CHAPTER 5

DEMAND FORECAST

Chapter 5
Demand Forecast

5-1 General

This chapter discusses the method and the results of demand forecast on the railways for the future years of 1996 - 2020. In the following subsection, 5-2, a block chart indicating main works of the forecast is shown together with conditions to be noted. Forecast method is briefed also. Then, statistical data of the socio-economic framework and transport volumes of the country in the past ten years are reviewed, and the forecast is made on the socio-economic framework in the future. In association with this forecast, the nation-wide volumes of all modes are estimated in 5-3 of this chapter. Letting those nation-wide estimates as the control total, growths of classified passengers and cargo volumes on railways are forecast in subsections 5-4 and 5-5. The result is summarized in 5-6, as the link-volumes of the main line and the handling volumes of stations for years in 1995, 2005, 2010, and 2020.

5-1-2 Block chart

A block chart of traffic forecast is shown in Fig. 5-1-1, where the entire forecast analysis is divided into 5 work groups. This chapter is edited in a manner to follow the grouping.

5-1-3 Forecast Conditions

Main Conditions of demand forecast are noted as under:

(1) Forecast Years

Forecast years are determined as 2005, 2010 and 2020, each is the first target year of benefits to be realized by the completion of the staged work plan.

(2) Economy

The economic data of the country are studied by GDP for 1985-95 with its components in constant 1993 prices of the country, and by population of the country in the same past 10 years. The economic development plan in terms of numeric figures by the new government was not shown when the study team was in Mongolia, July - September, 1996. Trend extrapolation, often used in the forecast of other developing countries, is applicable in a limited extent since the country experienced deep chaos and fluctuation of the economy in the early part of the 1990s. The growth of socio-economic framework for the future is determined by the team after review of available data and discussions with Mongolian government agencies concerned.

