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JAPAN INTERNATIONAL
COOPERATION AGENCY

MONGOLIAN RAILWAY
MONGOLIA

The Feasibility Study on the Rehabilitation Project of the Mongolian Railway

Final Report

Summary

January, 1998

Japan Railway Technical Service (JARTS)
Pacific Consultants International (PCI)

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1 US Dollar = 550 Tug. = 110 Yen
(August 1996)

PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a Feasibility Study on the Rehabilitation Project of the Mongolian Railway and entrusted the study to the Japan International Cooperation Agency(JICA).

JICA sent to Mongolia a study team headed by Mr. Naofumi Takashige, Japan Railway Technical Service (JARTS), 4 times between July 1996 and October 1997.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the team.

January 1998

Kimio Fujita

President

Japan International Cooperation Agency

Letter of Transmittal

January 1998

Mr. Kimio FUJITA
President
Japan International Cooperation Agency

It is my great pleasure to submit herewith our Report for the Feasibility Study on the Rehabilitation Project of the Mongolian Railway. The report is the result of the Study carried out by Japan Railway Technical Service and Pacific Consultants International Co. Ltd. as per the contract with Japan International Cooperation Agency (JICA).

The Study Team conducted field surveys four times during the period between July 1996 and October 1997. The team held sufficient consultations with the Mongolian governmental agencies concerned regarding the results of the field surveys and study activities in Japan, and drew up an adequate master plan of rehabilitation and a rehabilitation plan for the short-term urgent project after implementing comprehensive analysis of the rehabilitation plan of railway structures on the section between Sukhe-baatar and Bayan (about 450km) of the Mongolian Railway. In close cooperation with the Mongolian side, the team thereafter studied the feasibility of the rehabilitation plans from technical, environmental, economic, and financial aspects, and drew up this report.

On behalf of the Study Team, let me express my heartfelt thanks to the Mongolian governmental agencies concerned for the generous cooperation, assistance and warm hospitality they extended to us throughout the entire period of the Study.

Our thanks are also due to Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Transport, and the Japan Embassy and JICA Office in Mongolia for their valuable advice and support during the Study.

Yours faithfully,

N. Takashige

Naofumi TAKASHIGE
Leader
The Study Team of the Rehabilitation
Project of the Mongolian Railway

The Feasibility Study on the Rehabilitation Project of Mongolian Railway

Purpose of The Study	1. Establish a rehabilitation plan and implement related feasibility study for railway structures between Sukhe- baatar and Bayan(about 450km) of the Mongolian Railway to cope with their superannuation and also against natural disasters. 2. The rehabilitation plan consists of a Master Plan(target year, 2020) and a plan for Short-term Urgent Projects(target year, 2005) selected from the Master Plan.
Master Plan	1.Outline The Master Plan covers 184 places in total: 11 places for river bank protection, 22 places for slope stability, 1 place for track lifting, 12 places for bridge rehabilitation, and 138 places for drain improvement. 2. Amount of investment Construction period is from 1999 to 2019, and the construction is executed stage by stage, with the target years set at 2005, 2010, and 2020. The amount of necessary investment is about 26.2 million dollars at the price as of August 1996. 3. Evaluation This plan is technically feasible and its impact on environmental conditions will be also small. Its EIRR and FIRR are 12.09% and 8.34% respectively, and it is feasible from the national economic standpoint as well. Furthermore, the project implementation will be possible in respect of profitability. This plan is comprehensively feasible and enables stable transport in the Mongolian Railway, making a contribution to the social and economic development of the country.
Short-term Urgent Projects	1.Outline As the Short-term Urgent Projects, 72 places of high priority were selected from the Master Plan. They are 7 places for river bank protection,12 places for slope stability, 11 places for bridge rehabilitation, and 42 places for drain improvement. For each category of countermeasures, 17 standard sections and 55 sections for application were set up. An execution plan of the Short-term Urgent Projects was established by conducting approximate design, execution planning, and construction-cost estimation for the standard sections, and also applying the results to the sections for application. 2.Amount of investment Construction period is from 1998 to 2004. The amount of necessary investment is almost 12.2 million dollars at the price as of August 1996. 3. Evaluation EIRR and FIRR of the projects are 13.05% and 8.67% respectively. The projects are feasible from technical, environmental, economic, and financial standpoints. Stable transport on trunk lines of the Mongolian Railway will become possible by executing the projects coupled with the guarding against disasters including patrol during rainfall. Furthermore, the projects are important and require early implementation for the Mongolian Railway providing services closely related to people's living, such as coal transport for power generation and import of oil and consumer goods.
Recommen-dation	1. Besides the reinforcement of hardware sectors by the project execution, it is essential to strengthen software sectors such as train operation control during rainfall and disaster prevention systems. 2. From the managerial standpoint of the Mongolian Railway, in view of repayment of the existing loans and the funds necessary for other projects of Mongolian Railway, it is essential to conduct fund procurement which gives consideration to the server financial situation of the Railway in implementing the Short-term Urgent projects. 3. It is recommended that the Mongolian Railway should study such matters as the natural disaster countermeasures for lines other than the section between Sukhe-baatar and Bayan, by utilizing the countermeasures taken in this Study.

The Feasibility Study on the Rehabilitation Project of Mongolian Railway (Summary)

1. Purpose

In order to ensure stable transport in the Mongolian Railway, the Study aims to establish a rehabilitation plan and implement related feasibility for railway structures between Sukhe-baatar and Bayan (about 450km) where natural disasters often occur.

Specifically, for a Master Plan (target year, 2020) of the rehabilitation of railway structures on the above section and for Short-term Urgent Projects (target year, 2005), comprehensive evaluation is made concerning their feasibility from technical, environmental, economic, and financial standpoints.

2. Railway Natural Disasters and Railway Structures

Main natural disasters which occurred in the past in the Mongolian Railway are:

① drifting away of bridges and roadbed erosion due to flooding of major rivers;
② collapse of embankments due to flooding of medium or small rivers; and
③ stonefall from cuttings and slopes.

Furthermore, railway structures such as bridges have been in use for about 50 years since their construction, and superannuation of these structures is in progress due to severe meteorological conditions as well.

From 1991 to 1994, nine cases of natural disasters concentrated in the period from June to August in the Mongolian Railway, requiring 14 hours to 4 days for rehabilitation work. In this connection, serious natural disasters occurred in 1973 and 1978, and required 11 days and 10 days for rehabilitation, respectively.

3. Outline of the Project

(1) Master Plan

1) Outline of the plan

Table-1 shows an outline of the Master Plan of the railway structure rehabilitation directly necessary for countermeasures against natural disasters and superannuation of railway structures. The Master Plan covers 184 places.

Table –1 Outline of the Master Plan of the Rehabilitation

Item	Countermeasures	No. of Places	Remarks
River Bank Protection	Bank protection Groyne	11	31pk2-4:Track transfer 208-209km:River route transfer
Slope Stability	Clear slope	22	
Track Lifting	Lifting	1	
Bridge Rehabilitation	Beam replacement Repair	12	Beam replacement : 8 Repair : 4
Drain Improvement	Adding drain New drain	138	Adding : 116 New : 22
Total		184	

2) Amount and schedule of the investment

① The rehabilitation will be carried out in three stages. The target years of the 1st, 2nd, and 3rd stages are 2005, 2010, and 2020, respectively.

② The total amount of the investment is about US$ 26.2 million(about US$ 12.4 million in the 1st stage, about US$3.3million in the 2nd stage, about US$ 10.5million in the 3rd stage).

3) Economic and financial evaluation

① Result of economic analysis :

Economic Internal Rate of Return (EIRR) ··· 12.09%

② Result of financial analysis :

Financial Internal Rate of Return (FIRR) ··· 8.34%

4) Initial environmental examination (IEE)

Since this plan mainly concerns the rehabilitation planning of the existing line, it will not entail the separation of villages and removal of residents. The plan also does not conflict with regulations on development related to relics, cultural assets, protection areas, etc.

It is necessary to pay special care concerning the vibration, noise, river pollution and so forth caused in the construction as well as the disposal of spoil earth and sand.

However, in view of the object places and contents of the rehabilitation work, unfavorable environmental effects by this plan will be small on the whole.

5) Comprehensive evaluation

This plan aiming at the rehabilitation of the existing line is technically feasible and will not have large unfavorable effects on environment.

The EIRR of this plan from the national economic standpoint is 12.09%, and the plan is estimated to be feasible from that standpoint.

The FIRR is 8.34%, and, the project implementation will be possible in respect of profitability.

This plan concerns the rehabilitation planning and emphasis is placed on ensuring stable railway transport.

From the comprehensive standpoint, the plan is evaluated to be adequate and also feasible from technical, environmental, economic, and financial aspects.

Furthermore, the implementation of this plan will enable stable transport on trunk lines of the Mongolian Railway, and will also contribute to the development of the sound social and economic activities in Mongolia.

(2) Short-term Urgent Projects

1) Outline of the plan

As the Short-term Urgent Projects, 72 places of high priority were selected from the Master Plan.

The projects are conducted for river bank protection (7 places), slope stability (12 places), bridge rehabilitation (11 places), and drain improvement(42 places). (Table-2)

Since there are mainly similar countermeasure items, 17 Standard Sections and 55 Sections for Application were set up for each category of countermeasures. (Table-2)

An execution plan of the Short-term Urgent Projects was established under the procedure shown in Fig. -1

Table -2 Outline of the Short-term Urgent Projects

Item	Countermeasure	Standard Section	No.of Sections For Application
River Bank Protection (7places)	Track transformation	31pk2~4	0
	Revetment	54pk4~5	5
Slope Stability (12 places)	Slope surface improvement (I)	13pk3	1
	Slope surface improvement (II)	61pk10	3
	Slope surface improvement (III)	282pk9~283pk2	1
	Slope surface improvement (IV)	267pk2~3	1
	Concrete lining	18pk10~19pk1	0
	Telecommunication line removal	251pk2	0
Bridge Rehabilitation (11 places)	Beam replacement	334pk3	6
	Repair	255pk3	3
Drain Improvement (42 places)	Drain in Sukhe-baatar St.	23pk2	0
	Box culvert (2 x 1.5m)	253pk3	17
	Box culvert (2.5 x 2m)	389pk1	15
	Box culvert (2.5 x 2.5m)	356pk1	0
	Bridge (11.5 m)	235pk3	2
	Bridge (13.5m)	125pk8	1
	River width expansion	399pk1	0
Object sections (72 places in total)		17 places	55 places

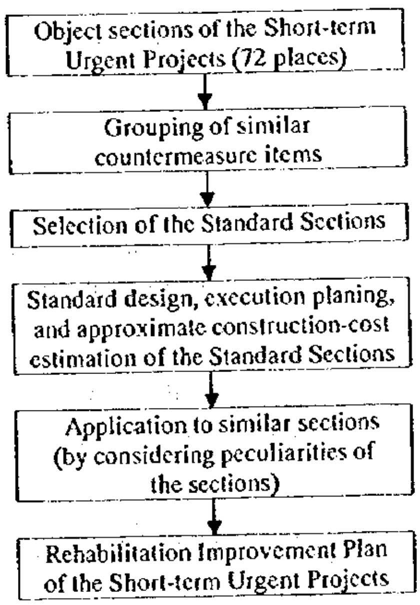


Fig.- 1 Procedure for the Planning

2) Amount and schedule of the investment

① The construction period is 7 years from 1998 to 2004 including the preparatory stage. The target year is 2005.

② The total amount of the investment is about US$ 12.2 million. It consists of about US$ 6.5 million for river bank protection, about US$ 0.7 million for slope stability, about US$ 0.5 million for bridge rehabilitation, and about US$ 4.5 million for drain improvement.

3) Economic and financial evaluation

① Results of economic analysis :

Economic Internal Rate of Return (EIRR) ··· 13.05%

② Results of financial analysis:

Financial Internal Rate of Return (FIRR) ··· 8.67%

4) Environmental impact assessment (EIA)

The Short-term Urgent Projects will not have large unfavorable effects, including pollution, on social and natural environments.

However, in Mongolia there are sufficient laws on environmental preservation, and the Mongolian Railway should get guidance from the government agencies concerned in implementing the projects.

5) Conclusion and recommendation

[Conclusion]

The Short-term Urgent Projects are technically feasible and will not have large unfavorable effects on environmental conditions.

The EIRR is 13.05%, and, if other indirect benefits are considered, the projects are considered to be feasible from the national economic standpoint.

The FIRR is 8.67%. However, in view of the repayment of the existing loans and funds necessary for other projects of the Mongolian Railway, and also in the light of stable railway transport which the project of this time are aiming at, efforts should be made, in implementing the projects, to realize fund procurement which gives consideration to the very sever financial situation of the Mongolian Railway.

This project concerns the rehabilitation planning for the railway structures where natural disasters in the raining season compel the Mongolian Railway to cancel train operation, and emphasis is placed on ensuring stable transport.

From the comprehensive standpoint, the projects are evaluated to be adequate and also feasible from technical, environmental, economic, and financial aspects.

The implementation of the projects, coupled with the guarding against disasters including the checkup by patrol during rainfall, will enable the stable transport on the trunk line of the Mongolian Railway.

Furthermore, the Mongolian Railway is a life line providing freight transport services closely related to people's living, such as coal transport for power generation(accounting for 80% of domestic freight traffic volume)and import of oil and consumer goods for Mongolian people.

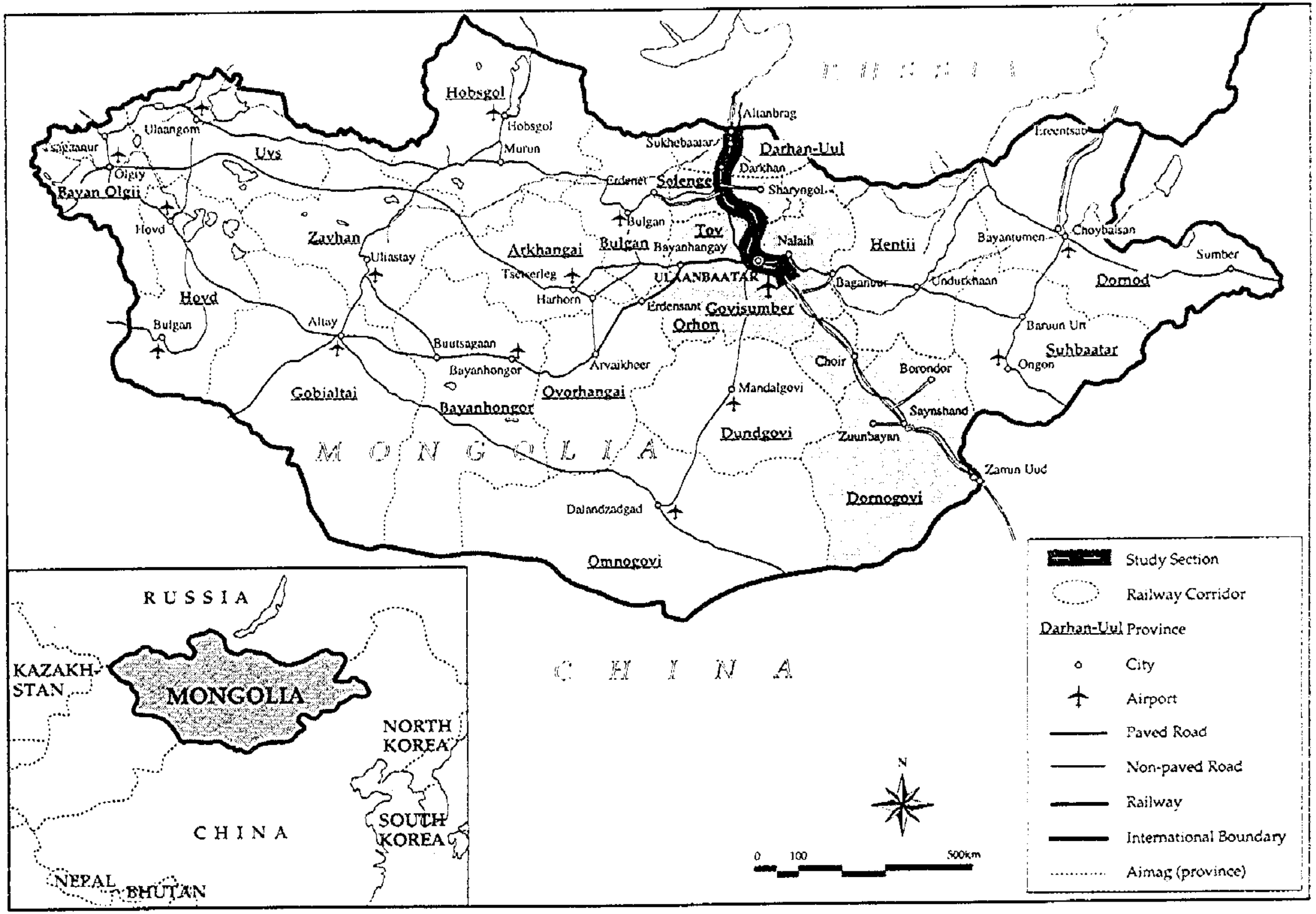
Therefore, the projects which mainly concern natural disaster countermeasures are important for stable railway transport and require early implementation.

