

(i) Maximum gradient : 14 o/oo

(ii) Minimum radius of curvature except Japeri station and its annexed subsection : 1,500 meters.

(iii) Total length : about 30 kilometers
(shorter than existing line by 9 kilometers)

(iv) Double track and electrified.

(v) Number of tunnels is enumerated at 12 ; the longest one is 10.35 kilometers long.

(vi) 2 passing siding stations shall be constructed, effective siding length being 1,000 meters and the gradient 10 o/oo.

This is designed to provide staying of a freight train for the passing over of express passenger trains.

The conditions of new line including the other improved sections, are shown in the Chart 5, attached.

The cost for this program, civil works, track-laying and electrification included, is approximately estimated at 26,800 million yen (74.4 million U.S.$). Time for the construction of this new line is approximately estimated at four years. The time for completion of 2nd step program may be able to be shortened by 2 years if the execution of the longest tunnel will be started at the time of the start of 1st step program.

It is emphasized that the proposed new line shall be constructed because the existing line of this section will become the bottle neck in the entire route for increasing volume of transport of iron ore from Bello Horizonte to the port of Rio de Janeiro and to the port of Septiba (now under planning), of increasing manufactured commodities (mainly of the products in Volta Redonda) from interior industrial district, including Sao Paulo and its suburban area, to Rio de Janeiro and of increasing agricultural products from interior farm centers to Rio de Janeiro and its suburban area.

(5) Other Improvement Works of the Route

(a) The elimination of sharp curves in the section of 40 kilometers between Deodoro and Japeri where there exist successive reverse curves and sharp curves of less than 400 meters radius, shall be carried out for the purpose of securing the high speed passenger train.

(b) It is desirable to construct the new passing siding stations in the appropriate spots between Rio de Janeiro and Sao Paulo, the location of which will be determined according to the plan obtained by the studies of the schedule of express passenger trains which will be done in the program (4) of the 1st step.

(c) The cost for the programs (a) and (b) is approximately estimated at 800 million yen (2.2 million U.S.$).

(d) It is observed that it will become necessary to increase the number of track in some sections in compliance with the increase of high speed express passenger and other trains in the future. For this purpose, it is recommended that in course of execution of program of improvement of route, the track enhancing works shall be con-

sidered to be commenced in this 2nd step program if circumstances warrant, in spite of the track enhancing plan in the following 3rd step program.

(6) Betterment of Turn-out.

It is recommended that about 200 sets of turn-out, installed in the main tracks of intermediate stations, shall be replaced by new ones with movable crossing of #18 switch, shown in the Figure 5 (1 - 3), attached, for the purpose of eliminating the limited speed on the crossing of turn-out.

The cost for replacement of such turn-out, including installation works, is approximately estimated at 3,700 million yen (12 million U.S.$). It is noticed that this estimate amount shall be increased according to the results of detail survey because there exist some sets of turn-out on the curve sections of main track and they shall be improved for the purpose of eliminating the speed limitation of the high speed through trains.

(7) Safety Devices for Highways Crossing.

It is recommended that in some crossings of highway, special safety devices such as solid crossings, automatic barrier, alarm bell equipment for approaching trains etc. shall be constructed for the purpose of answering for the speed up and increased frequencies of trains.

The cost for this program is approximately estimated at 1,500 million yen (4.2 million U.S.$).

(8) Electrification of the Entire Line.

It is recommended that entire route shall be electrified prior to the increase of number of tracks. The distance to be electrified in this program is estimated at about 300 kilometers.

The criteria of the electrification shall be the same as existing i,e. 300 V, Double Trolly pattern. It is noticed that the electrification works shall be planned and executed in such manner as not to be duplicated in the course of the increase of number of tracks, planned in the 3rd step program. The reasons for the priority of the electrification to the dieselization are summarized in brief as follows:

(i) It is preferable to use the electric cars of light axle load in high speed express trains, taking in accounts the economy and balance of the maintenance of track structure. It is understood that the electric car of about 15 tons of axle load can be manufactured.

(ii) The hydrauelectric resources are much richer than the oil resources in Brazil.

(iii) In Brazil, the capability of manufacturing and repairing electric cars is higher than that of diesel cars and such tendency will continue in the future. Therefore, it is understood that the inspection and repair of electric cars will be done more smoothly and more economically than that of diesel cars.

The cost for this program of electrification of the section of 300 kilometers is approximately estimated at 9,500 million yen (26.4 million U.S.$).

(9) Preparation of CTC and ATC System in Entire Line.

CTC system shall be installed in all section of the line. The following subsections are not yet installed with CTC system.

(i) Subsection between D. Pedro II and Japeri: about 62 kil meters.

(ii) Subsection between Volta Redonda and Manoel Feio: about 308 kilometers.

(iii) Subsection between Eg. S. Caulberts and Roosevelt: about 6 kilometers.

In total, the distance to be newly installed will be about 376 kilometers.

The existing CTC system already installed shall be used as the anxiliary system of the entire system and the entire system shall be planned to be controlled at one center, D. Pedro II. ATC system, which has the functions of slowing down the speed by automatic brake, when a train speed exceeds its specified allowable limit, and of releasing the brake automatically to regain the specified speed, shall be constructed with cab signal equipment in the car. The cost for this program is approximately estimated at 12,400 million yen (34.4 million U.S.$).

(10) Rearrangement of the Use of the Tracks in the Section between D. Pedro II and Deodoro.

The rearrangement of the use of the tracks in the section between D. Pedro II and Deodoro shall be continued to be executed following the same program as in the 1st step. The plan shall be determined in the manner as suggested in the preceding paragraph (3), (A), Article 2 of this Chapter. The alternatives of the plans of rearrangement are given in the Figure 4, attached. It is preferable to adopt the alternative 4 due to the reason that the handling of the train running will

be simplified and the inspection and maintenance of the facilities will be well regulated.

The cost for this program is approximately estimated at 200 million yen (0.6 million U.S.$).

(11) Procurement of Electric-test Recording Coach.

The electric-test recording coach shall be procured for the purpose of collecting the following data automatically recorded:

(i) Voltage on the trolly wires.
(ii) Displacement of trolly wires.
(iii) Hight of trolly wires.
(iv) Finding of obstacles.
(v) Detachment states of trolly wires.
(vi) States of electricity transmission.
(vii) States of track currents.
(viii) States of electric bell.
(ix) Frequency of signal circuit.
(x) States of electric signal.
(xi) Unbalance current.
(xii) Frequency and characteristics of the current in the detecting apparatus of ground connection.
(xiii) Other states on the surface, relating to the electric appratus.

This coach can be used for emergency, carrying the workmen and materials needed for relief or repair.

The cost for procurement of this coach is included in the cost for the program of electrification, (8), (B), Article 2 of this Chapter.

(12) Train Operation, Rolling Stock and Workshops.

(a) Preparation of "Run-Curve" of the express train of electric cars, and other trains.

(b) Preparation of the running diagram of the express trains of electric cars at 2 minutes interval pitch, based on the corresponding "Run Curve" prepared, in order to secure the running time of this train within 5 hours between Rio de Janeiro and Sao Paulo.

(c) Studies for establishment of Plans, of the formation of the electric cars train and allocation thereof, and the determination of the number of electric cars required for the schedule of train running prepared in the preceding (b).

(d) Construction of the base of the electric cars in conformity with the plans prepared in the preceding (b) and (c).

(e) Construction of other fixed facilities necessary for the above plans.

(f) Design of the electric locomotive of light axle load. The object of this program is to prepare the adoption of electric locomotives for traction of special container and other trains in the future in the case where entire section of the line is electrified and the diesel locomotives now in service will be replaced by electric locomotives in the future.

It is understood that the diesel locomotives now in service will be replaced on by one by the electric locomotives, while such diesel locomotives shall be put in service on the line between Barra do Pirai and Bello Horizonte for satisfying the increasing demand of the transportation of iron ore in the future.

Such replacement plan shall be established taking the development of this region and the rearrangement of the train schedule corresponding thereto in the future into consideration.

(g) Procurement of Electric Cars

The number of electric cars are approximately estimated at 48 units for satisfying the formation of 6 trains of 8 cars, however, the number will be adjusted according to the schedule of the trains planned for satisfying the demand of passengers in the future.