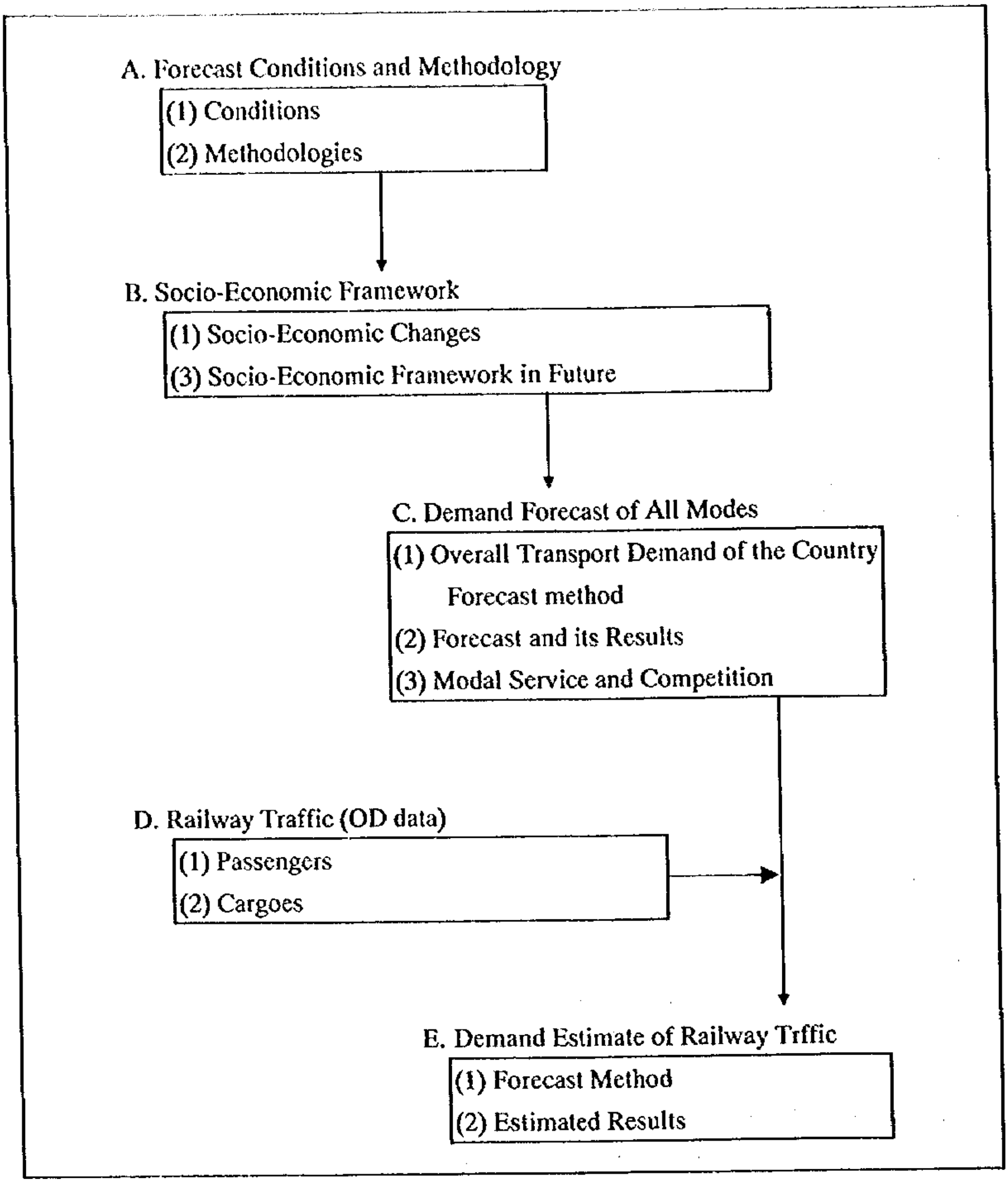


Fig. 5-1-1 Block Chart of Demand Forecast

(3) Nation-Wide Transport Volumes

In relation to the socio-economic data of the country, the transport data used for the estimate are shown for 1985-95 by total volumes in passenger-km, in persons, ton-km and tons which were presented by mode in the statistical yearbook and railway statistics of 1996. Modes in the transport sector are railways, roads, and airlines. Origin destination traffic is studied on railways since they are used in the estimate of link volumes and station handling volumes, while the total is discussed in other modes. Trends of changes in the past ten years were already discussed in the previous chapter.

(4) Classified Transport Volumes

Classified data of volumes transported by railways in 1995 are given by MR in OD tables showing movements of arriving and departing between railway stations. Also transport volumes in the past ten years are shown by MR. They are shown in classified tons and persons as well as in ton-km and passenger-km. The forecast in terms of annual growth rates (% per annum) are made for the total ton-km and passenger-km in each classification. Then these values are used to determine as the control total of the respective OD tables for 2005, 2010, and 2020 used in the analysis of railway traffic. The future OD matrix is developed in 21 zones to have the same summary in passengers and classified tons with the modal control total of passenger-km and ton-km. Since the network has not changed in the past years, both summed up measurements are thought to show similar tendency of increase or decrease.

(5) Transport Network

Main transport networks are railways, roads and airlines shown in Fig. 1-2-1. Those transport modes are not developed yet fully in terms of quantity and service quality. Networks covering the whole country are not developed for the simulation in this study. Only in the main transport corridor, a simple network corresponding to the railway stations are formulated on which the estimated volume can be figured out.

Even in the main corridor in which the railways run through the north to the south, surfaced roads do not extend from the Russian border to the Chinese border. Roads south of Ulaan-baatar are not surfaced and in rough conditions. Competition among the modes are modest as discussed in Chapter 2. Those network and operation conditions are considered likely not change substantially in those forecast years since transport demand is not so intensive and the funds for improvements may be too large to realize within the modest economy of the country.

(6) Urbanization

Available data showing changes in industrial production and population in Aimag from 1990 to 1995 are shown in Appendix 5-8-22. It is found there were no large change in population distribution in terms of Aimag boundary in those years. While industrial output increased in Ulaan-baatar and Orhon areas, they are not appropriate data to indicate concentrated activities in those urban areas. The percent changes by Aimag in those years are summarized as under.

	1990	1995	
Ulaan-baatar & Orhon	%	%	(ratio)
Population	28.8 %	29.5 %	(1.024)
Industries	69.2 %	80.1 %	(1.150)

The growth of trips in those Aimag will increase if the concentration trend continues in the future. This kind of industrial concentration will taper off gradually since the government plans to activate local economy by dispersing industries to rural areas and benefit of agglomeration diminishes when it goes excessively in the economy of Mongolia. The ratio of 1.04, a half of the average ratio of the above figures, is multiplied to the growth factor of Ulaan-baatar station representing the socio-economy in the zones of Ulan-baatar and Orhon for each target year. A half value of 1.02 is adopted to Darkhen station in OD matrices since it is the second largest city. Other rural zones are assumed to increase at the same rate after the adjustment of the above urbanization.