[Recommendation]

① For ensuring sound finance of the Mongolian Railway, it is essential to conduct fund procurement which gives consideration to the sever financial situation of the Railway.

② Concerning the natural disaster countermeasures, besides the reinforcement of hardware sectors by the project execution, it is also important to strengthen software sectors such as train operation control and disaster guarding systems during rainfall.

③ As for the countermeasures against natural disasters and superannuation of structures on trunk lines and branch lines of the Mongolian Railway other than the section between Sukhe-baatar and Bayan, it is recommended that the Mongolian Railway should promote necessary study by using as reference the countermeasures taken this time for standard sections by kind of countermeasures.



RUSSIA
Altanbrag
Sukhebaatar
Darhan-Uul
Darkhan
Erdenet
Selenge
Sharyngol
Hobsgol
Murun
Ulaangom
Uvs
Olgiy
Bayan Olgii
Hovd
Zavhan
Uliastay
Arkhangai
Tsetserleg
Harhorin
Bulgan
Bayanhangay
Tov
Nalaih
ULAANBAATAR
Hentii
Erdensant
Govisumber
Orhon
Baganuur
Undurkhaan
Bayantumen
Choybalsan
Sumber
Dornod
Ereentsav
Baruun Urt
Suhbaatar
Ongon
Altay
Buutsagaan
Bayanhongor
Arvaikheer
Gobialtai
Bayanhongor
Ovorhangai
Mandalgovi
Choir
Borondor
Saynshand
Zuunbayan
Dundgovi
Zamin Uud
Dornogovi
Dalandzadgad
Omnogovi
MONGOLIA
CHINA
RUSSIA
KAZAKH-STAN
MONGOLIA
NORTH KOREA
SOUTH KOREA
CHINA
NEPAL
BHUTAN
Study Section
Railway Corridor
Darhan-Uul Province
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Aimag (province)
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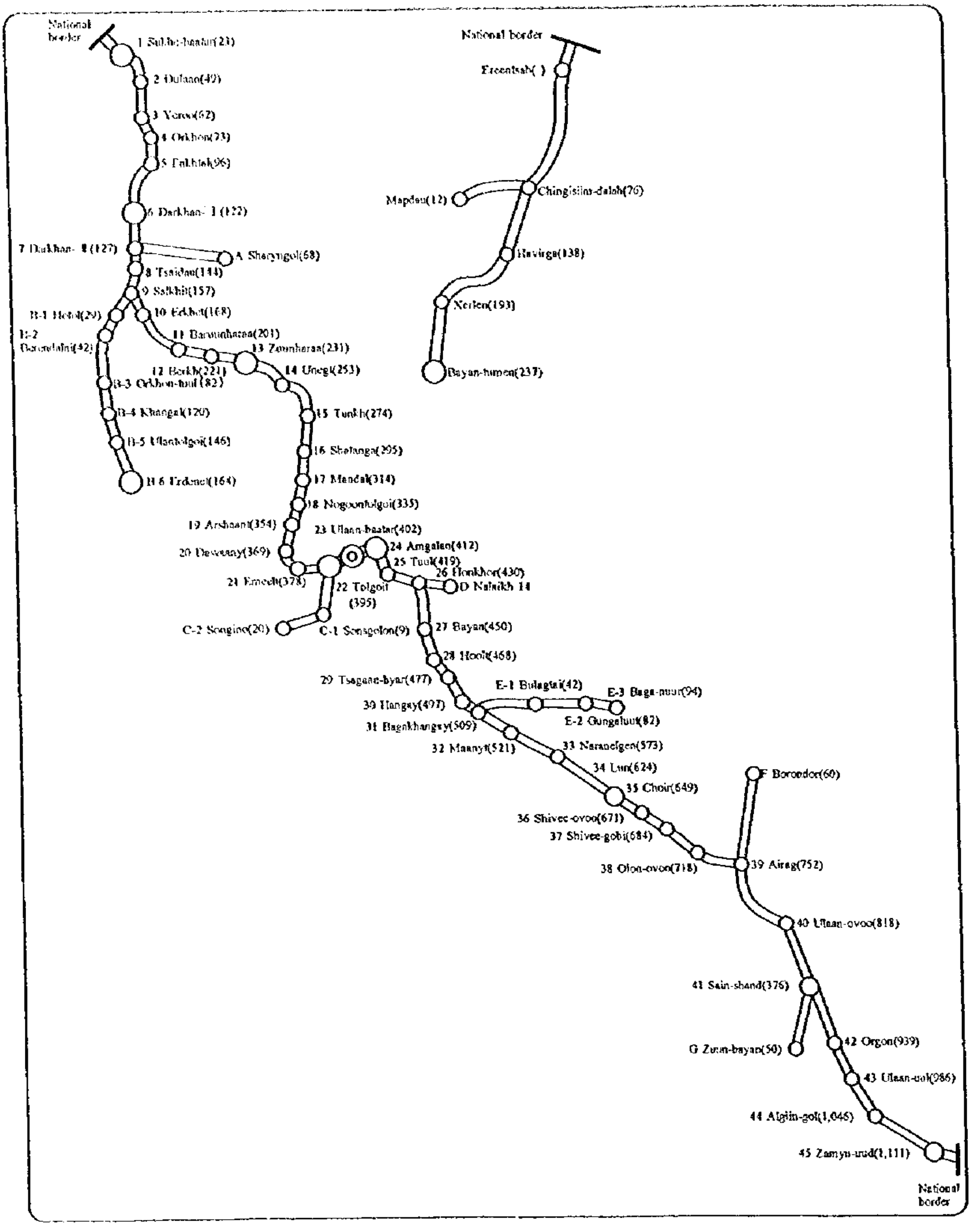
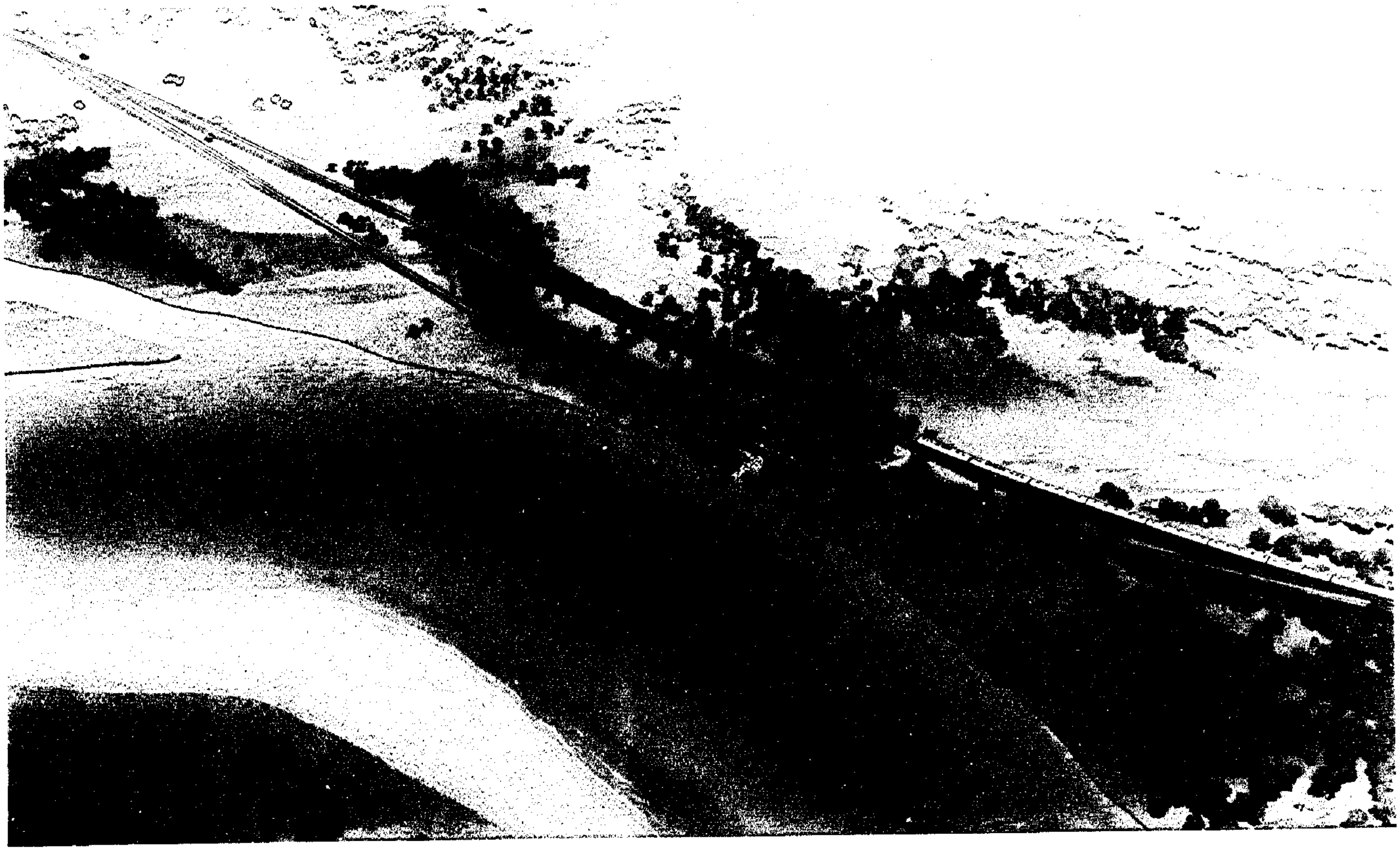
Mongolia



Railway Line of Mongolian Railway



The Feasibility Study on the Rehabilitation Project of Mongolian Railway (Summary)

Contents

Volume 2 Feasibility Study

INTRODUCTION

The main line between Sukhe-baatar and Zamyn-uud of the Mongolian Railway is an important transportation facility for Mongolia. The railway plays an important role as a major artery for freight distribution for long haul and international transportation services in particular, since roads have not been improved as expected. However, about 50 years have passed since the initial construction of the existing railway facilities, and the facilities are deteriorating due to severe weather conditions also. Railway operations are often unavoidably suspended due to natural disasters that occur during the rainy season between June and August. Freight distribution channels were often closed during such periods, seriously affecting economic activities.

In the 450km section between Sukhe-baatar and Bayan, disastrous incidents including floods of natural streams and rivers, wash-outs of the roadbed due to the inadequacy of bridges and drainage trenches, and rockslides have occurred frequently, and there has also been deterioration of bridges and earth structures. It has become imperative for the Government of Mongolia to establish plans immediately to make rehabilitation to the existing main railway line of the Mongolian Railway that supports the economy of the country.

With the above as background, the Government of Mongolia requested the Government of Japan to make up a rehabilitation plan for the existing railway structures in the 450km section between Sukhe-baatar and Bayan.

Upon receipt of this request, the Government of Japan dispatched a Preparatory Study Team from the Japan International Cooperation Agency(JICA) to Mongolia. An agreement between the two governments on the scope of work (S/W) for the detailed investigation was signed on November 16, 1995, based on the discussions made with the Government of Mongolia on the scope of the detailed investigations to be made.

The Study will be conducted based on the agreed S/W. This scope of work requires the development of a master plan (target year : 2020) for the rehabilitation of existing railway structures between Sukhe-baatar and Bayan of approximately 450km, and also requires the implementation of a feasibility study on the short-term urgent project (target year : 2005), in order to ensure stable railway transport on the section.

In parallel with this Study, it is also planned to transfer technologies to Mongolian specialists who will participate in the investigation through field investigation activities.

In this Study, the basic policy for planning the rehabilitation of existing railway structures is as stated below.

(1) Ensure harmony with the superior plans of Mongolia(national development plan, land utilization plan, etc.) and also with the projects the Mongolian Railway is now carrying out (with OECF loan, etc.) or is planning.

(2) The rehabilitation planning will be made in a manner to provide durable structures that can withstand the damaging affects of heavy rains during the rainy season, or structures that can be quickly and easily restored if they become damaged.

(3) In the planning, put higher priority on measures for ensuring safe and reliable transport, rather than those for increasing train speed and strengthening transport capacity.

(4) The rehabilitation planning will be made in a manner to assure a step-by-step feasible system at an appropriate investment, taking into consideration the economic strength of Mongolia and the financial condition of the Mongolian Railway. For the investment, the amount directly necessary for the rehabilitation plan will be earmarked.

(5) The rehabilitation planning will be made in a manner to reduce construction costs, taking into account the improvement of investment efficiency.

(6) The rehabilitation planning will be made in a manner to provide facilities that can be easily maintained in the future, taking into account the skills of workers and technical level of the Mongolian Railway.

(7) For all aspects of planning railway structures, including preliminary design and construction planning, natural conditions and environmental impact will be fully considered.

This Report(Summary) epitomizes the results of the comprehensive evaluation and feasibility study of the Master Plan and Short-term Urgent Project agreed between the Japanese and Mongolian sides.

Volume 1 Master Plan

1. Existing Conditions of Damage to Railway Caused by Natural Events

(1) Damage to Railways Caused by Natural Events

In the past, Mongolian railroads have incurred major damage from natural events, including flood damage, rockfalls from cut slopes(some natural slopes are included), and uneven frost heaving of tracks. The damage from these various natural causes is described below. The damage resulting from floods is considered to be the most significant.

① Damage from floods

The damage caused by floods typically consists of washed out bridges or eroded embankments of the following three patterns.

- Washed away railway embankments behind abutments of bridges, or collapsed piers and beams.
- Embankments washed out in the vicinity of drainage structures passing through the embankment.
- Embankments eroded by meandering rivers.

② Rock falls from cut slopes

North of Darkhan the rail lines are routed through hilly terrain or along narrow areas adjacent to rivers or streams. There are many cut slopes adjacent to tracks, and rocks often fall from these slopes onto the tracks. This is a common occurrence, and trains are exposed to this danger at all times.

③Uneven track caused by freezing

Railway embankments in areas where the ground is wet often experience frost heave in the winter when the weather turns severely cold. Freezing causes the ground under the tracks to heave and become uneven. This can significantly affect the safety of train traffic, but such dangers have been prevented by inspections conducted in advance. This type of damage has not yet obstructed train traffic.