The cost for procurement of electric cars, the construction of base of electric cars and other fixed facilities is approximately estimated at 6,000 million yen (16.7 million U.S.$). In this cost the expense for improvement and reinforcement of the workshops is included, and the cost for replacement of electric locomotives is excluded.

It is recommended that the transport by containers shall be assigned to the out side freight forwarders by contract, and, therefore, the cost for containerization shall be born by them.

The concrete plan of the containerization shall be established by the deliberate studies and investigations taking into account the progress of the containerization all over the world. The tresent container transport shall be continued until the final plan will be set up.

(13) The Cost and the Time for and Effect of the Second Step Program.
The total cost for the 2nd step program is approximately estimated at 77,600 million yen (215.5 million U.S.$), and the time for completion is approximately estimated at 4 years, but it can be shortened by 2 years if required.

The effects of the Second Step Program are summarized as follows:

(i) All trains run at higher speed than ever.
The allowable maximum speed of trains of electric cars can be estimated at 150 kilometers per hour, of tracted passenger trains at 120-140 kilometers per hour, and of freight trains at 80 - 100 kilometers per hour.

(ii) The transport capacity of the route increase from 50 up to 70 trains daily in the single track section.

(iii) All trains run on schedule in safer, more reliable and more comfortable conditions than ever.

(iv) The express passenger trains of electric cars runs between Rio de Janeiro and Sao Paulo in less than 5 hours.

(C) The Third Step

(1) General
It is surmised that the increase of transport demand of both passengers and freight will be arroused by the improved running conditions due to the completion of the program of the 2nd step.

For the purpose of satisfying such demand, the 3rd step program shall be commenced following or in advance of the completion of the 2nd program. It is understood that a certin works in the 3rd step program are the continued process of corresponding works in the 2nd step program, namely the 2nd program will be ableto obtain the expected effect by the completion of the 3rd step program. Upon the completion of the 3rd step program, this railway will be the most modernized railway in every respect and will become able to satisfy the expectation of the public.

The program of the 3rd step is itemized in the followings:

(2) Double Tracks and Electrification of Entire Route.
Double tracks line shall be completed all through the route by laying one more track along the existing one in the section of 335 kilometers between Barra do Pirai and Eg. M. Feio.

And the road bed therefor as well as the electrification, the signal system and other safety devices shall be constructed. The cost for this program is approximately estimated at 82,200 million yen (230 million U.S.$).

(3) The enlarging the curve radius up to 1,500 meters in the section of curves of less than 1,100 meters radius, simultaneously with the execution of the program (2) above mentioned.

(4) It is observed that the increase of the tracks in the sections between D. Pedro II and Japeri as well as between Eg. M. Feio and Sao Paulo, where there are double tracks or more laid already, may be required for the purpose of satifsying the increasing demand of transport of passengers in the future. In this case it is necessary to contemplate the plan not to disturb the existing suburban commuter service; furthermore, it shall be planned to maintain the high speed through train of this main line in spite of the enforcement of such suburban lines.

In this program no fund for such works is not estinated because it is deemed reasonably that the cost shall be born by the improvement of commuters traffic.

(6) Electric cars for increasing the express passenger trains shall be procured and the construction of base of the electric cars shall be completed for the increase of them.

It is proposed that the number of electric cars to be increased is estimated at 32 units in order to forming 4 trains of 8 cars.

The cost for this program is approximately estimated at 3,000 million yen (8.3 million U.S.$).

(7) The Cost and the Time for and the Effect of the Third Step Program.

The cost is approximately estimated at 97,200 million yen (271.6 million U.S.$).and the time for completion of the 3rd step program is estimated at 4 years.

The effect of the completion of the 3rd step program is extraordinally remarkable, summarized as follows:

(i) The allowable maximum speed of the trains of electric cars will be raised to 170 kilometers per hour.

(ii) The allowable maximum speed of the freight trains tracked by electric locomotives will be raised to 100 kilometers per hour.

(iii) All trains can run at higher average speed than that after the completion of the 2nd step program.

(iv) The express passenger train of electric cars can run in less than 4 hours between Rio De Janeiro and Sao Paulo.

(v) The transportation capacity of the entire route will be raised from 70 to 200 trains daily. It is understood that the transportation capacity of both passengers and freight will be increased to about 4 times of that in the present and all trains run is extremely far better conditions than the present.

(D) Final Step (4th step)

After the completion or during the progress of these programs (1st - 3rd), the final step, that is the construction of new line as the modernization program of the transport measure between Rio de Janeiro and Sao Paulo, may come into view aiming on the satisfaction of the traffic demand between these cities in the case where such demand might not be able to be born by the railway improved by the modernization program of 1st, 2nd and 3rd steps above mentioned.

On the other hand, it is surmised that the transport means on land Might change its structure into quite different pattern from the present railway or motor vehicles as the technical studies on the traffic means on land, it is imagined, might create a quite new pattern such as air tube system, jet propelling system and most probably the equipment of linear motor, in the future.

Therefore, it is imagined reasonable that the plan of new line construction between those cities shall be contemplated taking into considerations the demand of traffic and, on the other hand, the most up-to-date pattern of land transport in the future.

If it is concluded to construct the new line of the esisting railway pattern, the new line can be constructed in 5 or 6 years and can run the passenger train in less than 3 hours between these cities in the satisfactory conditions of running, maximum speed being allowed at 240 kilometers per hour. In such a case it is emphasized that deliberate investigation and studies on this plan shall be carried out in economical, technical and business respects.

It is recommended that the preliminary survey and basic studies on such plan shall be started as early as possible.

(E) Summary

The modernization program set forth in the preceding paragraphs is summarized in the Chart 6, attached.

As above mentioned, the time for completion of the program (1st - 3rd step) is estimated at 10 years, however, it may be shortened by 2 years if required. It is again emphasized that the second step program is the essential portion of this modernization project.

It is probable that while it is desired that the 2nd program shall be completed as early as possible, the commencement of the 3rd step program may be able to be postponed if circumferences warrant or the transport demand might not increase as expected in 5 years after the start of this project.

The cost estimated, excluding the final step program, is of approximate calculation based on the experiences performed in Japan, taking into account as much as available the local conditions of this region. Therefore, it is noticed that the plan and the cost estimate shall be adjusted according to the results of the main detail survey and studies which, it is hoped, shall be carried out as early as possible.

The main detail survey and studies shall comprise the technical survey and studies in detail as well as the economical analysis, including the forecast of the increase of traffic demand and the rate structure to be adopted in the future. It shall be throughly and quantitatively carried out.

It is desired that the financial arrangement shall be established according to the results of the main survey.

In the main survey, the Japanese Government may cooperate with railway organizations in Brazil concerned.

- THE END -

CHART I States of Railway between Rio de Janeiro and São Paulo

	Section	Distance (in km)		Maximum Gradient (in %)	Minimum Radius of Curvature (in meter)	Number of Curve Sections (Classified into radius of curvature)									
						Less than 300m	300m-400m	400m-500m	500m-600m	600m-700m	700m-800m	800m-900m	900m-1000m	1,000m-1,100m	larger than 1,100m
1	D. Pedro II ~ Deodro	22		0.8	318		5	8	4	4	5	3		1	16
	Deodro ~ Japeri	40	62	0.8	311		5	9	10	6	3	2	4	3	11
2	~ B.Pirai	46	108	2.0	125	78	25	20	13	5	2	5	4	2	11
3	~ Cachoeira Paulista	152	260	0.5	163	34	20	7	14	28	6	14	7	1	37
4	~ Eg Manoel Feio	188	448	0.5	688					2	9	20	1	7	58
5	~ Roosvelt	30	478	0.5	300		24	3		1	1	2		1	1