5-1-4 Forecast methodology

A modest but stable economic growth of the economy is assumed which can be represented by GDP and population. Then, a relationship between the GDP per capita and the nation-wide transport volumes is determined up to 2020 in which the annual growth rates of the transport volume by main mode can be calculated for every 5 or 10 years.

Using the rates of increase as the control total, the OD figures by main classification among the railway stations are developed for 2005. 2010 and 2020. Specific consideration is paid to the cargo movements on railways such as export of copper and domestic transport of coal to urban centers and others. Estimated OD trips are assigned on the rail network through which loaded and arriving volumes at each station is calculated, and the link volume from a station to the next is also calculated.

5-2 Forecast of Socio-Economic Framework

5-2-1 Socio-Economic Changes

(1) Changes in the Past

-1.Economy

Mongolian economy was managed by "planning" under the socialist economic system up to the late 1980s in close relationship with the Soviet economy and COMECON. However, in the subsequent several years the economic system has been reformed into the market economic system in which prices, demand and supply are closely correlated to the market mechanism. The country had increased GDP unto 1989 under the socialist system, then restructuring of the economic system started in 1990 and the GDP in constant prices had reduced its scale drastically from 214 bln (1989) to 166 bln (in 1993 prices), a reduction of -23 % in four years in real terms. Then, redevelopment could be seen; the new economic system has shown increases of GDP in 1994 and 1995 with a continuous growth expectable in the future. Fig. 5-2-1 is the map of the country with transport networks of railways, roads, and airports, a duplication of the map at the beginning of this main report.

-2.Sectional Characteristics of the Economy

One unique feature of the economy is found in employment statistics, which was mentioned in Chapter 1. The agri-livestock sector is posted at the first largest sector in the GDP components, and it employs the largest number of workers.

New born of manufacturing activities are urgent need for development. They will participate in export and economic growth. However, there are a number of problems to be solved for development of new subsectors in this direction: education, technical training, energy supply, shortages of foreign funds and of persons with entrepreneurship capable persons, financial market development, and so on. It may require many years to overcome those problems.

Price escalation continues still in recent years. It will deprive sources of development of the country. Policy implementation to reduce the inflation rate are in urgent necessity.