(2) Railway Structure of Each Section

① The 231 km Section between the Northern Border and Zuunharaa

The Haraa river flows northward in this section and joins with the Orhon river near the 95 km point and joins with the Selenge river 19 kms further downstream, increasing the water flow. The railway is laid out in the shape that is climbing up southward as if it sneaks through narrow areas between hills and river along the right bank of the river. Therefore, it can be seen at many places where the rail line is placed on fill along the river bank (revetment) that significant erosion is occurring because of the meandering of the river (erosion of 1 to 4 meters every year); in addition, rocks are falling off the weathered cut slopes and often affect train operations.

② The 402 km Section between Zuunharaa and Ulan-baatar

The railway runs down southward along the Haraa river in this section. Since the water flow is less in the upstream portions of the river, the level of damage caused by erosion to the embankment accordingly is less in the upstream areas. As the area of land between the river and the hills is wider, slopes cut along the railway are also less in area, the number of bridges (7 m to 12 m) crossing over tributary streams draining into the Haraa river and the number of box culverts (2 m x 2 m and 2.5 m x 2.5 m) used as water channels or a passage also increase because the number of slopes cut along the railway are less and the most tracks are on embankment.

Bridge beams are mostly simple T-beams, and most of them are deteriorated. Significant defects, including cracks, exposure of main reinforcement on the undersides of beams, and vertical cracks in front of bearing joints (these can lead to structural breakdown in the future) were noted.

In embankment areas, slopes and areas behind box culverts are often eroded, and rails have been washed away because the box culverts are undersized and floodwater often becomes ponded behind the embankment. Embankment areas behind the abutments of bridges also fail because of the shortage of water conveyance capacity.

③ The 450 km Section between Ulan-baatar and Bayan

The point highest in elevation is located on the main line at 471 km south of Bayan and situated south of Ulan-baatar. Since trains are forced to climb steep grades to accommodate the large differences in elevation, hairpin curves or S-shaped curves are provided at various places. The railway is laid out as if it sneaks through the plain land in this section. Structure is mainly on embankment, and box culverts and bridges are constructed at various places.

The back of embankment is often washed out and the tracks fail during floods because bridges and culvert are deficient in water conveyance capacity.

2. SOCIO-ECONOMY AND DEMAND FORECAST

2 - 1 Socio-Economy

The states of Mongolia has a land of 1.57 million km2 on which the population registered 2.3 million in total in 1996. An increase of population of 0.5 million over the 11 years has shown an average rate of 2.3% per annum, however the average annual rate decreased to 1.8% in the recent years of 1992-96. (Table 2-1)

The economy was under the socialist planning system with Soviet in COMECON, and could have the growth of GDP at a 4% per annum in the years 1985-90. With the collapse of Soviet Union, the country had to change into the market oriented economic system which resulted in high inflation and reduced GDP in real terms. The economy has shown a recovery since 1993/94 although the rates are modest in those years (Table 2-1). The composition of GDP in 1996 was 32% in manufacturing, 35% in agri-livestock and 32% in others, while employment in manufacturing was 13% but the traditional agri-livestock sector enrolled 45% in the same year.(Fig.2-1 and 2-2) Unemployment rate was 6.5% in that year, according to the Mongolia Annual Statistical Yearbook of 1996.

Table 2-1 Population, GDP and GDP per Capita 1985-95

Year	Population in '000		GDP in mn 1993 Price		GDP per Capita in Tug	
		Av. rate.p.a.		Av. rate.p.a.	1993 pr.	Av. rate.p.a.
1985	1822.6	2.30%	172737.3		94.78	
1986	1872.6		188929.2	+9.4%	100.89	+6.4%
1987	1920.3		195461.5	+3.5%	101.79	+0.9%
1988	1966.9		205439.7	+5.1%	104.45	+2.6%
1989	2018.8		214027.7	+4.2%	106.02	+1.5%
1990	2075.5		208641.9	-2.6%	100.53	-5.5%
1991	2129.0		189349.2	-9.3%	88.94	-13.0%
1992	2177.1		171365.4	-10.5%	78.71	-13.0%
1993	2221.3		166219.1	-4.0%	74.83	-5.2%
1994	2259.0		170042.3	+2.3%	75.27	+0.6%
1995	2293.9		180775.4	+4.2%	78.81	+2.6%
1996	2329.9		185547.9	+2.6%	79.61	+1.02%

Source: Mongolian economy and Society in1996 (SOM,1997), and data in STOM

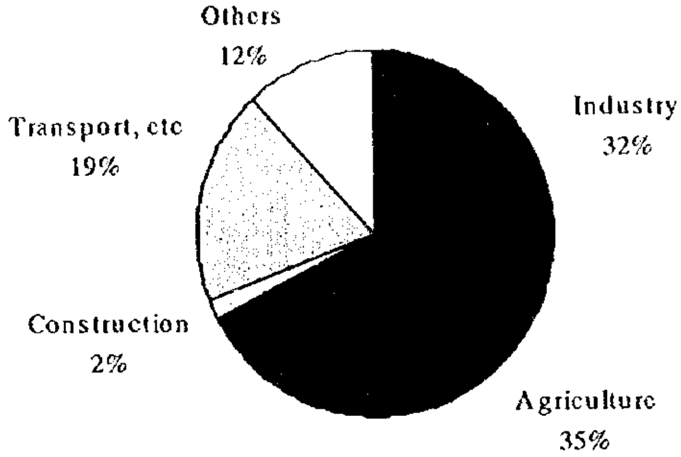


Fig.2-1 GDP by Sector % in 1996

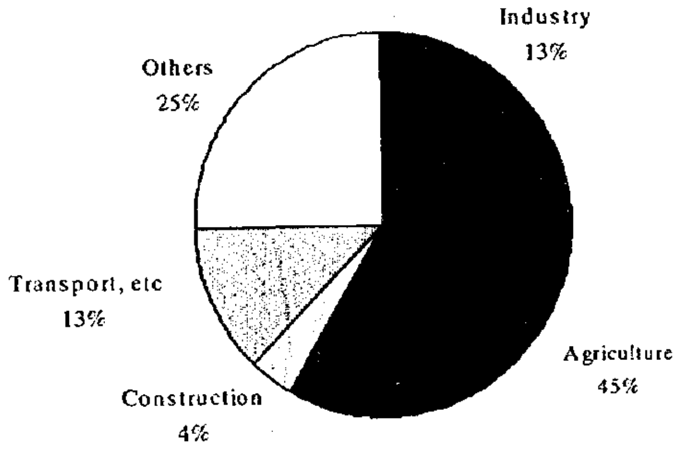


Fig. 2-2 Employment by Sector, % 1996

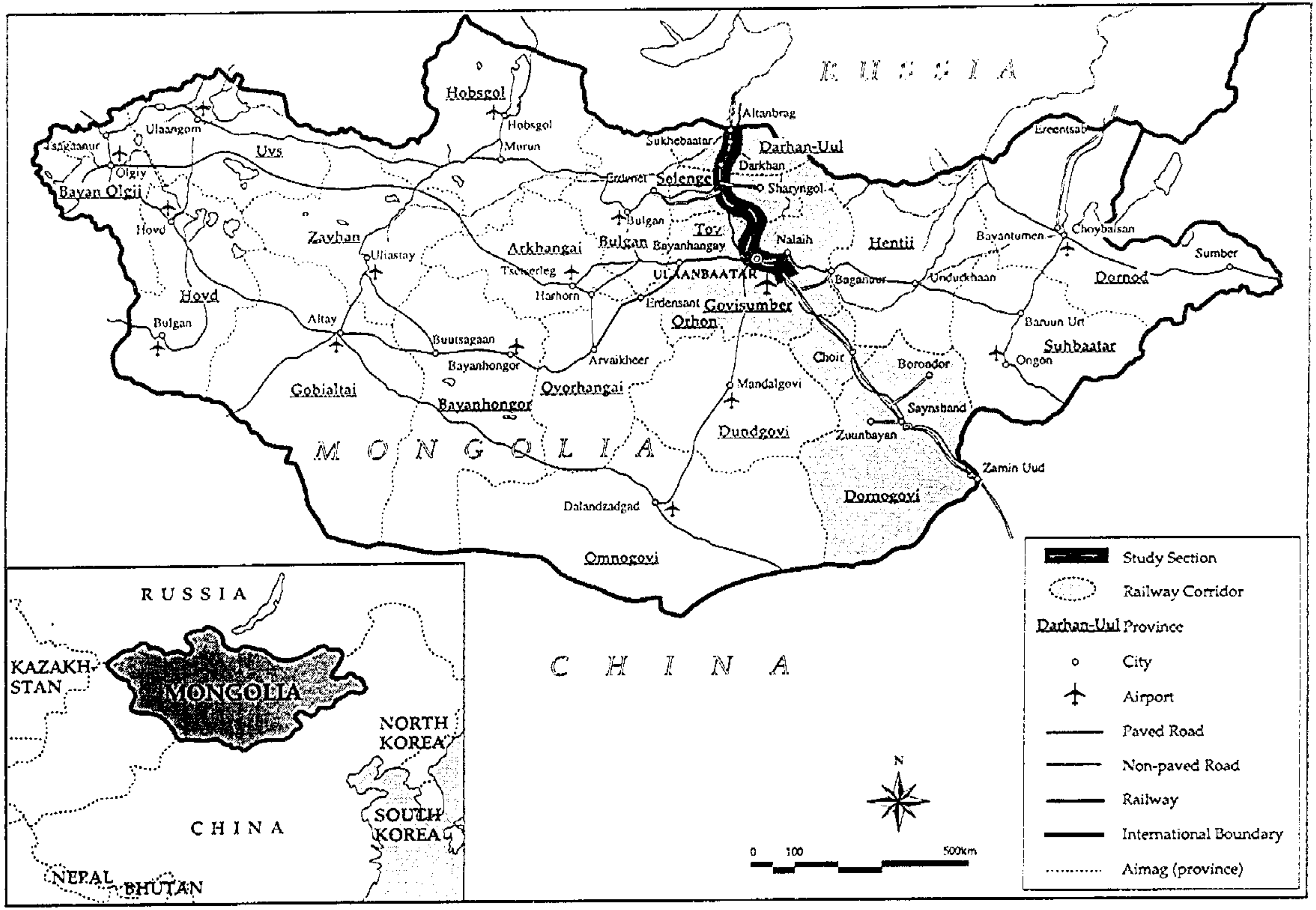


Fig. 2—3 Mongolia Transport System

2 - 2 Transport System

The overall transport network is shown in Fig.2-3. Railways and paved roads are serving in parallel in the corridor of Russian Border Ulaan-baartar for 450km, while other regions are covered by unpaved national roads mostly. Mongolian Railway operates the following distance in which the transit line from the Russian Border to the Chinese one extends for 1,100km.

East line (with branches)	249km
Trunk line (with branches)	1,556km
Total	1,805km

Fig.2-4 is the conceptual presentation of the system over the country. Competitive relationship may be seen in the corridor of Russian Border Ulaan-baartar, while the road network alone extends into other regions having a supplemental function to/from the trunk railway lines. However, the transport of bulky coal to major cities and imports of petrol fuel depends on railways because of cargo characteristics.

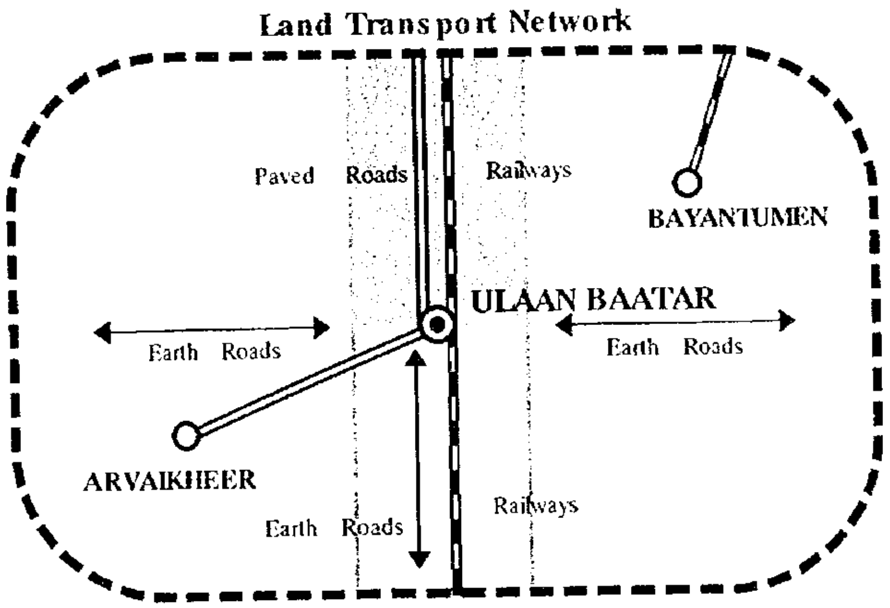


Fig.2-4 Spatial Distribution of Modal Services

Transport volumes have fluctuated as shown in Fig.2-5. Modal shares of transport of passengers did not change drastically, but substantial changes are found in the case of cargo transport, which were caused by large reductions in the share of roads. Main reasons are decreased economic production, collapsed transport schedules, and sales of trucks to the private sector.

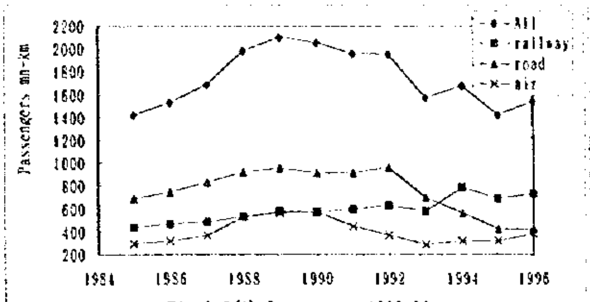


Fig 2-5(A) Passengers, 1985-96

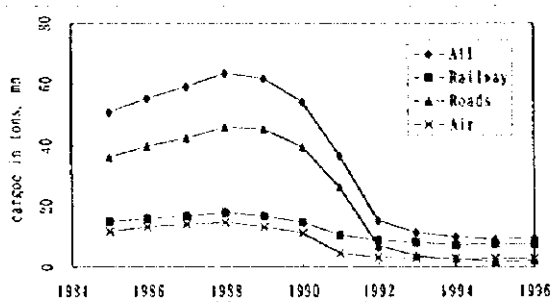


Fig 2-5(B) Cargoes 1985-96

Passenger person-km(%) | Cargo ton-km(%)