CHART 3 Ststes of Electrification Signal and Telecommunication Systems

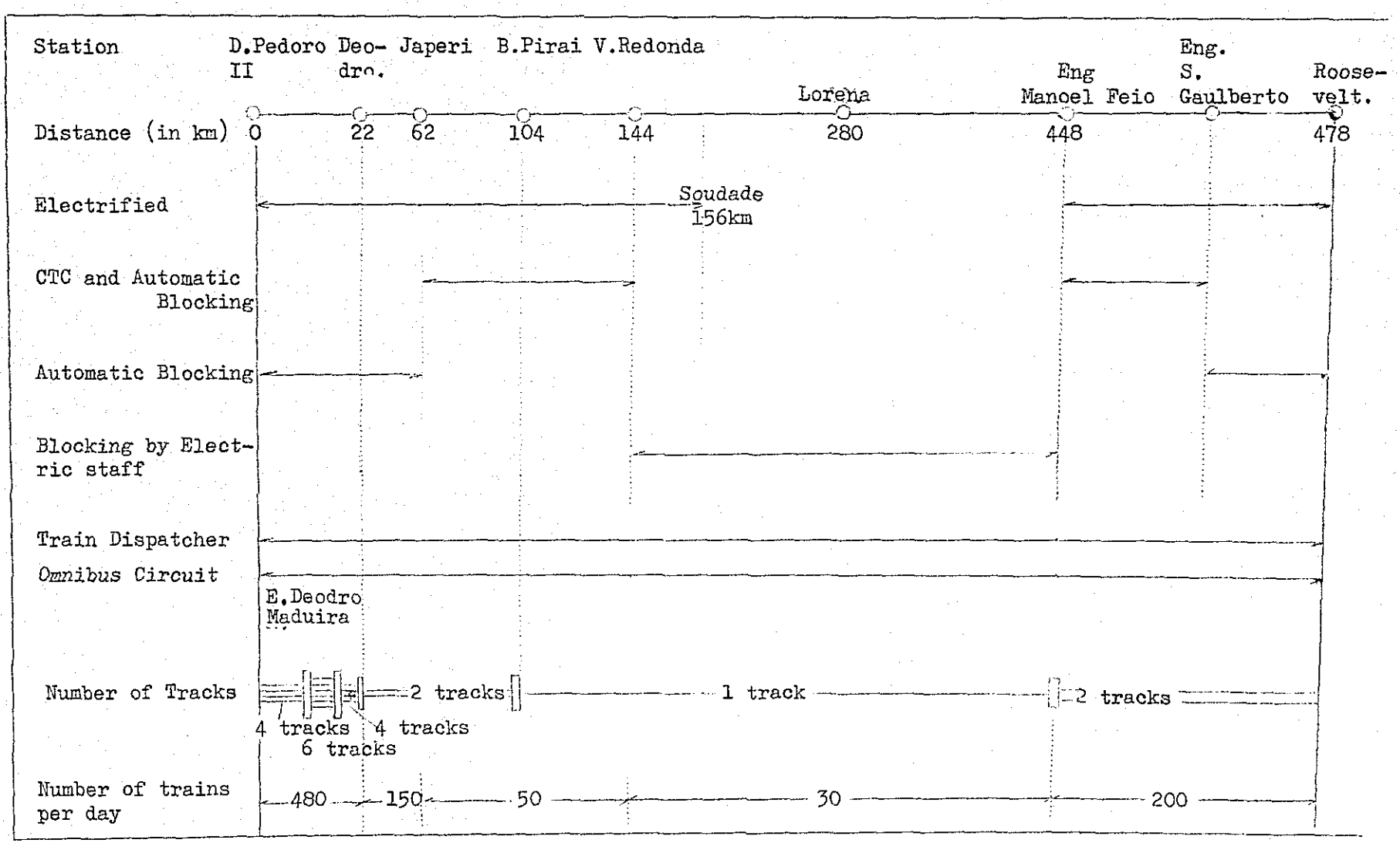


CHART 2. Comparison between Existing and Improved Line.

Section	Existing or Improved	Distance	Total number of curve sections	Minimum radius of curvature (in m)	Number of Curve Sections (clasified into radius of curvature)									
					Less than 300m	300m-400m	400m-500m	500m-600m	600m-700m	700m-800m	800m-900m	900m-1,000m	1,000m-1,100m	Larger than 1,100m
Pinihero	Existing	17k033	32	229	2	10	3	4	1	1	-	-		11
|	Improved	13k327	14	688	-	--	-	-	5	-	4	1		4
Volta Redanda	Difference	-3k706	-18											
Queluz	Existing	17k775[5]	45	163	20	8	3	8	-	4	-	-		2
|	Improved	17k012[5]	18	688	-	-	-	-	10	4	-	3		1
Lavrinhas	Difference	-0k763	-27											
Crozeiro	Existing	13k107[5]	17	191	12	2	1	2	-	-	-	-	-	
|	Improved	12k477[5]	10	688	-	-	-	-	5	-	1	1		3
Cachoera	Difference	-0k630	-7											
	Total Difference	-5k099m												

CHART 4. States of Train Operation

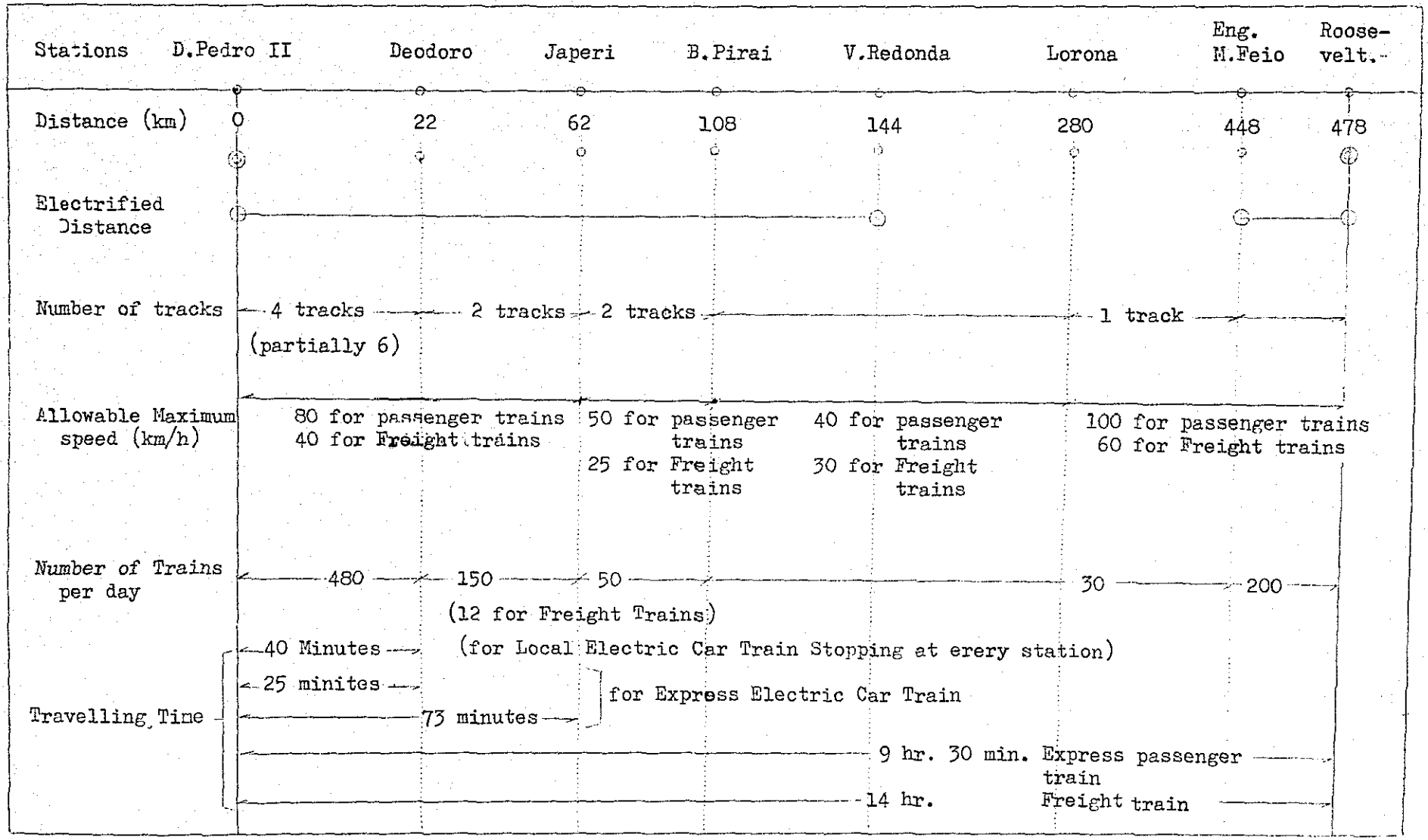


CHART 5. States of Railway Line after Completion of 2nd Step Program between Japeri and E. Manoel Feio