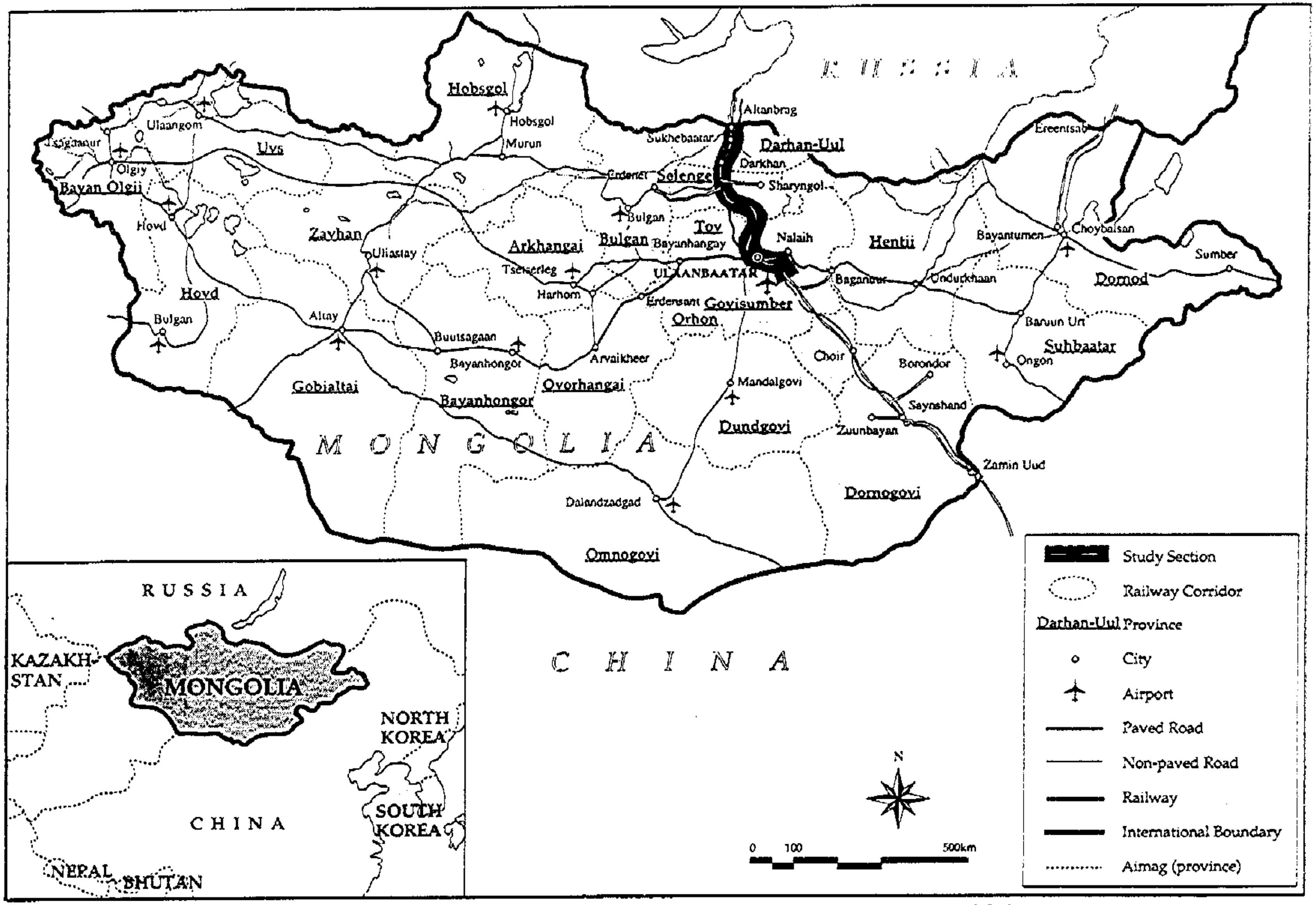


Fig. 5-2-1 Mongolia: Roads, Railways and Airports 1995

It was said the government would announce a new development plan some time in the latter half of 1996, however no numerical economic framework for a long range plan is shown yet. It is said the new plan emphasizes particular development of new manufacturing sub-sectors with export capability to the Asian and European markets. They are, for example, electronics and electric appliances, garment and wool-textile, and others. Improvements of tourism facilities are also given priority in development policies.

(3) Forecast of the Socio-Economic Framework

-1.Examples of Other Developing Countries

In general, economic growth of developing countries can be classified to proceed hopefully the following stages:

1) Chaos of the economy with urgent need to rehabilitate government and infrastructure systems.
2) Economy is in stabilization and indicates growth in private and public sectors.
3) Growth continues as to have accumulation of funds of investment manageable partly or entirely by their own resources. Repayment of loans seems manageable under expanding economic scale.

However, there are many countries which could not move forward its development process as above. Stagnation & collapse of the economy are found in countries which require remedy assistance from the World Bank, IMF and other aid agencies. The following table is the summary of growth for 20 years of developing countries since 1973 for categorized groups.

Both low and middle income countries registered lower growth rates in the second period, while China and India only had a larger rate in the second period. This tendency of reduced growth rate in the long run of developing countries is taken into consideration in the forecast of the Mongolian economy: the averaged annual growth rate would decrease in every five years while the economic magnitude will increase continuously.

Table 5-2-1 Changes in GDP in Summary, 1973-93

(Constant prices of 1987 in mn dollars)

	Country Group	Pop. mn in 1994	GDP per capita 1994 pr.	GDP in mn in Constant dollars of 1987				
				1973	1988	1993	(83/73) ratio p.a.	(93/83) ratio p.a.
A	Low income Conty.	2,085.3	303	185,303	279,280	377,846	1.042	1.031
B	China & India	2,104.5	434	228,019	376,855	775,282	1.052	1.075
C	Middle income Count	1,077.7	1,670	1,715,373	2,485,212	2,876,154	1.038	1.015
D	Total of A.B.C	5,267.5	635	2,128,695	3,141,347	4,029,282	1.040	1.025

Source: World Tables 1995 (world Bank, 1995) and World Social Indicators of Development, 1996 (World Bank, 1996)

Notes : Low income countries (upto $725) are 62 in total, and middle income ones ($726..$2895) are 67 .