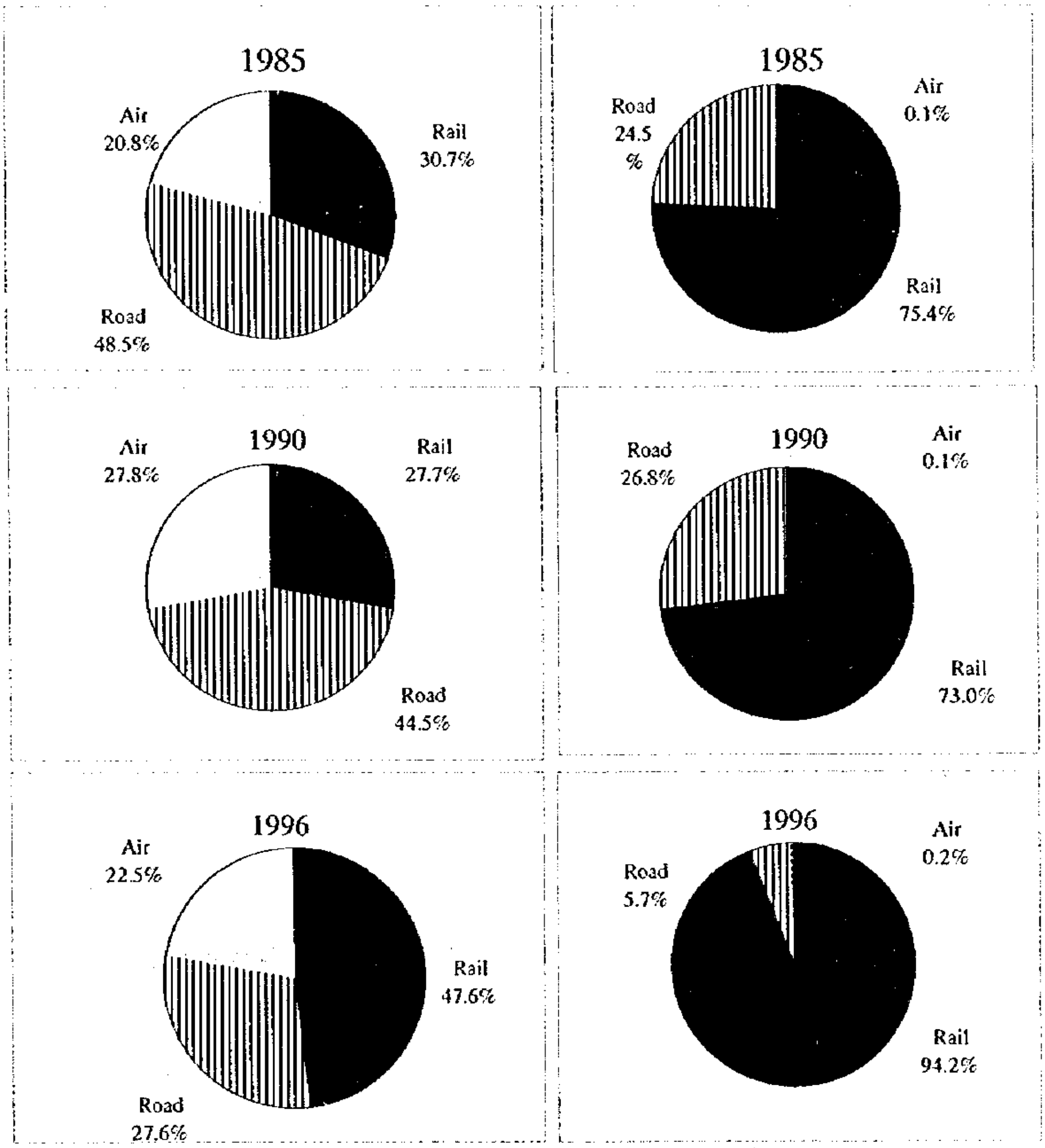


Fig.2-5 Changes in Transport Demand by Modes, 1985-96

2 - 3 Demand Forecast

Socio-economic framework

Development of Socio-economic framework was forecast for years 1995-2020 by taking into consideration of economic changes in the past and examples of development in other countries. Population will increase at smaller rates 2% to 1.2%, while the economy will enlarge the scale at 4.5% to 3.5% per annum (Table 2-2).

Table 2-2 Socio-Economic Framework of Selected Years

Year	Population		GDP		GDP/Pop.	
	000 prs	ratio p.a.	mn Tug.	ratio p.a.	000 Tug/Y	ratio p.a.
1985	1823	1.023	172737	-1.004	94.8	-1.020
1989	2019		214028 +		106 +	
1994	2259		170042 -		75.3 -	
1995	2294	1.02	180775	1.045	78.8	1.023
2005	2831	1.016	280739	1.04	99.2	1.023
2010	3067	1.012	341562	1.038	111.4	1.025
2020	3457		493571		142.8	

Transport Demand

Because of Changes in the economic system, which caused reductions in transport volumes for several years from 1989, the forecast method using the extrapolation of the past trend is not applicable. Instead a relationship between GDP per capita and total transport volumes was analized for years 1989-95 and determined growths of transport demand under the market mechanism economy over the main modes for 1995-2020 (Table 2-3).

Transport demands by commodity on railways were estimated by considering in past development, production development plan, possible market expansion, etc. Together with the above modal estimate (Tables 2-4 and 2-5). Applying those growths by commodity, the OD tables for the future years were calculated for respective commodity.

Table 2-3 Summary of Demand Forecast by Mode, 1995-2020

A. Passengers in mn pass-km and the annual average growth rate is in ( ).

Year	Railways	(ratio p.a.)	Roads	(ratio p.a.)	Airlines	(ratio p.a.)	Total	(ratio p.a.)
1995	681		424		320		1,426	
		(1.03)		(1.05)		(1.02)		(1.04)
2005	925		691		390		2,007	
		(1.02)		(1.04)		(1.02)		(1.03)
2010	1,029		841		431		2,301	
		(1.01)		(1.03)		(1.01)		(1.02)
2020	1,157		1,103		476		2,764	

B. Cargoe in mn ton-km and the annual average growth rate is in ( ).

Year	Railways	(ratio p.a.)	Roads	(ratio p.a.)	Airlines	(ratio p.a.)	Total	(ratio p.a.)
1995	2,284		153		4.5		2,441.5	
		(1.05)		(1.05)		(1.02)		(1.05)
2005	3,499		249		5.5		3,753	
		(1.04)		(1.04)		(1.02)		(1.03)
2010	4,118		303		6.1		4,427	
		(1.03)		(1.03)		(1.01)		(1.01)
2020	4,809		407		6.7		5,223	

The estimate shows that passengers on railways will increase 3% per annum for 1995-2005. 2% for 2005-10 1% for 2010-2020, while cargo in total will grow 5% for 1995-05, 3% for 2005-10 and 1% for 2010-20.

The estimated OD tables in the future were, then, used to show the link volume between the rail stations and on/off volumes at each station (Fig. 2-4 and 2-5). In total on railways, the passengers will increase by 70% and cargo by 120% from 1995 to 2020. The main reason of the difference in growth would be increases of coal transport.

Table 2-4 Passenger OD Summaries on Railway for 1995-2020

(In persons'10³ and annual ratio)

	1995	2005		2010		2020	
	Persons	Persons	Ratio 2005/1995	Persons	Ratio 2010/2005	Persons	Ratio 2020/2010
Domestic	2,427,932	3,264,374	1.34	3,604,382	1.104	3,983,520	1.105
			(1.03)		(1.02)		(1.01)
Going Out	62,281	101,451	1.63	123,434	1.22	165,885	1.34
			(1.05)		(1.04)		(1.03)
Coming in	82,965	111,498	1.34	123,105	1.104	135,982	1.105
			(1.03)		(1.02)		(1.01)
Transit	8,468	8,468	1.00	8,468	1.000	8,468	1.000
			(1.00)		(1.00)		(1.00)
Total	2,581,646	3,385,791	1.31	3,859,389	1.140	4,293,855	1.105
(Annual Ratio)			(1.03)		(1.02)		(1.01)

Ratio : Upper figures are ratio of increase from the previous year
: Lower ones in ( ) means the average annual rate of increase.

Table 2-5 Cargo OD Summaries on Railway, 1995-2020

(In '10³tons/ year)

	1995	2005		2010		2020	
	10³tons	10³tons	Ratio	10³tons	Ratio	10³tons	Ratio
Domestic	5,460.3	9,265	1.70	11,185	1.20	12,646	1.17
			(1.06)		(1.05)		(1.02)
Coal	4,340.5	7,367	1.70	8,822	1.20	9,704	1.10
			(1.06)		(1.04)		(1.01)
Others	1,119.8	1,898	1.70	2,363	1.20	2,942	1.24
			(1.06)		(1.05)		(1.02)
Import	868.6	1,476	1.70	1,771	1.20	2,007	1.13
			(1.06)		(1.05)		(1.01)
Petrol	328.3	591	1.80	726	1.23	864	1.18
			(1.06)		(1.05)		(1.02)
Others	540.3	885	1.65	1,045	1.18	1,143	1.10
			(1.06)		(1.05)		(1.01)
Export	845.4	1,009	1.19	1,100	1.10	1,277	1.17
			(1.02)		(1.02)		(1.01)
Copper & F	585.8	586	1.00	586	1.00	586	1.00
			(1.00)		(1.00)		(1.00)
Others	259.6	423	1.63	514	1.22	691	1.34
			(1.05)		(1.04)		(1.03)
Transit	133.8	134	1.00	134	1.00	134	1.00
			(1.00)		(1.00)		(1.00)
Total	7,308.1	11,884	1.53	14,190	1.22	16,064	1.13
(Annual Ratio)			(1.05)		(1.04)		(1.01)

Ratio : Upper figures are ratio of increase from the previous year
: Lower ones in ( ) means the average annual rate of increase.

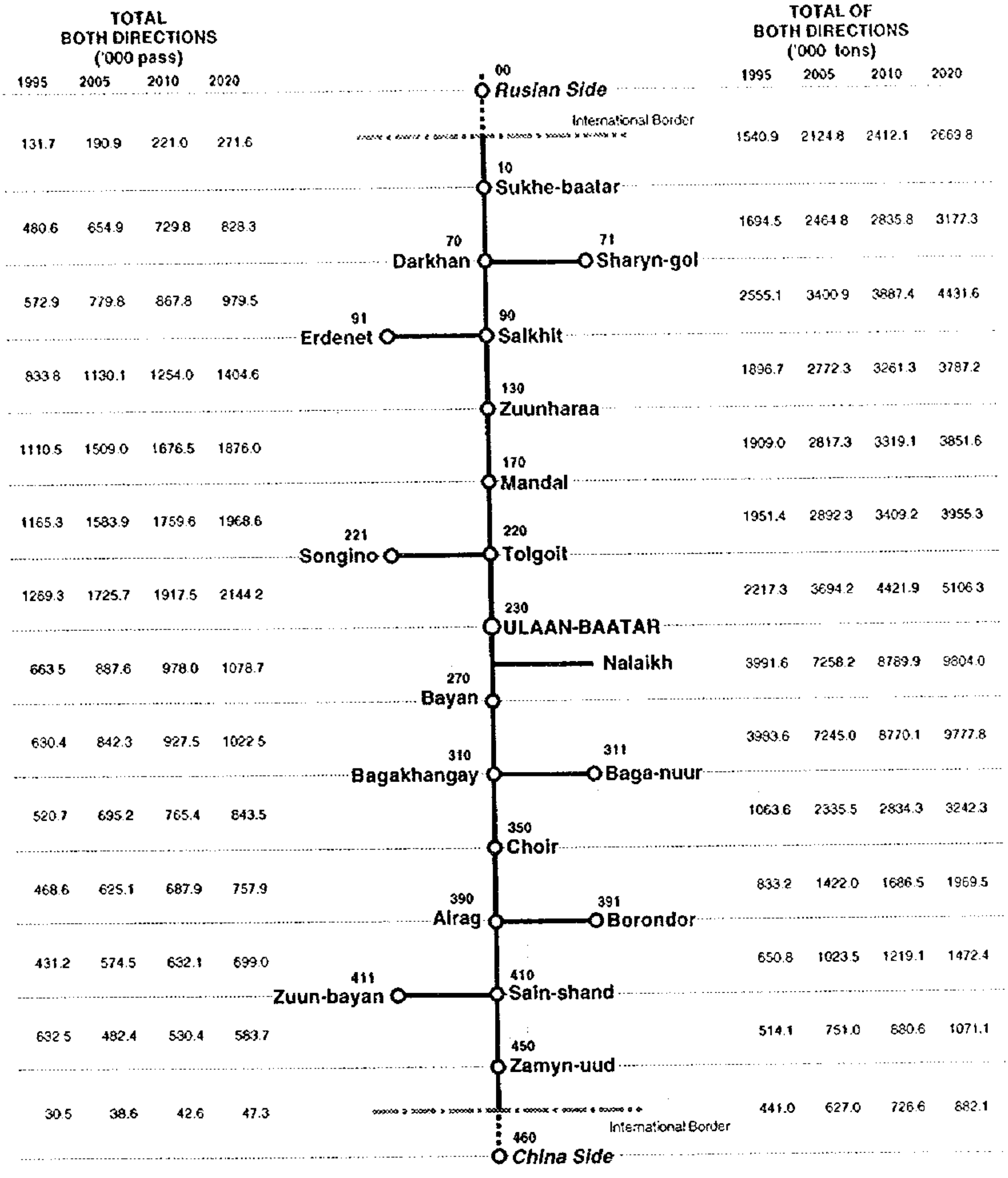


Fig. 2-6 Link Volumes for Future Years

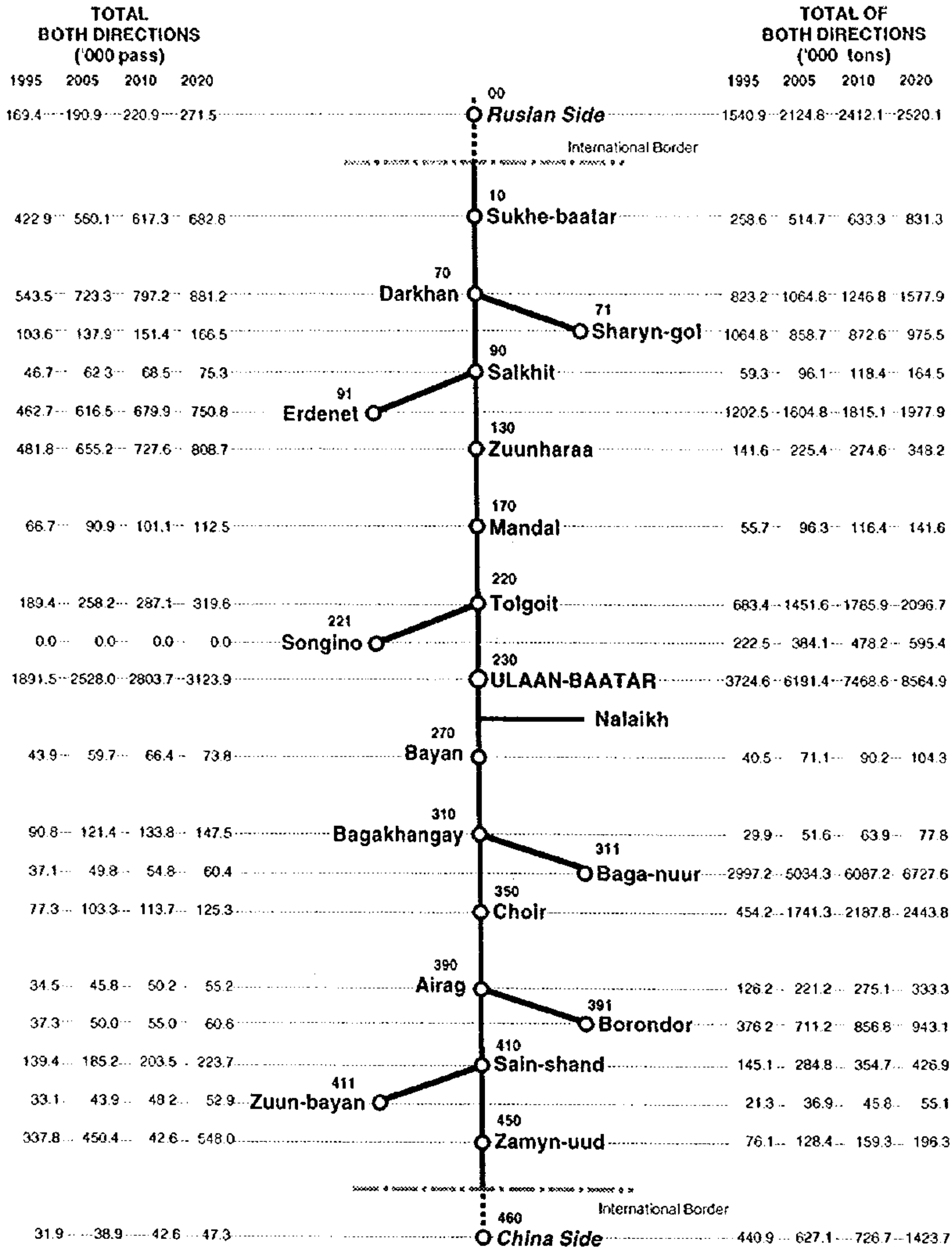


Fig. 2-7 Handing Volumes by Station for Future Years

3. *TRANSPORT AND ROLLING STOCK PLANNING*

Since train and rolling stock operation is conducted throughout the entire sections, the transport and rolling stock planning is carried out for the section between Sukhe-baatar and Zamyn-uud and for the branch-line sections as well.