Section	Distance (in km)	Max. Gradient (in %)	Min. Radius of Curvature (in meter)	Number of Curve Sections					
				600m-700m	700m-800m	800m-900m	900m-1,000m	1,000m 1,100m	Larger than 1,100m
Japeri ⟩ B. Pirai	37	1.4	1,500						18
⟩ Cachoeira Paulista	147	0.5	688	27	1	14	7	1	32+α
⟩ Eg. Manoel Feio	188	0.5	688	2	9	20	1	7	58

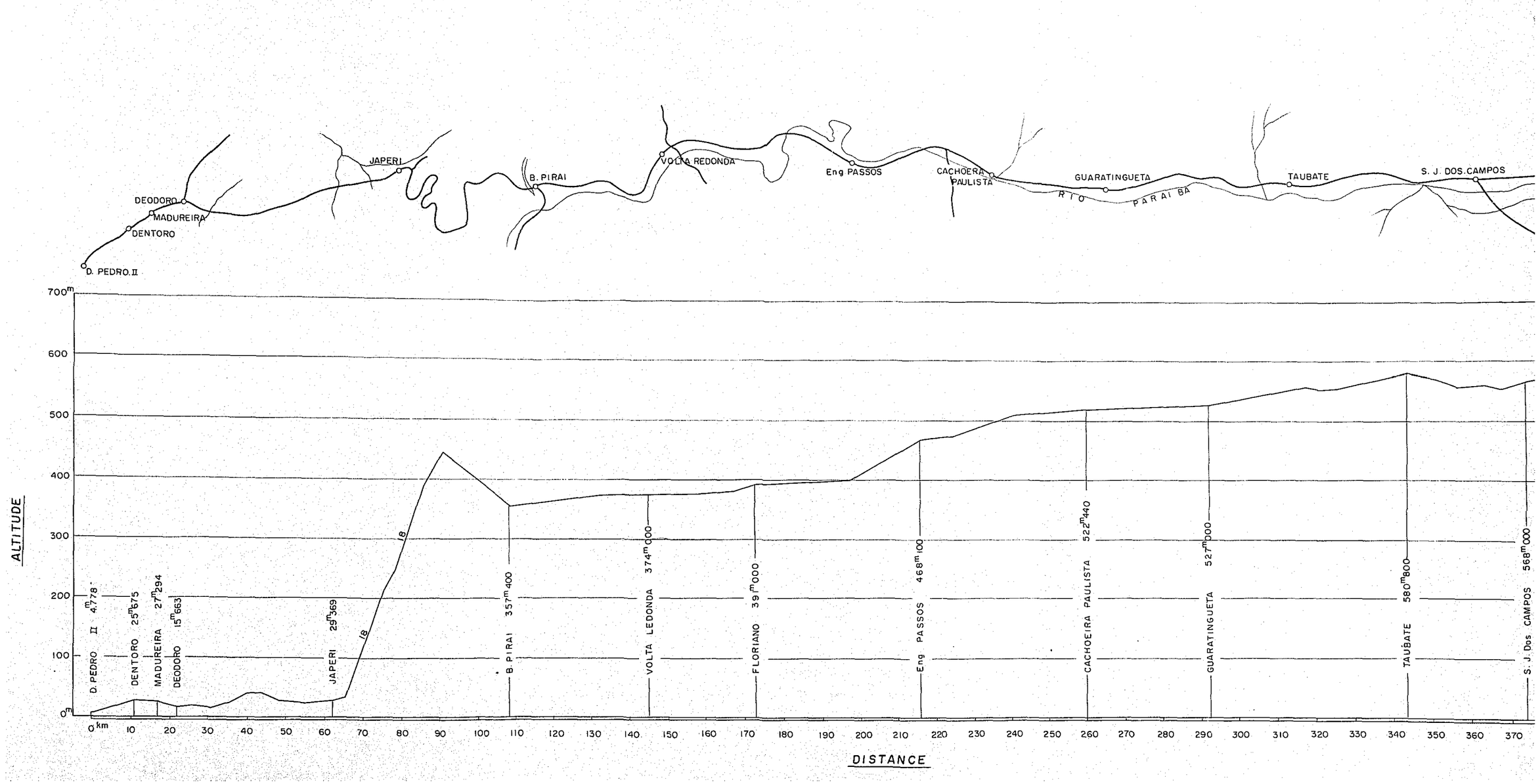
Remarks ; α : Number of curve sections after the improvement of 3 sections in the 1st step program. Refer to Chart 2.

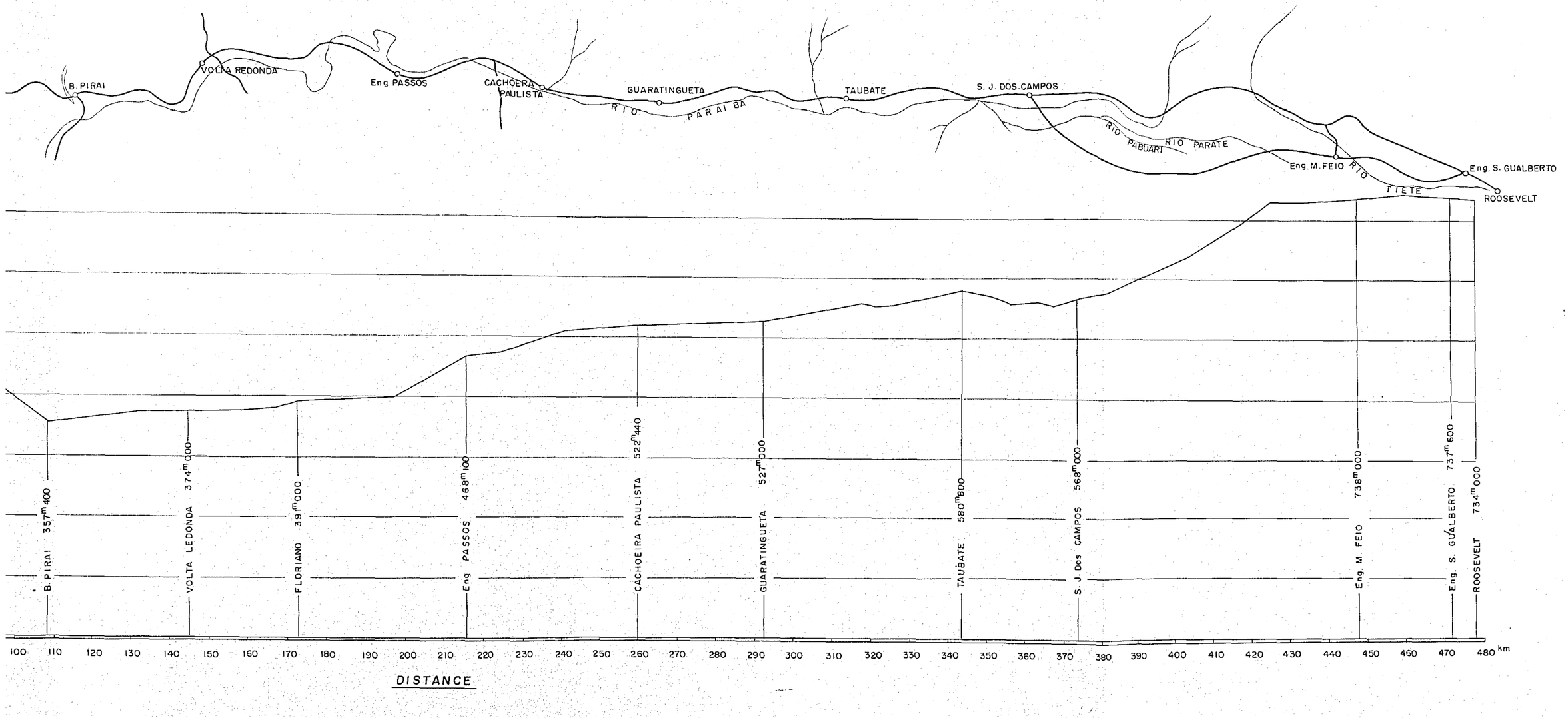
CHART 6. Summary of Modernization Project of Railway Line between Rio de Janeiro and Sao Paulo