3-1 Existing Traffic and Rolling Stock Conditions

(1) Railway line and layout of stations

The Mongolian Railway (MR) lines consist of the main line from Sukhe-baatar on the Mongolian-Russian border to Zamyn-uud on the Mongolian-Chinese border and other lines including branches from the main line, as shown in figure 3-1.

The commercial distance of all lines is 1,805 km in total.

On the main line there are 45 general stations including 25 freight handling stations. The average distance between stations is 25 km.

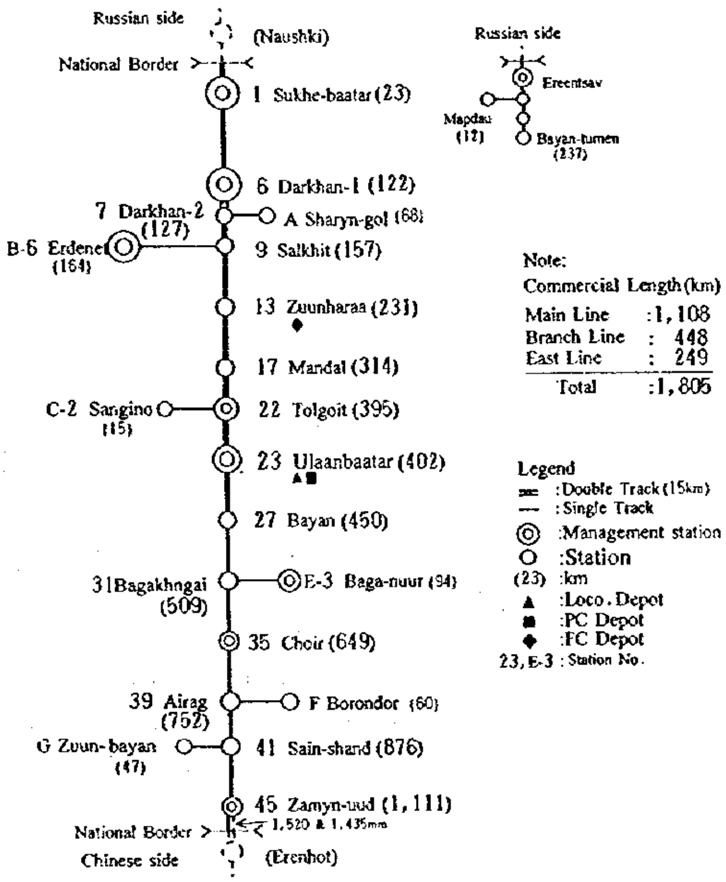


Fig. 3-1 Railway Lines of Mongolian Railway

(2) Present conditions of transport

The number of passengers carried in 1995 was 2,830 thousand, of which domestic traffic volume accounted for 93%. The average distance of travel was 240km.

Table 3-1 Transportation of Passenger Volume

Year			1991	1992	1993	1994	1995	%
No. of Passengers (×1,000 passengers)	Arrive	From Russia	105.3	123.1	98.2	96.3	61.5	2.2
		From china	11.6	24.2	41.6	48.7	22.7	0.8
		Total	116.9	147.3	139.8	145.0	84.2	3.0
	Depart.	To Russia	194.9	171.8	138.0	117.7	60.9	2.2
		To China	42.1	46.1	57.1	38.8	39.6	1.4
		Total	237.0	217.9	195.1	156.5	100.5	3.6
	Transit	To Russia	13.8	17.9	10.5	6.8	4.1	0.1
		To China	27.3	17.9	10.2	8.9	4.4	0.2
		Total	41.1	35.8	20.7	15.7	8.5	0.3
	Domestic		2,141.3	2,170.3	1,893.4	2,567.4	2,634.3	93.2
Ground Total			2,536.3	2,571.3	2,249.0	2,884.6	2,827.5	100.0
%			100.0	101.4	88.7	113.7	111.5	

Freight traffic volume in 1995 was 7,300 thousand tons. Of domestic freight (5,460 thousand tons), coal accounted for 80% (4,350 thousand tons). The 2nd was export copper ore, followed by imported oil and so forth. The average distance of transport was 310 km.

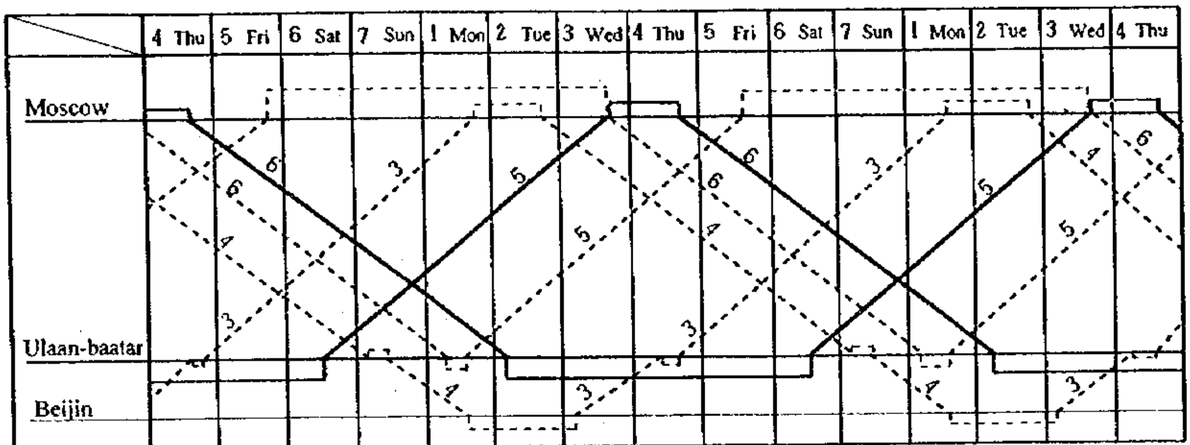
Table 3-2 Transportation of Freight Traffic Volume

Year			1991	1992	1993	1994	1995	%
Traffic Volume (×1,000 tons)	Domestic	Coal	4,910	4,698	4,541	4,330	4,351	59.4
		Other	2,203	1,195	1,073	1,011	1,109	15.1
		Total	7,113	5,893	5,614	5,341	5,460	74.5
	Inter-National	Export	1,707	1,372	993	879	862	11.8
		Import	1,281	943	946	886	869	11.9
		Transit	169	309	303	171	134	1.8
		Total	3,157	2,624	2,242	1,936	1,865	25.5
Grand Total			10,270	8,517	7,856	7,277	7,325	100.0
%			100.0	82.9	76.5	70.9	71.3	

(3) Present conditions of train operation, operational safety system, etc.

As passenger trains, international trains between Moscow, and domestic trains are operated. The international trains are operated on specific days of the week. As for the domestic trains, some trains are operated every day, and other trains on specific days of the week. All freight trains are irregular trains and are operated depending on transport demand.

The average number of trains per day (passenger and freight trains total) is 14 to 22 trains (up and down trains total) between Darkhan and Salkhit where the number of single-track sections is the largest. The maximum train speed is 90 km/h (80 km/h in the past) for passenger trains and 80 km/h for freight trains. Passing speed at stations excluding main stations is 70 km/h (50 km/h in the past). (train schedule revision on June 1, 1997)



Note 1. —— : MR's rolling stock - - - : Russian rolling stock (including some Chinese rolling stock)
Note 2. Moscow~U.B.:4 days 7 hours U.B.~Beijin:1 day 5 hours (Time difference : Moscow 5 hours, Beijin 1 hour)

Fig. 3-2 Example of Train Diagram (1997.6.1)

For ensuring safe train operation, sophisticated systems such as the tokenless block system and overall-control electric relay interlocking system are in use. However, the devices of these systems have considerably superannuated and require replacement in the near future. For train operation administration, there is a control center in the head office of the Mongolian Railway, and operational adjustment is made in accordance with a basic train diagrams for the time between 17:00 of a day and 17:00 of the following day.

(4) Present condition of operating accident

Operating accident and incident are decreasing. The number of serious accidents such as train collision in the past 6 years is 8 cases.

Table 3-3 Number of Operating Accident and Incidents

Year	1990	1991	1992	1993	1994	1995	Yearly average
I Train derailment etc.	0	1	1	2	3	1	1.3
II Wagon derailment etc.	83	76	84	85	98	81	84.5
III Loco. Breakdown etc.	79	90	216	283	247	222	189.5
Total	162	167	301	370	348	304	275.3

Note: The number of train derailment, etc.per million train-km is 0.25 on the average, and is small compared with other countries.

(5) Present conditions of rolling stock and rolling stock base

The number of passenger cars, freight cars, and locomotives owned are as follows.

Table 3-4 Number of Passenger Cars Owned (1996)

Kinds of cars	Sleeping	Dinning	Seat car	Baggage	Others	Total
No. of cars	132	6	80	10	5	233
Seating Capa.(ps.)	28~36	43	54~81	-	-	-
Car weight (ton)	56	66	54	51	54	-

Table 3-5 Number of Freight Cars Owned (1996)

Kinds of cars	Open car	Box car	Container	Tank car	Others	Total
No. of cars	1,591	367	70	36	449	2,513
Ave. load (ton)	68	66.4	65.7	60	60~65	-
Car weight (ton)	22	24	23	25	23	-

Table 3-6 Number of Locomotive Owned (1996)

Kinds of cars	2M62	M62	TEM	GE	Total
No. of cars	64	13	28	2	107
Out-put (HP)	4,000	2,000	1,200	3,000	-
Car weight (ton)	240	120	120	135	-

Note: All are disel electric locomotives(DEL).

The Mongolian Railway has a rolling stock base in Ulaan-baatar for passenger cars and locomotives, and also has a base in Zuunharaa for freight cars. Simple repairs and inspections are conducted at main stations as well. The number of employees engaged in these kinds of work are about 1,400 persons in passenger transport sector, about 1,500 in the freight transport sector, and about 1,400 in the locomotive sector.

3 - 2 Principles and Basic Conditions of the Planning

(1) Principles of the planning

The transport plan is drawn up based on the "Basic Principles of the Planning" shown in Introduction.

① Emphasis is placed on ensuring safe and stable transport.

② The objective of the planning is limited to ensuring the necessary transport capacity. Measures for modernzation are taken up in another project.

③ Target years at the planning are 2005, 2010, and 2020.

(2) Basic conditions of the planning

① Since trains are operated throughout the entire sections, planning is done for the entire sections excluding the East Line.

② Demand forecast is conducted for the planning.

③ Main factors, such as the train consist and kinds of trains, are planned on the basis of current figures(as of 1996).

3 - 3 Transport Planning

In the transport planning for each year, such figures as train-km were calculated after estimating the number of trains by year, by section, and kind of train, based on the cross-sectional traffic volume per week. The results of the calculation are shown in the following tables. The number of trains by section and related figures are shown in Table 3-13.

Table 3-7 Passenger Train-km and Car-km (1,000km)

Item \ Year	1996		2005		2010		2020	
		%		%		%		%
Train-km	2,564	100	2,692	105	2,766	108	2,946	115
Car-km	30,640	100	33,634	110	35,113	115	36,941	121

Table 3-8 Freight Train-km and Car-km (1,000km)

Item \ Year	1996		2005		2010		2020	
		%		%		%		%
Train-km	2,732	100	3,480	127	4,084	149	4,778	157
Car-km	81,086	100	126,135	156	154,531	191	184,520	228

Table 3-9 Locomotive-km (1,000km)

Item \ Year	1996	%	2005	%	2010	%	2020	%
Loco.-km	5,747	100	7,477	130	8,319	145	8,940	156

3 - 4 Rolling Stock Planning

Based on the results of the transport planning, the number of cars and locomotives necessary for the planned transport were estimated. These figures were calculated by drawing up train diagrams for each year and based on their execution diagrams. In this connection, the investment necessary for increasing rolling stock is not included in the amount of investment for this project.

Table 3-10 Number of Required Passenger Cars

Item \ Year	1996	2005	%	2010	%	2020	%
Sleeping Car (Increase)	132	132	29	132	28	132	24
Seat Car (Increase)	80	85 (+ 5)	20	85	20	88 (+ 3)	20
Dinning Car	6	6	-	6	-	6	-
Baggage Car	10	10	-	10	-	10	-
Mail Car	2	2	-	2	-	2	-
Total (Increase)	230	235 (+ 5)		235		238 (+ 3)	

Note: Seat cars include cars for suburban lines(7 cars).
"%" shows the reserve ratio (percent of reserve cars of the total number of cars).

Table 3-11 Number of Required Freight Cars

Item \ Year	1996	2005	%	2010	%	2020	%
Tank Car (Increase)	36	118 (+ 82)	5.2	144 (+ 26)	5.1	171 (+ 27)	4.9
Others (Increase)	2,477	2,477	28.9	2,477	14.7	2,495 (+ 18)	5.1
Total (Increase)	2,513	2,595 (+ 82)		2,621 (+ 26)		2,666 (+ 45)	

Note: "%" shows the reserve ratio (percent of reserve cars of the total number of cars).

Table 3-12 Number of Required Locomotives

Item \ Year	1996	2005	%	2010	%	2020	%
2M62, GE (Increase)	66	66	25	69 (+3)	15	73 (+4)	15
M62	13	13	-	13	-	13	-
TEM2	28	28	-	28	-	28	-
Total (Increase)	107	107		110 (+3)		114 (+4)	

Note: 1. The number of GE Type locomotives operated is 2 cars.
2. TEM2 Type locomotives (28 cars) are introduced to 15 stations (including Sukh- baatar for use in shunting).
3. "%" shows the reserve ratio (percent of reserve locomotives of the total number of locomotives).

Table 3-13 Transport Plan (Number of train between main station) {Up & Down}

Station Number		1 6 7 A 7 9 B 9 13 17 23 27 31 E 31 35 39 F 39 41 G 41 45																
Section km		99	5	68	30	164	74	83	108	48	43	94	148	103	60	124	47	235
2005	PC(No./week)	48	97	28	69	28	55	55	69	36	36	6	30	26	6	26	28	26
	(No./ day)	6.9	13.9	4	9.9	4	7.9	7.9	9.9	5.1	5.1	0.9	4.3	3.7	0.9	3.7	4	3.7
	FC(No./week)	48	48	36	62	94	48	52	66	146	144	100	46	30	22	20	-	16
	(No./ day)	6.9	6.9	[illegible]+2	[illegible]+6	[illegible]+2	6.9	7.4	9.4	[illegible]+4	[illegible]+4	[illegible]	6.6	4.3	3.1	2.9	-	2.3
Total (No./ day)		13.8	20.8	8	19.9	10	14.8	15.3	19.3	19.1	19.1	8.9	10.9	8	4	6.6	4	6
2010	PC(No./week)	55	97	28	69	28	55	55	69	36	36	6	30	26	14	26	28	26
	(No./ day)	7.9	13.9	4	9.9	4	7.9	7.9	9.9	5.1	5.1	0.9	4.3	3.7	2	3.7	4	3.7
	FC(No./week)	56	56	40	72	102	56	60	76	192	174	120	56	34	26	22	-	18
	(No./ day)	8.0	8.0	[illegible]	[illegible]+6	[illegible]+2	8	8.6	10.9	[illegible]+4	[illegible]+4	[illegible]	8	4.9	3.7	3.1	-	2.6
Total (No./ day)		15.9	21.9	8	21.9	12	15.9	16.5	20.8	21.1	21.1	10.9	12.3	8.6	5.7	6.8	4	6.3
2020	PC(No./week)	62	104	28	76	28	62	76	76	36	36	6	30	26	14	26	28	26
	(No./ day)	8.9	14.9	4	10.9	4	8.9	10.9	10.9	5.1	5.1	0.9	4.3	3.7	2	3.7	4	3.7
	FC(No./week)	62	62	42	82	116	66	70	98	192	192	132	64	40	26	28	-	22
	(No./ day)	8.9	8.9	[illegible]	[illegible]+4	[illegible]	9.4	10	14	[illegible]+4	[illegible]+4	[illegible]	9.1	5.7	3.7	4	-	3.1
Total (No./ day)		17.8	23.8	8	22.9	12	18.3	20.9	24.9	21.1	21.1	10.9	13.4	9.4	5.7	7.7	4	6.8
Between staion		1--6	6--7	7--A	7--9	9--B	9-13	--17	--23	--27	--31	--E	--35	--39	--F	--41	--G	--45
Track Capacity	MR method	19	88	6	27	12	16	21	22	18	17	10	11	14	7	9	9	7
	JR method	28	117	8	38	17	22	30	32	28	27	16	16	21	8	12	11	11

Note : ▮ : Indicate double locomotives hauling.