Step	Main Objectives	Main Programs	Main Works	Cost in Million ¥ (in ml. U.S.$)	Time for Completion of the program in years	Effects of the Completion of the Program
The 1st Step	Improvement of Track Maintenance and Highway Crossing.	(a) Improvement of Track Maintenance Works and Renewal and Improvement of trank Structure.	(a) Rationalization of Track Maintenance Works. Mechanization of Track maintenance Works. Renewal and Imprbvement of Rails. Cross-ties and other Track materials. Weld-joint of rails. Construction of Drainage Devices. Construction of Safety Devices in Highway Crossing.	7,300 (20.4)	2	Allowable Max. Speed : 120km/h for Passenger trains. 60km/h for Freight trains. Capacity : 50 Trains per day even in the section of least capcacity. Running Conditibns : Safer More Comfortable. More Accurate on schedule than ever. Travelling time of the Express through Passenger Train tracted by locomotives between Rio de Janeiro and Saô Paulo : 6.5 hours.
		(b) Completion of the Improvement Works now under Construction.	(b) Completion of Improvement Works of 42 km in 3 Subsections between Barra do Pirai and Cachoeira Paulista.	3,500 (9.7)		
		(c) Rearrangement of the Use of Tracks in the Section of 4-6-4 Tracks (1st step)	(c) Rearrangement of Turn-out and Signal System in the Section between Pedro II and Dendoro (4-6-4 Tracks) and Rearrangement of Signals in the Section between D.Pedro and Iguchi.	500 (1.4)		
		Sub total		11,300 (31.5)		
The 2nd Step	Electrification of the Single Track Section and Improvement of Facilities.	(a) Electrification of Entire Route	(a) Electrification in the Section of 300 km (where not electrified)	9,500 (26.4)	4	Allowable Max. Speed : 150 km/h for passenger Trains of Electric Cars. 120-140km/h for passenger Trains, tracted by locomotives. 80-100km/h for Freight Trains. Capacity : 70 Trains per day even in the section of least capacity. Running Conditions : Much safer, Much Comfortable, Much more Acculate than ever. Travelling time of Express through Trains of Electric Cars between Rio de Janeiro and Sâo Paulo : Less than 5 hours.
		(b) New Line Construction between Japeri and Barra do Pirai (Improvement of the Existing Line between Japeri and Barra Do Pirai.	(b) New Line Construction (Max. gradient : 14%) (Min. Curvature: 1,500m) (Distance : 30 km) and Double Tracks and Electrification.	26,800 (74.4)		
		(c) Construction of CTC and ATC of Entire Route.	(c) Establishment CTC center at D.Pedro II. and Construction of ATC with Equipment of Cab Signal.	12,400 (34.4)		
		(d) Rearrangement of the Use of Tracks in the Section of 4-6-4 Tracks (2nd step).	(d) Rearrangement of the Use of Tracks.	200 (0.6)		
		(e) Strengthening of Track Structure.	(e) Strengthening of Track Structure, Improvement of Turn-out. Mechanization of Track Maintenance Works and Construction of Safety Devices in Highway Crossing.	21,400 (59.5)		
		(f) Enlargement of Curve Padius and Enhancement of Number of Tracks (Partial.)	(f) Enlargement of Curve Radius in the section between Deodro and Japeri and Construction of 2 passing and Siding Stations.	1,300 (3.6)		
		(g) Procurement of Rolling Stock and Construction of Rolling stock Base.	(g) Procurement of 48 Units of Electric Cars forming 6 Trains of 8 Cars, Strengthening Inspection Dep. and Procurement of Electric Test Recording Coach.	6,000 (16.7)		
		Sub Total		77,600 (215.6)		

Step	Main Objectives	Main Programs	Main Works	Cost in million ¥ (in nl. U.S.$)	Time for Completion of the program in years	Effects of the Completion the program
The 3rd Step	Completion of Double Tracks and Electrification	(a) Electrification and Laying of 1 more Track in the Section of Single Track; resulting in Electrification and Double Track all through the Line. (b) Improvement of Curve Section and Preparation of Track Machineries and Tools. (c) Procurement of Rolling Stock and Construction of Rolling Stock Base	(a) Increase of one more Track, Construction of Road Bed , therefor, Installation of Signal and Telecommunication Systems in the Section of 335 kilometers between Barra do Pirai and M.Feio. (b) Enlargement of Curve Radiuo Simultanecusly with the Increase of Number of Tracks. Mechanization of Track Maintenance and Construction of Protecting Works of the Line. (c) Procurement of 32 units of Electric Cars forming 4 Trains of 8 Cars, and Improvement of Inspection Works of Rolling Stock and Strengthning of Inspection Dep.	82,200 (230) 12,000 (33.3) 3,000 (8.3)	4	Allowable Max. Speed: 170km/h for Passenger Trains of Electric Cars, 100km/h for Freight Trains Capacity : 200 Trains per day Travelling time of Express Through Trains of Electric Cars between Rio de Janeiro and São Paulo : Less than 4 hours.
		Sub Total		97,200 (271.6)		
Grand Total				186,100 (518.7)	10	
Final Step	Construction of New Line of Double Tracks and Electrified	Construction of New Line of Double Tracks and Electrified connecting direct between Rio de Janeiro and São Paulo.	Construction of New Line on which trains run at the speed of more than 200 kilometers/hour in case where the demand of transport exceeds the capacity of the existing line at the states of Completion of the Project.		5 - 6	Travelling time of Express Through-Trains of Electric Cars between Rio de Janeiro and São Paulo : Less than 3 hours.

FIG 1. PLAN AND PROFILE OF THE EXISTING LINE
BETWEEN RIO DE JANEIRO AND SÃO PAULO.




B. PIRAI
VOLTA REDONDA
Eng. PASSOS
CACHOEIRA PAULISTA
GUARATINGUETA
TAUBATE
S. J. DOS CAMPOS
RIO PARAIBA
RIO PARAIBUARI
RIO PARATE
Eng. M. FEIO
RIO TIETE
Eng. S. GUALBERTO
ROOSEVELT
B. PIRAI 357m400
VOLTA REDONDA 374m000
FLORIANO 391m000
Eng PASSOS 468m100
CACHOEIRA PAULISTA 522m440
GUARATINGUETA 527m000
TAUBATE 580m800
S. J. Dos CAMPOS 568m000
Eng. M. FEIO 738m000
Eng. S. GUALBERTO 737m600
ROOSEVELT 734m000
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 km
DISTANCE

THE PROPOSED NEW LINE
J JAPERI AND B. PIRAI

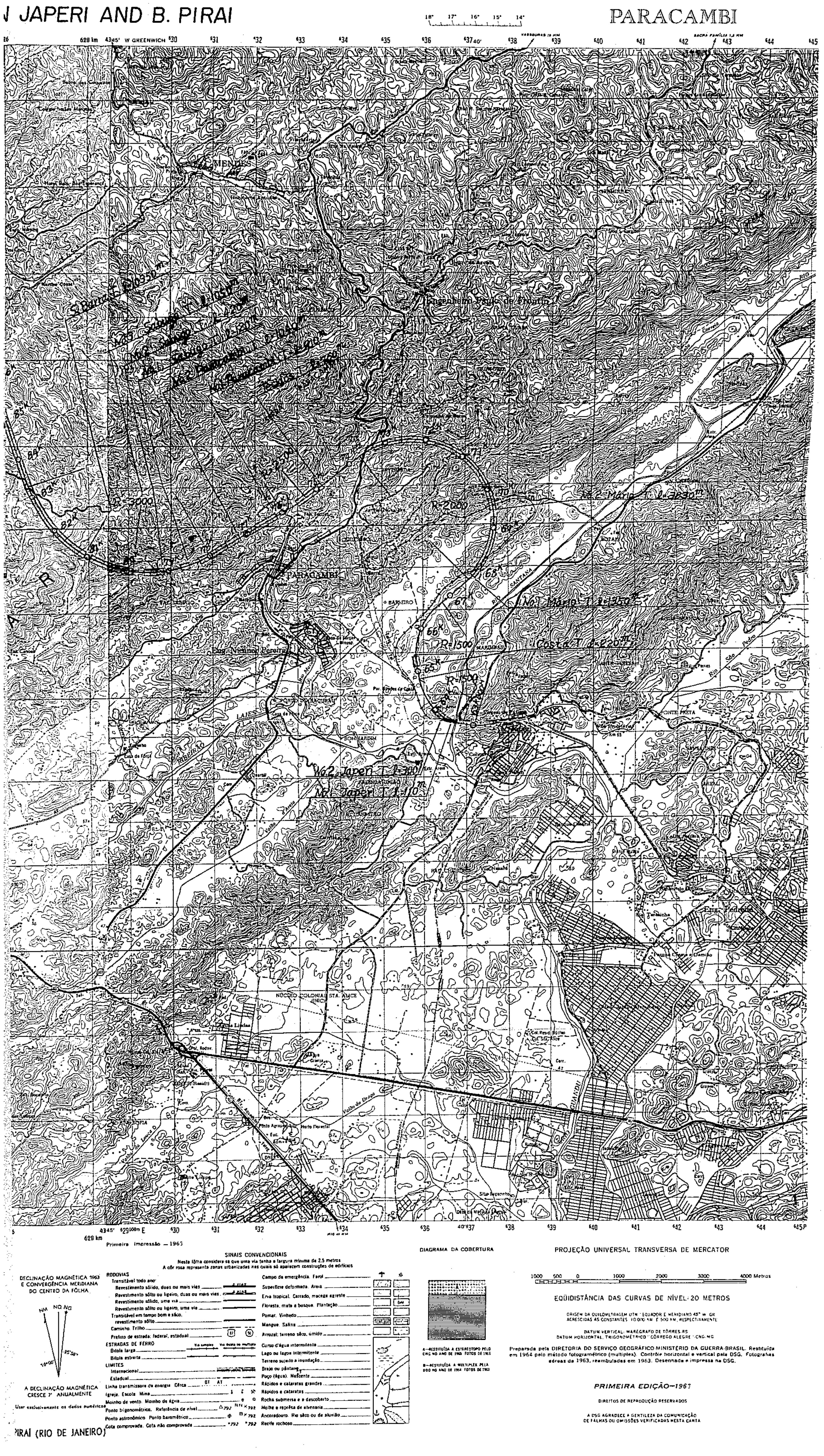


FIG.2. PLAN OF THE PROPOSED NEW LINE