4. RAILWAY FACILITIES PLAN

4 - 1 Construction Plan for Railway Structures

4-1-1 Technical Criteria

The Mongolian Railway was constructed based on the requirements for Class 4 railways specified in the Russian Railway Construction Standards, but efforts are being paid to upgrade it to the level of Class 3 at the time it is modified.

Upon establishment of the rehabilitation plan, plans for the subject project location are made based on the technical criteria, shown in Table 4-1.

Table 4-1 Specification

Item	Project Specification
Gauge	1,520 mm
Minimum curve radius	600 m , 300 m (Special case)
Maximum gradient	9 / 1,000
Rail size	R50 (50kg/m), L=25 m
Sleeper	PC sleeper, Double elastic fastening
Ballast depth	250 mm
Live load	S – 14
Formation with	6.5 m

4-1-2 Improvement Policy

This investigation project is planned with its aim of the year 2020 set at the completion of railway structure rehabilitation project, taking into consideration the following conditions.

- Scope of work to be incorporated in the master plan includes all structures of main line from the Russian border to Bayan.
- Importance is placed on measures required to assure safe and stable railway operations. Individual measures for improving speed and traction capability will be planned separately.
- Permanent measures, such as flood control plans, which are difficult for the railway authority to address by itself, will be considered separately from items of work that can be planned solely by the railway authority.

• Construction plans will be developed taking into account the financial status and cash flow of the Mongolian Railway. Measures for extending the life of facilities and improvement of facilities by maintenance technology will also be taken into consideration.

• Priority ranking of the sites to be rehabilitated will be made in establishment of plans, taking into account the existing condition of damaged facilities, the degree of damage anticipated in the future, the state of urgency, the estimated construction cost, and the expected effects of the investment.

4-1-3 Evaluation of Railway Structures and Rehabilitation Plan

(1) Riverbank Protection

1) Characteristics of Subject Rivers

Scouring and erosion of fills or river banks are a potential threat to the Mongolian Railway. These have become serious problems as they can damage railroad embankments in northern areas, particularly in areas from the 208 km point to the northern border with Russia, in areas along the Orhon river leading to Sukhe-baatar, and in areas along the Selenge river.

For solving such problems, it is important to understand characteristics of rivers in these areas (hydraulic characteristics and other factors, including geographic elements that can be affected by the meandering of rivers, gradient of river beds, flood frequency, water levels, and flow velocity).

From the conclusion based on the results of analysis made on these factors, it can be presumed that the subject rivers have characteristics similar to "Segment 2-2," category of rivers classified by segment, proposed by Koichi Yamamoto et al.

2) Rehabilitation Plan

The rehabilitation plan is based on the concept of providing necessary repairs in order of priority which is ranked depending on the risk of rivers classified by the method described 1) above.

a) Ranking by risk

Risk of rivers classified as Segment 2-2 are ranked as described below.

Rank 1 Conditions where toe of banking slopes and river banks are significantly lacking in stability. Such river banks, railway embankments, and railway operations can be seriously affected by scouring anticipated in the near future.

Rank 2 Although scouring is occurring, existing conditions are not as bad as Rank 1 and the estimated risk is not so high. It is not considered at present that definitive defects and the lowered safety of train operation can rapidly develop in the near future.

Rank 3 Conditions where erosion is not presently considered a problem.

b) Ranking of subject rivers and methods of rehabilitation

Since rivers classified as Rank 1 show a significantly lack of stability and their watercourses always are changing, it is considered most desirable to provide groynes combined with masonry block revetment consisting of gabions, mats, or rock protection (including concrete blocks), where careful consideration is made on the availability of materials on site and the flexibility of design and method of construction. Changing the location of the river channel can be considered a potential alternative.

For changes in river course and spur dykes, it is considered practical and most effective if such methods are applied step by step, based on the analysis of the effects of such methods made after careful inspections of field conditions during floods, after first constructing levees.

As an exception, future levee improvement work can be carried out repeatedly at the 31 km point (31pk2-4). An alternate railway relocation plan has been made for this area.

It can be considered that river banks classified as Rank 2 can be improved only with concrete block levees.

3) Revetment Improvement for Individual Sites

The proposed levee improvements to be provided for the eleven sites are shown in Table 4-2.

Table. 4-2 Proposed Improvement Method of Bank Protection

Location	Counter measure
11 pk 1-4	Revetment and Groyne
16 pk 1-4	Revetment and Groyne
31 pk 2-4	Revetment and Track Realignment
31 km	Relocation of Railway
51 - 52	Revetment and Groyne
54 pk 4-5	Revetment and Groyne
55 pk 9	Revetment and Groyne
57 pk 9	Revetment
65 pk 7	Revetment and Groyne
67 pk 7	Revetment
88 pk 10	Revetment
208pk - 209pk	Revetment and Groyne and Cut-off

Note: Same place as 31pk2-4 and 31km

(2) Slope Stability

1) Existing Condition of Cut Slopes

Rockfalls can occur often in cut slopes having weathered surfaces. Rockfalls occur where joints in the bedrock lose their strength or where parent rock has lost its strength by weathering.

It can be judged from field observations that rockfalls were mainly caused by weathering of cut surfaces of rock slopes with gradients of approximately 1: 0.8, and with heights of 20 to 25 meters. Recent cuts of unweathered rock normally have sufficient strength and present no problems.

2) Improvement Plan

The rehabilitation plan can be broken down into the categories of Prevention Countermeasure and Protection Countermeasure as shown in Table 4-3.

Table 4-3 Countermeasure of Slope Stability

Prevention Countermeasure	Protection Countermeasure
Removal of unstable rocks, Weathered slope surface	Concrete wall
Foot protection of boulder to be fallen down	Wire net or fencing
Shotcreting or Cast in place concrete protection	Piling
Cast in place concrete crib	Cast in place concrete crib with Anchoring
Rock bolting, Anchoring	Others

Of the measures shown in Table 4-3, plans will be made to remove and clear all loose weathered surfaces, unstable rocks and boulders from the slope, based on field inspections and the results of analysis. In addition, a pilot project is proposed to do the following work.

The pilot project includes removal of loose rock by blasting, foot protection, rock pools (rock catchment areas), and protection of the slope by paving with concrete.

3)Slope Stability Individual Sites

The rock-fall prevention plan for 22 sites, based on studies of the individual sites, is shown in Table 4-4.

Table 4-4 Slope Stability + Rock pool

Location	Counter measure
8 pk 10	Remove weathered slope surface+Rock pool
9 pk 5	Remove weathered slope surface+Rock pool
10 pk 7	Remove weathered slope surface+Rock pool
10 pk 8	Remove weathered slope surface+Rock pool
12 pk 2	Remove weathered slope surface+Rock pool
13 pk 4	Remove weathered slope surface+Rock pool
14 pk 8	Remove weathered slope surface+Rock pool
17 pk 6	Remove weathered slope surface+Rock pool
18 pk 1	Foot protection + Rock Pool
18 pk 10	Remove weathered slope surface+Rock Pool
19 pk 1	Remove weathered slope surface+Conc. Lining
51 pk 9	Remove weathered slope surface+Rock Pool
52 pk 3	Remove weathered slope surface+Rock Pool
52 pk 9	Remove weathered slope surface+Rock Pool
54 pk 2	Remove weathered slope surface+Rock Pool
57 pk 9	Remove weathered slope surface+Rock Pool
61 pk 9	Remove weathered slope surface+Rock Pool
88 pk 4	Remove weathered slope surface+Rock Pool
250 pk 7	Remove weathered slope surface+Rock Pool
251 pk 10	Remove weathered slope surface+Rock Pool
267 pk 4	Remove weathered slope surface+Rock Pool+Blasting
282 / 283 pk	Remove weathered slope surface+Rock Pool

(3)Track Lifting

1) Existing Conditions

Since existing embankment fill between the 92 km and 96 km points can be affected during spring and autumn seasons by floods of the Orhon river and other streams, the track raising work in this section must be executed.

2) Improvement Plan

Based on the past records of floods, the average 2.5 m height of embankments will be increased by 1.0 to 1.5 m. Gradient of fill slopes will be changed to 1: 1.5, and formation width will be set to 6.5 m. It is also planned to repair the shoulders of slopes and to reinforce the inlets and outlets of drainage facilities.

Based on the results obtained from boring investigations and standard penetration tests, N value increases from 15 to 45 depending on the depth measured from ground surface.

Since allowable bearing capacity of Qa = 15 to 20 t/m^2 can be expected, there will be no problem with the bearing capacity.

(4)Bridge Rehabilitation

1) Condition of Existing Bridges

The results of field investigations are described below.

① Significant defects

Cracking that can affect structures is occurring continually, and length, width and number cracks can increase. Cracks 0.1 to 0.2 mm in width can be seen. Final judgment must be made only after periodic follow-up inspections, but the following conditions were observed during the last investigation.

- Cracks were seen on the sides of beams and spalling of concrete was noted.
- Cracks and exposed corroded axial reinforcement was seen on the undersides of concrete bridges.
- Cracks over 0.2 mm wide were noted on beam surfaces.

It is considered that these defects can sooner or later cause significant structural problems because of being affected by repeated freezing and thawing of infiltrating water.

② Other defects

Other major defects observed include the following.

a. Main concrete beams

- Honeycombing due to poor workmanship.
- Damage to the underside surface of concrete beams from the traffic.
- Pattern cracking with extrication and efflorescence
- Corrosion of exposed reinforcement.
- Shortage of concrete cover.

b. Ballast stops and slabs

- Cracks in axial directions on ballast stops.
- Extrication and efflorescence from pattern cracking

c. Bearing shoe

• Frozen steel plate type shoes due to dire and corrosion

d. Substructures

• Cracks noted on parapet walls of abutments

2) Improvement Plan

Wherever there is any danger to publics safety, structural repairs become top priority.

① Basic concept for rehabilitation

Repairs of structural cracks that can affect the safety of bridges are given top priority. Urgent measures must be provided and the following are the proposed methods of repair.

② Methods of improvement

There are two methods for repair and improvement of bridges.

a. Repair by replacement

Where significant defects are found as described in 1), ① above and where repair costs are estimated to be very high compared to cost of replacement, subject bridge should be replaced with a new one. It is important to minimize nuisance to train operations in the project location by carrying out replacement of bridges while trains are not being operated, based on close review of the train schedule.

b. Grout injection method, or replacement of concrete

Where significant defects are found in existing conditions described in 1), ② above, it is necessary to remove all cracked concrete and spalls from the edges of main beams and to inject resin containing concrete or resin containing grout to fill all damaged portions.

Prior to commencement of work, it is necessary to remove rusts formed on exposed reinforcement, or remove and replace corroded steel rods as required, and deteriorated portions of concrete, and to conduct careful surface treatment to assure proper bonding between old and new concrete surfaces.

3) Bridge Rehabilitation for Each Site

Bridge improvement plans made for 12 sites are shown in Table 4-5.

Table 4-5 Proposed Improvement Method of Bridge Rehabilitation

Location	Counter measure
235 pk 3	Replace with a new Beam L=9m
245 pk 5	Crack injection
255 pk 3	Replace with a new Beam L=7m
255 pk 8	Crack injection
285 pk 1	Replace with a new Beam L=9m
289 pk 1	Replace with a new Beam L=12m
326 pk 9	Crack injection and Recasting Concrete
334 pk 3	Replace with a new Beam L=12m
338 pk 10	Replace with a new Beam L=7m
342 pk 2	Crack injection and Recasting Concrete
344 pk 1	Replace with a new Beam L=7m
356 pk 1	Replace with a new Beam L=7m

(5)Drain Improvement

1) Condition of Existing Drainage Facilities

Existing drainage facilities consist primarily of either concrete box culverts with inner dimensions from 1.0 m to 3.0 m or concrete bridges with span length of less than 13 meter. Most of the facilities are deficient in water carrying capacity.

2) Improvement Plan

① Selection of drainage structures to be enlarged

Drainage structures to be improved will be selected based on the discharge rates determined by calculations made for each drainage basin. Where shortage of discharge rate is obtained, the desired cross section is selected from design discharge rate of various structures shown in Table 4-6. Selected facilities are installed next to the existing drainage structures. Where a new drainage system is to be provided, the most adequate site for the drainage is determined after a field investigation.

Table 4-6 Drainage Dimension and Discharge Capacity

Drainage Facility and Dimensions	Approx. Discharge Capacity
One-cell type Box Culvert	
Clear space*Clear Height	
2.0 m*2.0 m	10-15 cu.m/sec.
2.5 m*2.5 m	15-25 cu.m/sec.
Simple Span Bridge	
Clear span length L meter	
5.0 m	20-25 cu.m/sec.
7.0 m	30-40 cu.m/sec.
10.0 m	40-60 cu.m/sec.

② Methods of installation for various structures

a. Box culverts

Box culverts are shop fabricated and delivered to sites by train. Embankments are excavated in advance, and culvert sections are lifted and placed by crane while train traffic is stopped temporarily.

b. Bridges

Precast beams are used because it takes considerable time to construct abutments in advance of installation. Beams are fabricated in a shop and delivered by train to the site and are lifted and placed by crane.

c. Protection work

Protection structures are constructed in front of abutments and at the inlets and outlets of box culverts to prevent erosion during floods.

③ Based on the results of the last boring investigation and standard penetration tests, weak loam deposits of $N < 15$ or $N = 4$ to 5 were noted in areas near the 90 km, 164 km, 168 km, 170 km, 218 km, and 253 km points. Therefore, plan and design of foundations for the structure will be made based the data obtained from the boring investigations.

3) Drain Improvement for Each Site

Measures required for 138 sites based on the analysis made on each site is shown in Table 4-7.