BETWEEN JAPERI AND B. PIRAI

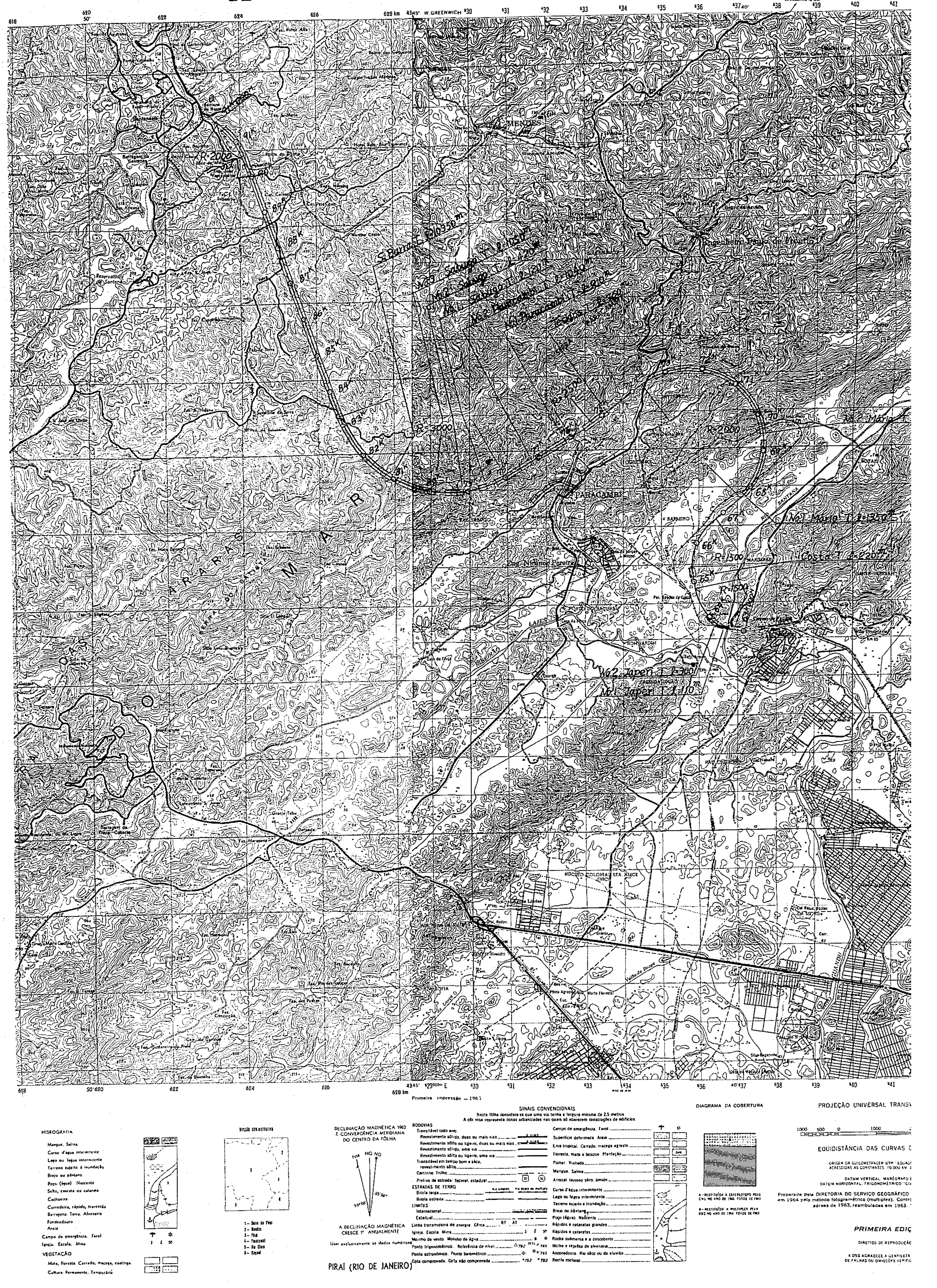
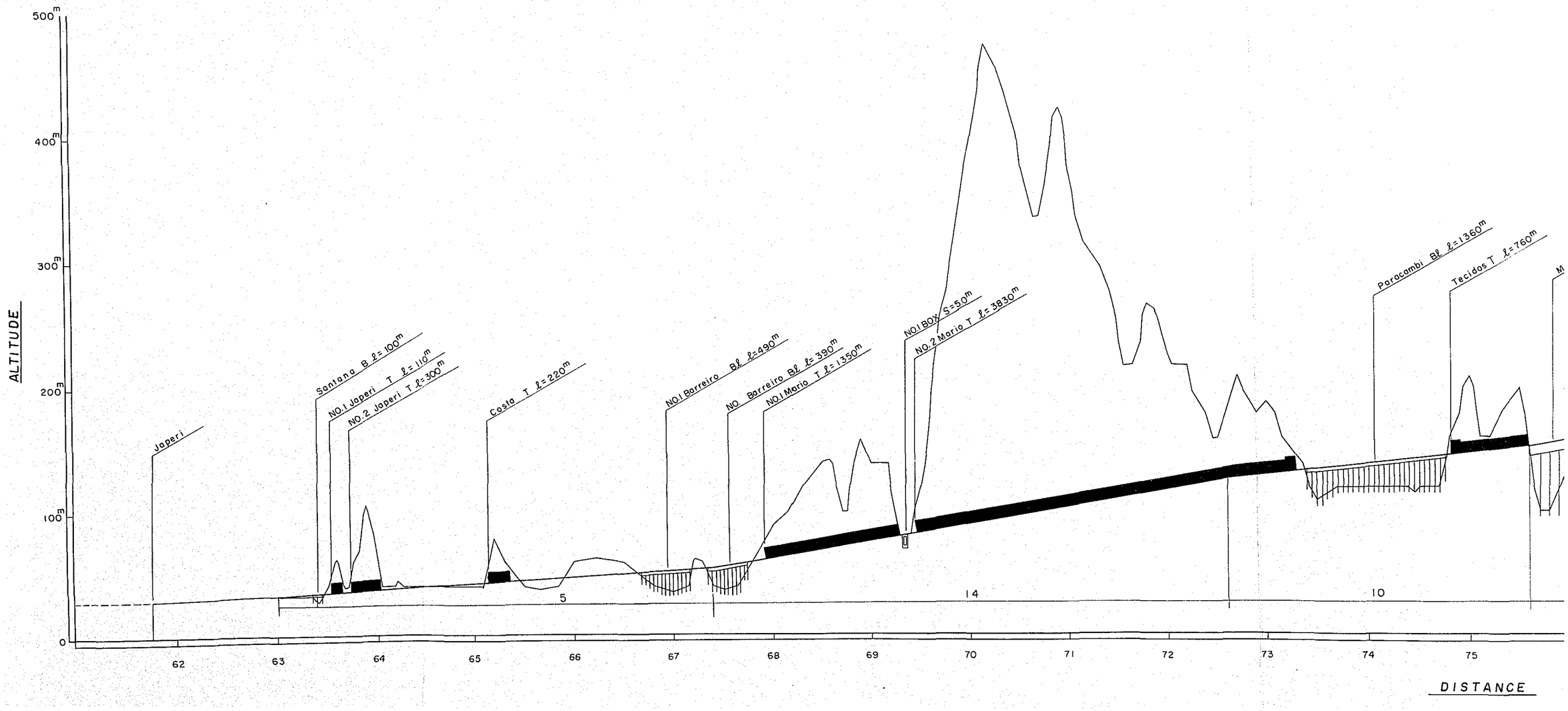
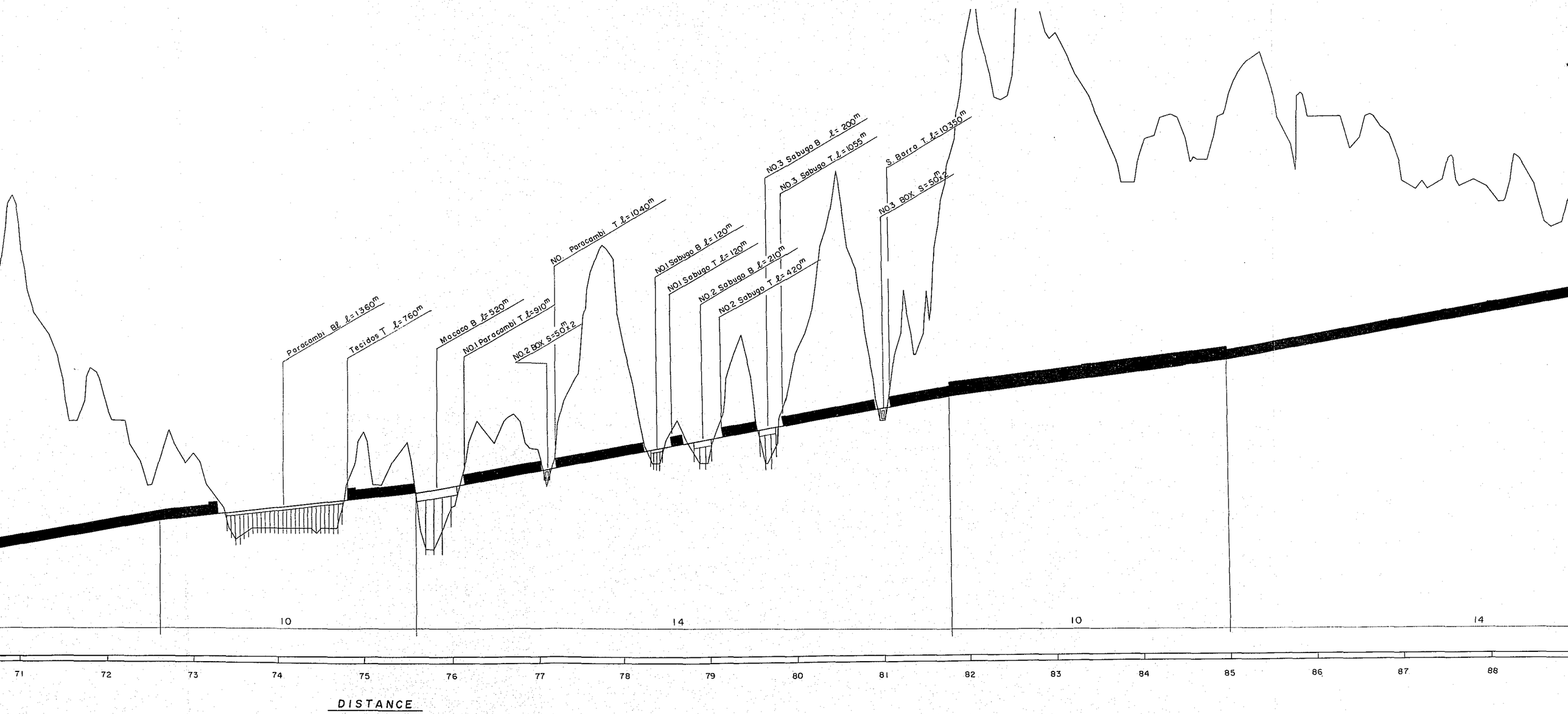


FIG 3. PROFILE OF THE PROPOSED NEW LINE BETWEEN JAPERI AND B. PIRAI




Paracambi BJ. ℓ=1360m
Tecidos T ℓ=760m
Macaco B ℓ=520m
NO.1 Paracambi T ℓ=910m
NO.2 BOX S=5.0m x 2
NO. Paracambi T ℓ=1040m
NO.1 Sabugo B ℓ=120m
NO.1 Sabugo T ℓ=120m
NO.2 Sabugo B ℓ=210m
NO.2 Sabugo T ℓ=420m
NO.3 Sabugo B ℓ=200m
NO.3 Sabugo T ℓ=1055m
S. Barra T ℓ=10350m
NO.3 BOX S=50m x 2
10
14
10
14
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
DISTANCE

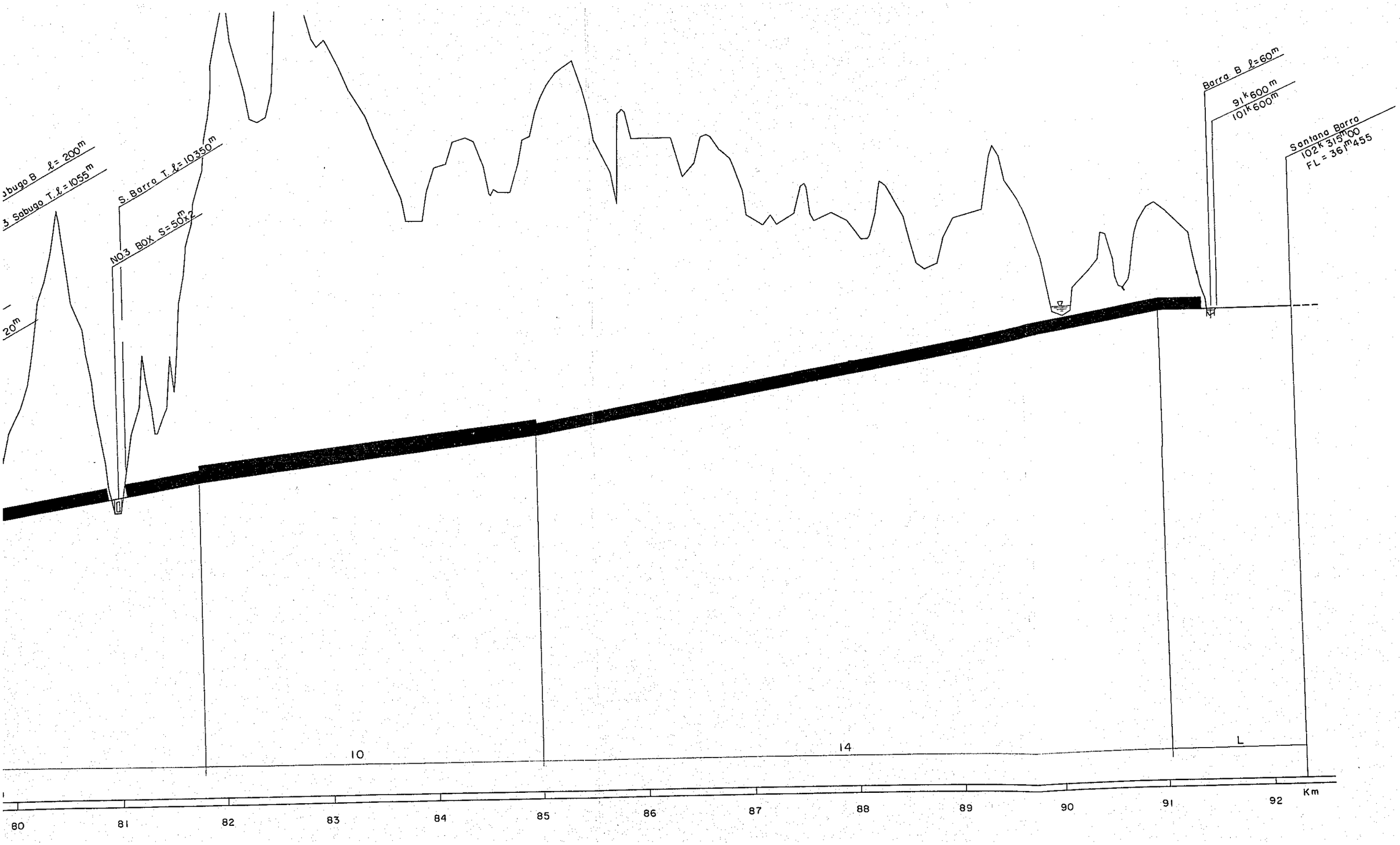

Sabugo B ℓ= 200m
Sabugo T. ℓ= 1055m
20m
S. Barra T. ℓ= 10350m
NO3 BOX S=50x2
Barra B ℓ=60m
91K600m
101K600m
Santana Barra
102K 315m00
FL = 36m455
10
14
L
80
81
82
83
84
85
86
87
88
89
90
91
92
Km

FIG. 4 PROPOSED REARRANGEMENT PLAN FOR REARRANGEMENT OF TRAIN RUNNING IN THE SECTION OF 4-6-4 TRACKS

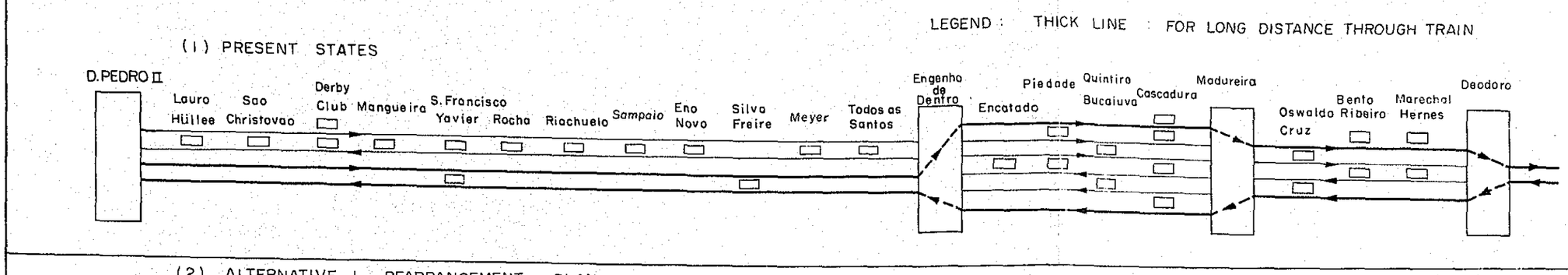
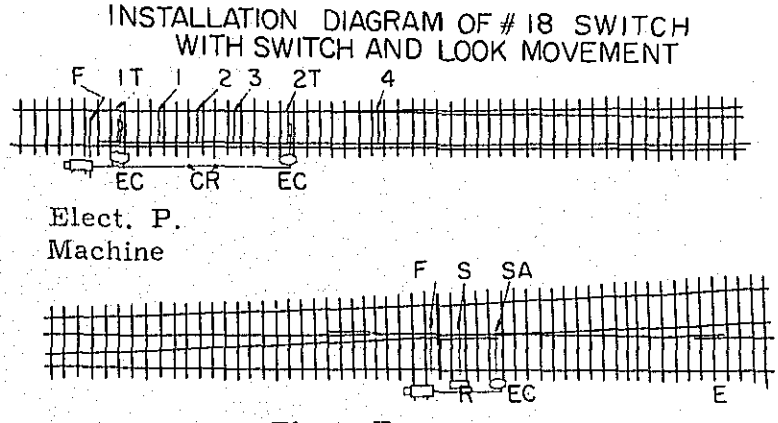


Fig. 5-1. Installation Diagram of #18 Switch with Switch and Lock Movement



Where F is front rod position, 1T and 2T are first and second tie bar respectively; 1, 2, 3 and 4 are the position of respective stay rod; EC is escape crank; CR is carrier roller; S is aux. switch adjuster; SA is switch adjuster, and R is right angle crank.

Fig. 5-2. Movable Crossing of #18 Switch

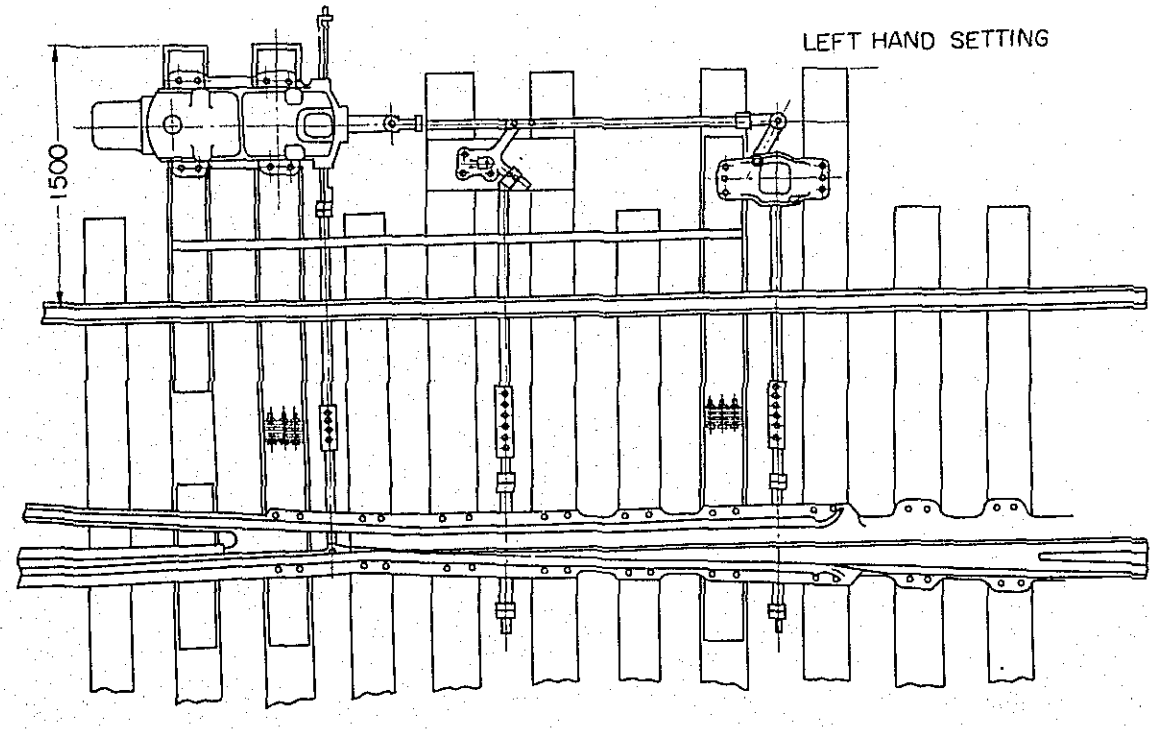


Fig. 5-3.