Table 4-7 Proposed Improvement Method of Drain Improvement

Countermeasure	Location
1 Cell Concrete Culvert W 2.0m * H 2.0m	11pk8, 14pk1, 21pk6, 22pk8, 22pk10, 23pk2, 34pk3,37pk7, 41pk2, 50pk5, 51pk3, 54pk10,56pk8, 57pk10,59pk9, 66pk4-5, 82pk6, 88pk6, 88pk9, 93pk1, 93-95km, 95pk2, 97pk5, 107pk6, 111pk9, 113pk4, 116pk6,123pk1, 128pk7, 132pk6, 135pk3, 136pk8, 138pk6, 141pk6, 143km,151pk3,155pk5, 157pk5, 158pk9, 160pk9, 166pk2, 168pk4, 170pk8, 170pk1-3,171pk5, 172pk10,176pk6, 177pk6, 178pk7, 183pk3, 184km, 185pk6, 189pk7, 190-192km, 191pk5, 197pk9, 205pk7, 207pk2, 207pk8, 211pk1, 210pk6,212pk8, 216pk6, 217pk9, 218km, 222pk10, 223pk7, 225pk8, 228pk6, 230pk9, 236pk8, 238pk4, 239pk9, 242pk4, 243pk10, 244pk7, 252pk1, 253pk3, 261pk1, 261pk6, 270pk1, 276pk8, 277pk8, 279pk3, 280pk5, 280pk10, 282pk6, 289pk7, 307pk3,313pk10, 319pk2, 319pk6, 323pk5, 324pk5, 329km, 331pk7, 332pk4, 333pk5, 340pk5, 348pk10, 349pk10, 357pk7, 365pk3, 367pk5, 370pk9, 378pk3, 381pk4, 386pk8, 391pk4, 416pk10, 417km, 420km, 424pk3, 428km, 438km
1 Cell Concrete Culvert W 2.0m * H 2.5m	100pk7, 145pk1
1 Cell Concrete Culvert W 2.5m * H 2.5m	20pk2, 89pk7, 268pk3, 273pk1, 311pk8, 342pk2, 345pk7, 348pk7, 389pk1
1 Span Bridge L=10m	125pk8, 235pk3, 255pk3, 334pk3, 334pk4, 356pk1, 394pk4
2 Span Bridge L=10m	125pk8
1 Span Bridge L=12m	352pk7
Drain Improvement	23pk2
Widening of channel, Revetment, Demolition of superstructure	399pk1

4 – 2 Track – Station Yard Planning

(1) Track

At the beginning stage of construction, R43 (43kg/m) type of rail was adopted, however, after weight (axle load) of train becoming heavier, rails have been replaced by R50 (50kg/m) from 1976, completing 1,115km of track line replaced with the heavier rail while 14km of length partially between 725 – 870km is still remained as with R43 type rails and replacement of rail for this section is being progressively advancing.

Wear of rail is particularly notable at small radius curved section and at present, with the assistance of World Bank (W/B) and Loan from OECF, Austrian made heat-treated rail replacement is done for about 250km. Beside this, wheel burn and shelling caused from heavy axle are seen quite often.

At present, all sleepers are of wooden ones, however, with the technical – introduction from China, concrete sleeper production plant is now being built (scheduled to be completed August 1997) and preparation is advancing to replace with concrete sleeper instead of wooden ones.

For the Fastening of rail, dog spike is used by inserting rail-plate placed on all sleepers.

Rail bed was constructed mainly with un-screened gravel in railway construction stage but, nowadays, crushed stones are introduced. Sections surveyed at this occasion is mostly with un-screened gravel.

Roadway diagram stipulates to secure rail bed with 50cm to the road shoulder, however, the laying condition now hardly to find such places therefore, there are many cases of ballast washed down to the slope and there are many places the edge of sleepers are shown up.

On main line, No. 11 simple turnout is used and fixed crossing is adopted. Maximum passing speed on straight – track is regulated to 50 km/h, then, in 1997, it has been improved to 70 km/h operation.

(2) Track Maintenance Structure

Track Facility Department (TFD) is taking change of normal maintenance of entire track and control related facilities (track, embankment, bridge and culvert). In TFD, there are 5 normal track maintenance depot and 1 track construction / improvement depot. Other than these, there is a sleeper – production site and ballast production plant, totaling 8 field organization. There are total of 2,747 staff, whereby 2,195 is for main line relation and 552 for exclusive industrial line and line for workshop.

Structure to keep the safety of railway track, Facility Maintenance Dispatcher is placed at each track maintenance depot in 24 hours operation and all data from various observation point with partial performance condition, weather forecast information, track condition are informed by direct circuit or telephone. From outside organization, it is so arranged to receive State Weather Information by means of mail or telephone contact and that information is transmitted to Security Section enable to make provision against disasters. Other than security maintenance, ridden patrols are done to supervise the live – stocks to enter in to tracks and immediate contact is made to the "Dispatcher" to transmit the same to trains in operation.

In raining season, water – levels of Rivers and Streams are measured and when the water go over the designated level, it is so arranged to secure the safety of train operation.

As a precautionary arrangement against disasters, collection of weather information, complete preparation of emergency–contact–structure, well prepared staff mobilization plan at each track maintenance depot are arranged in advance.

Main disaster is mostly wash–out of rail-bed caused by flood and, from 1991 on, there are already 10 cases of disastrous floods which took between 12 hours – 4 days for restoration work.

In MR's (Mongolian Railway) history, there are two (2) cases of disaster occurred which took 10 – 11 days for restoration.

(3) Track Maintenance Work

Track maintenance work in MR is largely divided into two (2), one is the group to make renewal exclusively by large machine and the other group is to conduct normal maintenance work in their respected assigned sections. The group which handle large machine is placed near by Ulaan-baatar and to conduct yearly planned scheduled works.

On the other hand, for the group doing the every-day inspection / repair works, it seems that equipment / tools to handle larger size rail and ballast works are not adequately provided.

(4) Concept of Tracking Plan of Improving Section of Track Structure

1) Sections where to be repaired or improved, track renewal work should be done.

2) Rail shall be re-used from existing ones and sections where rails are extremely worn, Mr's stock rail shall be used.

3) Sleepers ; Use sleepers produced by the completed concrete sleeper plant.

4) Ballast is laid to keep the depth of 250mm under the sleeper and if track formation is less than what stipulated, widening work should be secured with 500mm of width between the end of ballast to the sloop end.

(5) Present State of Railway Station

Effective length of each of Mongolian Railway are secured with 850m main track and sub main track, which is capable to accord the prospected increasing transport volume. And also sub main track is also provided with enough facilities.

Partially, there are places where stations forced to be at the curved station, however, there are less facilities around hindering clear sight passage. There are many industry side tracks laid for each enterprise but they are all facilitated branched from the station yard and there is no problem for future development.

4-3 Electrical and Communication Facilities

(1) General Condition of Electrical Facilities

Diligent inspection and maintenance efforts directed by headquarters have kept the Mongolian Railway's electrical facilities in good working order so as to assure continued train operations. However, some facilities are old, having been manufactured over 40 years ago, and various problems are beginning to appear in the field of inspection and maintenance.

An equipment upgrading program has now been established by the Mongolian Railway. This program includes upgrading of the data carrier system using optical fiber cables, replacement of the exchange system with a digital type, and replacement of old generators and provision of additional new generator units.

(2) Condition of Various Types of Equipment

1) Signal System

A "tokenless block system" is used as the block signal system and one train is blocked for each section between stations. Track circuits are provided without a discontinuation for each station compound. The interlocking system is linked with Class 1 relays except for the Class 2 relays of the Zamyn-und Station.

Multiple-color light signal system is used for signals, based on the G-Y-R color system. Switching equipment on the main line is all electrical. Track circuits are provided for controlling barriers to automatically operate railway crossing alarms and barriers in response to the approach of trains.

Drawings of all these facilities are well maintained in files. There is a plan to provide a CTC train operation system at the time optical fiber cables are installed.

2) Telecommunication Equipment

Eight pairs of overhead bare cables are laid out over composite wood and concrete poles spaced at 50 meters, and are used as operation command circuits, communication media between stations, communication media for maintenance purposes, and bare cable frequency division multiplex transmission media consisting either of 3 channels or 3 to 12 channels.

Two different types of radio equipment are used for train operations and shunting of trains. Radio equipment for train operation uses the 2130–2150 kHz frequency band and equipment for shunting of trains uses the 150 MHz frequency band. Radio equipment used for train operations is used for communication between locomotives or for communication between locomotives and stations. Radio equipment used for shunting of trains was upgraded to the type manufactured in the United States

(Motorola, Inc.) two years ago. All other communication equipment was made in Russia.

Telephone switchboards are located at 16 stations. Five stations have replaced old switches with new digital switches. Most stations still use analog switchboards (crossbar switches) made in Russia. Digital switchboards located at Ulaan-baatar Telecommunication Center are linked with telephone lines of the Telecommunication Company via an optical carrier system (STM-1).

At the Ulaan-baatar Telecommunication Center, telegraph equipment is installed at various places to transmit gathered data. All these facilities were also made in Russia.

As there are locations where poles installed on hillsides can be affected by rockfalls, it can be presumed that train operations can be affected if a rockfalls damages the telecommunication circuits. It is important to consider the relocation of poles, and the replacement of existing telecommunications and electrical poles with concrete poles.

3) Power Source Facilities for Signal and Telecommunication Systems

Transformers (for AC circuits), rectifiers (for DC circuits), and batteries are installed as power sources for signal and telecommunication systems. Also, gasoline engine driven generators (24 kW or smaller) are provided for emergency use.

4) Electric Power and Water Distribution Facilities

Electric power is distributed to all stations via overhead distribution lines suspended from electric poles (combination poles), installed at a spacing of 50 to 70 meters, to feed power to trains for operation, for station buildings, and for the use of station employees. At the Ulaan-baatar Power and Water Distribution District, all necessary facilities are provided to distribute electric power received from the power generation plant for the use in railway operation. All these power distribution facilities use equipment that was made in Russia.

The electric power department is also responsible for management of water distribution facilities, including monitoring systems for all water wells at stations, pumping facilities, and drinking water distribution pipelines. All equipment for these water distribution facilities was also made in Russia.

(3) Electric Power Distribution Facility Improvement Plan

There are two electric power distribution facilities to be subjected to field investigations under this project. The first facility is located close to 31pk2-4 where approximately 2 km of telecommunication lines are to be rerouted, and the second facility is located near 251pk2 where rockfall prevention work is to be carried out.

1) At the proposed project site close to 31pk2-4, new telecommunication lines will be installed along the course of a new railway routing, and these new lines will be connected to existing lines at both ends to minimize interruptions to existing telecommunications while distribution lines are being rerouted.

2) At the site near 251pk2 the railway is not affected directly by rockfalls, but telephone and electric poles on the hillside could be affected by rockfalls and telecommunication lines could be cut. At this site it is planned to relocate a 200-meter stretch of existing poles that are exposed to rockfalls. The lines will be relocated approximately 30 meters towards the railway.

For construction costs, refer to the Rehabilitation Project Execution Plan.

5. INITIAL ENVIRONMENT EXAMINATION (IEE)

Environmental impacts that this project will produce are shown in Table 5-1.

(1) Social environment

1) Because neither a large route change nor a new line construction will be done, there is little impact relating to resettlement, economic activities, traffic, public facility, split of community, cultural property, water right and rights of common.

2) A lot of domestic wastes will not be produced during constructions, and then the produced ones will be appropriately treated..

3) Construction wastes, surplus soils and so on will occur during constructions, but they will be treated after consultation with local governments. The construction site at 399 km is in an industrial area and it is necessary to analyze surplus soil and sediments and to take consideration into the method of disposition of contaminated wasted soil which the construction will produce.

4) It is necessary to consider if natural disasters happen as a result of new tracks, new drainage facilities and a short cut of river flow.

(2) Natural Environment

1) There is little impact relating to topography, geology, groundwater, meteorology and landscape.

2) Soil Erosion: A new track construction (a relocation of railroad) will be done at 31 km. This place is located in the Orkhon river bank and is surrounded by elms, peashrubs, sedges, herbs and grasses (projective cover: 35-40%). After the construction the land around the railroad should be recovered with natural plants in order to prevent the soil erosion. And then new drainage facility constructions also have a possibility of introducing soil erosion. It is necessary to try to minimize it.

3) Hydrology of rivers: Rivers in the study area are rarely protected with bank protection, and their flow is determined by the natural condition. Snow-water in spring and a localized torrential downpour in summer deform the flow of rivers. The part of the railway to which the river comes close shall be protected from disasters through

straightening river bet or reinforcing bank. On the occasion of these protection work, the following points should be considered:

1. reduce impacts toward aquatic biota
2. hold the function as a watering place for domestic animals
3. not induce a disaster along the river

4) Fauna, Flora and Aquatic Biota: Some rare animal species were found along the railway in the study area of the rehabilitation project of the Mongolian Railway, but only nests of crow, raven, magpie, skylark and sparrow were found in the study area along the railway, but nests of rare birds were not found. And also a spawning ground of fish was not found in the study area. The secondary data were used because the investigation period was very short and some birds and fish migrate. Routes of migration of birds are away more than 1 km from the railway. Rare mammals except *Erinaceus dauricus* don't constantly live near the railway, and only pass there. Eight rare plant species were found in the study area. These plants except *Pinus sibilica* are harvested in autumn to make hay. So these plants have adaptation for such human activities.

5) Specially Protected Area: The study area is only adjacent to Bot Khan UAL (south of Ulaan-baatar), and constructions will not be done near there. Tujiin Nars (west of Sukhe-baatar), one of proposed protected areas, is away more than 10 km from the study area.

6) Grassland: A road network in Mongolia is not sufficient developed. In the constructions relating to this rehabilitation project of the Mongolian railway, chaotic sprawls of unpaved multiple tracks that scar the landscape are causing severe damage to soil and plant cover if there is not a prepared road that leads to the construction site. It is desired to transport materials and equipment, and furthermore workers to the construction site by train.

(3) Pollution

1) There is little impact relating to air pollution, water pollution, soil contamination, noise, vibration, land subsidence and offensive odor.

Table 5-1 Format of Screening (railway)

No.	Environmental Item	Description	Evaluation	Remarks (Reason)
Social Environment				
1	Resettlement	Resettlement by land occupation (transfer of rights of residence, land ownership)	[Y] · O [N] · [?]	no large construction in densely populated areas
2	Economic Activities	Loss of production base (land, etc.) and change of economic structure	[Y] · O [N] · [?]	no construction such as a large route change and a new line
3	Traffic and Public Facilities	Impacts on existing traffic, schools, hospitals, etc. (e.g., traffic jam, accidents)	[Y] · O [N] · [?]	no construction such as a large route change and a new line
4	Split of Communities	Separation of regional communities by hindrance of regional traffic	[Y] · O [N] · [?]	no construction such as a large route change and a new line
5	Cultural Property	Loss or deterioration of cultural properties, such as temples, shrines, archaeological assets, etc.	[Y] · O [N] · [?]	no existence near the railway
6	Water Rights and Rights of Common	Obstruction of fishing rights, irrigation, water rights and rights of common	[Y] · O [N] · [?]	no existence now
7	Public Health Condition	Worsening of health and sanitary condition due to generation of garbage and appearance of harmful insects	[Y] · O [N] · [?]	appropriate management
8	Waste	Generation of construction waste, surplus soils, sludge, domestic waste, etc.	[Y] · [N] · O [?]	contaminated wasted soil (sediment) may be produced
9	Hazards (Risk)	Increase in risk of cave-ins, ground failure and accidents	[Y] · [N] · O [?]	new track and drainage facility construction has a possibility of inducing risk
Natural Environment				
10	Topography and Geology	Change of valuable topography and geology due to excavation and earthfill	[Y] · O [N] · [?]	no large geographical change
11	Soil Erosion	Topsoil erosion by rainfall after land reclamation or deforestation	[Y] · [N] · O [?]	new track and drainage facility construction has a possibility of inducing soil erosion
12	Groundwater	Lowering of groundwater table due to overdraft and turbid water caused by construction work	[Y] · O [N] · [?]	no construction of tunnel
13	Hydrological Situation	Flow's change of river accompanied with reclamation or inflow of drainage	O [Y] · [N] · [?]	there are revetment and spur dike along track embarkment and short cut of river flow
14	Coastal Zone	Coastal erosion and sedimentation due to change of littoral drift and reclamation	[Y] · O [N] · [?]	no passing near shores
15	Fauna and Flora	Interruption of reproduction or extinction of species due to change of habitat condition	[Y] · [N] · O [?]	no great inpact if appropriate mitigation is done
16	Meteorology	Change of micro-climate, such as temperature, wind, etc., due to large scale reclamation and construction	[Y] · O [N] · [?]	no large building to construct
17	Landscape	Deterioration of aesthetic harmony by structures and topographic change by reclamation	[Y] · O [N] · [?]	no change of impacts toward landscape
Pollution				
18	Air Pollution	Pollution caused by exhaust gas or toxic gas from locomotives and factories	[Y] · O [N] · [?]	no construction neither great change of service frequency to induce air pollution
19	Water Pollution	Water pollution of river and groundwater caused by drilling mud and oil	[Y] · O [N] · [?]	appropriate management
20	Soil Contamination	Contamination caused by discharge or diffusion of sewage or toxic substances	[Y] · O [N] · [?]	no existence of conduct to contaminate soils
21	Noise and Vibration	Generation of noise and vibration due to operation of locomotives, a marchaling yard and so on.	[Y] · O [N] · [?]	no existence of residence near the construction sites
22	Land Subsidence	Deformation of the land and land subsidence due to lowering of groundwater table	[Y] · O [N] · [?]	no pumping up a large amount of groundwater
23	Offensive Odor	Generation of offensive odor and exhaust gases	[Y] · O [N] · [?]	no conduct to cause odor
	Overall Evaluation:	EIA is necessary for the project implementation?	O [Y] · [N]	check unclear points with collecting additional data

6. REHABILITATION IMPLEMENTATION PLAN

6 – 1 Implementation Plan

(1) River Bank Protection

The project will be carried out in three (3) stages, divided depending on the criticality and the importance. Stage 1 is scheduled for the period from 1999 to 2004, Stage 2 from 2005 to 2009, and Stage 3 from 2010 to 2019.

1) River Bank Protection

Under the current situation where river banks are being eroded, embankments located in areas where train operations can be threatened because clearance between the railway and river bank is restricted, and the railway relocation project to be carried in areas close to 31pk2-4, will be completed by 2004. Scouring prevention project for embankments that are not being eroded significantly will be carried out after 2005. Spur dyke project to check the meandering flow of rivers will be carried out after 2005, based on detailed investigation of rivers and streams. Rerouting of river channels with sharp bends will be carried out after 2010, based on the results of investigations to be performed in upstream and downstream river channels and environmental investigations.

2) Slope Stability

Rockfall prevention and removal of loose rock for areas where slope surfaces are weathered and rockfalls are a threat will be completed by 2004. Project schedule for other locations will be determined based on continuous observation of the deterioration of the sloped surfaces.

3) Track Lifting

Rail embankments now being flooded will be raised by an amount determined after continuous observations of flood conditions, and in coordination with flood control plans. The project will be carried out after 2010.

4) Bridge Rehabilitation

The repairing or replacement of bridges with seriously damaged concrete surfaces and other significant defects will be completed by 2004. Project schedule for other bridges will be determined based on the results of continuous observations of the ongoing deterioration.

5) Drainage Improvement

A project to improve drainage structures that have had problems in the past, and to provide additional structures where required, will be completed by 2004. For other locations, box culverts will be added successively after 2005, taking into account the shortage of drainage capacity and the conditions of sites affected by floodwater.

6) Miscellaneous Work

Schedules, methods of construction, and effects of investment for various projects, including construction of new double-track railways, improvement of curved railway sections, and relocation of railways, will be summarized based on the results of reviewing investigation data showing changes in transportation volume. These plans will not be incorporated in this project to completed by 2019

6 – 2 Investment Cost and Schedule

The amount of investment required for improvement of facilities is estimated to be around US$26,230,000. The investment will be made in three different stage. During the Stage 1 period the rehabilitation project will be carried out with an investment of US$12,397,000. Funds will be obtained by 2000 and the project will be completed by 2004 through the process of design and construction.

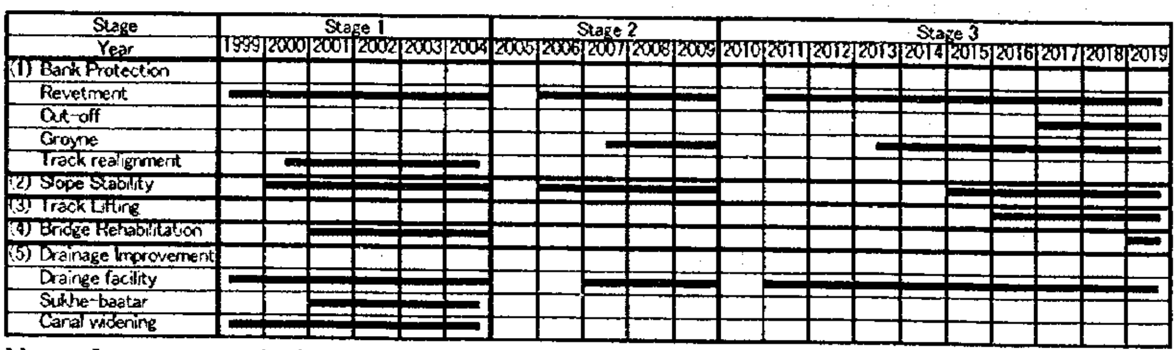
Stage 2 work of the project will be completed by 2009 for an investment of US$3,293,000. During the Stage 3 period, the project work will be carried out to be completed by 2019 for an investment of US$10,540,000. The amount of investment to be made for each phase and investment schedules are shown in Table 6-1 and Table 6-2. The number of various project sites in each phase is shown in Table 6-3.

Table 6-1 Investment Cost of Each Stage

(Unit : 1,000US$)

Stage / Description	Stage 1			Stage 2			Stage 3			Total Stage		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
Revetment	419	628	1,047	148	223	371	54	81	135	621	932	1,553
Cut-off	0	0	0	0	0	0	37	1,812	1,849	37	1,812	1,849
Groyne	0	0	0	365	548	913	274	411	685	639	959	1,598
Track realignment	263	2,661	2,924	0	0	0	0	0	0	263	2,661	2,924
Slope stability	30	340	370	11	126	137	2	28	30	43	494	537
Track lifting	0	0	0	0	0	0	154	1,765	1,919	154	1,765	1,919
Bridge rehabilitation	158	634	792	0	0	0	3	14	17	161	648	809
Drain improvement	578	1,073	1,651	217	403	620	785	1,459	2,244	1,580	2,935	4,515
Skhu-baatar drain improvement	82	245	327	0	0	0	0	0	0	82	245	327
Canal widening	17	97	114	0	0	0	0	0	0	17	97	114
Direct cost of civil work	1,547	5,678	7,225	741	1,300	2,041	1,309	5,570	6,879	3,597	12,548	16,145
Indirect cost	231	925	1,156	82	122	204	48	640	688	361	1,687	2,048
Physical contingency	168	670	838	90	134	224	53	704	757	311	1,508	1,819
Engineerin services	168	1,541	1,709	90	369	459	80	719	799	338	2,629	2,967
Total	567	3,136	3,703	262	625	887	181	2,063	2,244	1,010	5,824	6,834
Tax & Duties	1,469	0	1,469	365	0	365	1,417	0	1,417	3,251	0	3,251
Ground total	3,583	8,814	12,397	1,368	1,925	3,293	2,907	7,633	10,540	7,858	18,372	26,230

Table 6-2 Investment Schedule



Note : Investment schedule is included Preliminary Works.

Table 6-3 Number of Various Project in Each Stage

Countermeasure	Stage 1	Stage 2	Stage 3	Total
(1) Bank Protection	7	2	2	11
- Revetment	7	2	2	11
- Cut-off			(1)	(1)
- Groyne		(2)	(3)	(5)
- Track realignment	(1)			(1)
(2) Slope Stability	13	7	2	22
(3) Track Lifting			1	1
(4) Bridge Rehabilitation	11		1	12
(5) Drainage Improvement	42	19	77	138
- Drainage facility	40	19	77	136
- Sukhe-baatar	1			1
- Canal widening	1			1
Total	73	28	83	184

7. OPERATING AND MANAGEMENT PLAN

7 - 1 Organization and Personnel

For organizations of the Mongolian Railway (MR), the headquarters personnel assigned to the railway transportation make up only two to three percent of the total number of employees. Six top personnel are responsible for management of all divisions. It can be appreciated that the headquarters is simply organized as a whole. (Table 7 – 1)

MR is handling fairly wide range of business and services. The range of business and services other than railway transportation can be classified into those concerned with the railway (wood work, crushed stone production, manufacturing of wooden sleepers, etc.) and those for the welfare of the employees (education, housing construction, medical care, commodity distribution, cultural activities, etc.). The former should be commissioned to private sectors if commercial enterprises have become established and it is natural that the latter be handled by the government or by public corporations. For now, however, the present systems cannot be avoided in the current status of Mongolia, where the past system and organizations still survive. In the past, the products and the services of MR's non-railway divisions were almost for its own railway division and employees, but last year the section dealing commodity distribution to employees handled retail sales of provisions to outside customers for the first time and obtained some profit. Hotel operation was also started.

MR has reduced approximately 2,000 persons or about 13% of its total employees for the period from 1991 to 1996. On such an occasion, it was a wise choice that reduction of non-railway service employees was preferred. Later, as the transportation volume began to recover from the bottom in 1994, the number of personnel turned into a slight increase in railway division. Meanwhile, the number of the non-railway service employees still continued to decrease exceeding expansion of the railway service personnel and thus, total number of employees has kept downward trend.

Table 7-1 Number of Employees, Mongolian Railway

Year	Number of Employees			Transportation Volume				Total
				Freight		Passenger		
	Railway	Others	Total	Mil.ton	Mil. Ton-km	Mil. Pass	Mil. P.-km	Mil. p./ton-km
1991	7,023	7,907	14,930	10.2	3,013	2.5	596	3,609
1992	6,654	7,126	13,780	8.5	2,763	2.5	636	3,399
1993	6,654	6,556	13,210	7.8	2,527	2.2	583	3,110
1994	6,581	6,428	13,009	7.1	2,150	2.9	789	2,939
1995	6,636	6,361	12,997	7.3	2,284	2.8	681	2,965
1996	6,709	6,240	12,949	7.5	2,540	3.0	744	3,284
'91/'96	-314	-1,667	-1,981	-2.7	-473	0.5	148	-325

It is considered important to set up a proper manpower plan based upon the suitable number of personnel needed in the railway transportation division in the future, taking into consideration the long-range tendency of transportation demands and the future prospects for introduction of new technologies enabling labor saving. As for non-railway divisions, rationalization and improvement of management seem to be coming to the limit. It is advisable for MR to appeal for separation of social welfare matters for which the government should be responsible.

Other commercial business is just in trial stage, but MR should take up such kind of business positively after checking up the profitability carefully. In the reformation of organizations in October last year, Management and Planning Department was newly established under the direct control of the Chairman. It makes up MR's future plan covering all spheres of its business including non-railway divisions. Good results of its activities are highly expected.

7 – 2 Operating and Management Expenditures

(1) Setting of Expense Items

Classify the operating management expenditures for this project into labor costs and material costs, and set the following eight expense items. Estimate necessary expenses based on the balance sheet of 1995, taking into consideration the price increases until the time investigations are conducted. Where any expense item shown in the financial statement of the MR does not fall in one of the following categories, refer to the financial statement of a similar railway company in Japan.

① General administrative expense: expenses required for operating management of general affairs and accounting departments, including welfare expenses for employees.

② Maintenance management expense: expenses required for the management of the maintenance of track, cars, and communication facilities, including expenses required for management of education and training of employees.

③ Transportation management expense: expenses required for handling of transportation service (railway stations) and expenses required for education and training of employees.

④ Railway maintenance expense: expenses required for maintenance of tracks, structures and other facilities related to maintenance of railways.

⑤ Communication maintenance expense: expenses required for maintenance of electric power, signaling and communication facilities.

⑥ Car maintenance expense: expenses required for inspections, repairs and maintenance of cars.

⑦ Transportation expense: expenses required for transportation of passengers and freight, including salaries and wages for station employees and conductors.

⑧ Operation expense: expenses required for operation of cars including power cost.

(2) Setting of Base Units

Set base units that are considered to be the most appropriate for each expense item. Apply the number of employees to labor cost and the following units to material cost.

① General administrative expense: number of employees

② Maintenance management expense: car travel distance in kilometers

③ Transportation management expense: transportation volume

④ Railway maintenance expense: car travel distance in kilometers

⑤ Communication maintenance expense: train travel distance in kilometers

⑥ Car maintenance expense: car travel distance in kilometers

⑦ Transportation expense: transportation volume

⑧ Operation Expense: transportation volume

Base units were set based on the actual record of operating and management expenses obtained from 1995 financial statement of MR. If any expense item shown does not exactly correspond to the above items, adjustment was made by referring to the financial statement of a similar railway company in Japan. Adjustment to price hike was also made by using 37.8% up of the consumer price index to get base units at the time of investigation.

(3) Calculation of Operating and Management Expenses

Operating and management expenses for the year of 2005, 2010 and 2020 are calculated from base units and the increase from the year 1996 of the number of employees, the transportation volume, car kilometers and train kilometers.

Table 7 - 2 Personnel, Transportation Volume, and Car and Train Travel Distance (km)

Item	Year	1996	2005	2010	2020
Number of Employees		3,590	3,912	4,131	4,279
(Persons)	Increment against 1996		322	541	689
Transportation Volume	Passenger	371	487	541	606
(Million Prs.km)	Increment against 1996		115	169	235
Transportation Volume	Freight	994	1,443	1,700	1,937
(Million ton km)	Increment against 1996		449	706	943
Transportation Volume	Total	1,365	1,930	2,240	2,543
(Million Prs.ton km)	Increment against 1996		565	875	1,178
Car km	Passenger	14,576	14,676	15,940	18,240
(1,000 km)	Freight	34,356	54,456	65,670	84,547
	Total	48,932	69,132	81,610	102,787
	Increment against 1996		20,201	32,679	53,855
Train km	Passenger	1,364	1,364	1,471	1,532
(1,000 km)	Freight	986	1,354	1,565	1,769
	Total	2,350	2,718	3,036	3,301
	Increment against 1996		368	687	951

Table 7 - 3 Base Unit

(Unit : Tugrik)

Expense Cost	Base Unit	
Labor cost	560,560/person	(number of employees)
Material Cost		
General Administrative Expense	11,457/person	(number of employees)
Maintenance Management Expense	0.27/km	(car km)
Transportation Management Expense	6.62/1,000prs.ton.km	(transportation volume)
Railway Maintenance Expense	15.33/km	(car km)
Communication Maintenance Expense	66.02/km	(train km)
Car Maintenance Expense	14.72/km	(car km)
Transportation Expense	732.50/1,000prs.ton.km	(transportation volume)
Operation Expense	53.07/km	(car km)

Table 7 - 4 Operating and Maintenance Expense

(Unit : Million Tugrik)

Item / Year	2005	2010	2020
Number of Employees (persons)	322	541	689
Transportation Volume (million passenger./ton-km)	565	875	1,178
Car Km (1,000 km)	20,201	32,679	53,855
Train Km (1,000 km)	368	687	951
Labor Cost	181	303	386
Material Cost			
General Administrative Expense	4	6	8
Maintenance Management Expense	5	9	14
Transportation Management Expense	4	6	8
Railway Maintenance Expense	310	501	826
Communication Maintenance Expense	24	45	63
Car Maintenance Expense	297	481	793
Transportation Expense	414	641	863
Operation Expense	1,072	1,734	2,858
Total Material Cost	2,130	3,424	5,432
Grand Total	2,311	3,727	5,819
US Dollar Equivalent (1,000 US$)	4,201	6,776	10,579