5-2-2. Socio Economic Framework in Future

(1) GDP

Mongolia has suffered from chaos and inflation in the process of economic reform since late 1980s. It is expected the economy would not reduce the magnitude anymore since it has shown some recovery in 1994 and 1995. In July 1996, the new government has been formulated. Its basic policies are said to indicate the following directions.

1) Slowdown the inflation and keep balances in the government budgets.
2) Encourage the development of export oriented sectors: manufacturing and tourism by mobilizing local and foreign resources.
3)Improve social infrastructures to support regional economic production and distribution, and so on.

However, the followings are constraint characteristics of the economy which would rather lead to a modest growth rate of the economy in the future.

1) Magnitude of the domestic market with a population of 2.3 million is modest and is not large enough to attract many new businesses from other countries. Consequently participation in the free world market is in urgent necessity, with which new sector may find enough demand and competition.
2) Agri-livestock sector is of prime importance in the country, but it cannot expand the grass area physically for livestock raising since virgin land to be developed remains little. Productivity of land and technology should be improved to expand output which would support the population depending on livestock raising, however the growth will be not high as can be seen in other subsectors.
3) Mineral output (copper, fluorite, gold, etc.) is said to maintain the current export volume. Foreign demands on those products have registered not stable in price and volume in the recent years, indicating difficulty of having a sustained growth prospect.
4) Education and technical training for the employees in manufacturing and various service sectors are absolute necessity, but it will take a long period to see favorable results.
5) Considering above constraints and global tendency of developing countries, the economic growth is assumed as under:

(Period)	(Growth rate for the period)	
1995 - 05	4.5 % p.a.	(a growth ratio of 1.55)
2005 - 10	4.0 % p.a.	(a growth ratio of 1.22)
2010 - 20	3.75 % p.a.	(a growth ration of 1.44)

(2) Population

The population of the country was 2.3 million in 1995. The growth rate was 2.5 % p.a. in the years of 1980 - 1985 and 2.3 % p.a. in 1985 - 1995. The growth rate has shown a gradual decrease and this tendency is likely to continue in the future. An estimate is determined by referring to the forecast data of Statistics Office of Mongolia. The estimate in the study is shown under:

	(In '000)	(Average Growth per annum)
1995	2293.9	
		2.0 %
2005	2830.6	
		1.6 %
2010	3067.4	
		1.2 %
2020	3457.2	

(3) GDP per capita

GDP per capita in constant 1993 prices are estimated by calculating GDP divided by population in respective future years. The socio-economic framework shown in three indices are summarized in Table 5-2-2, together with the averaged annual ratio of increase between the selected future years. Traffic demand in the future years are estimated by setting formulas related to GDP per capita which can represents the forecast figures of those socio-economic framework..

Table 5-2-2 Socio-Economic Framework of the 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	1.020 ↓	180775	1.045 ↓	78.8	1.023 ↓
2005	2831	1.016 ↓	280739	1.040 ↓	99.2	1.023 ↓
2010	3067	1.012 ↓	341562	1.038 ↓	111.4	1.025 ↓
2020	3457		493571		142.8	

Notes: The sign of + in 1989 means increases from 1985, and that of - means decreases from 1985.

5-3 Demand Forecast of All Modes

5-3-1 Overall Transport Demand of the Country

(1) Forecast Method

A flowchart summarizing demand forecast steps of all modes are in Fig. 5-3-1. Chronological changes of cargoes transported in ton-km volumes by mode from 1985 to 95 are shown in Fig. 5-3-2 A, in which the curves indicate decreases in transport volume after 1989/90.

1) Also Fig. 5-3-2 B shows the representative case of the relationship between the GDP per capita and the transport volumes on railways for the same period, in which the curve indicates reduction both GDP per capita and transport demand of cargo on railways. Both transport volume and GDP per capita went down from 1989 to 1993 in this example. They showed a recovery in 1994 and 1995. If the socialist planning economic system is maintained, growths in transport volume would be upward in parallel or similar to the line of reduction in Fig. 5-3-2 B since there is no charge in the background economy. However, transport demand in the new market mechanism will be different and the demand line will go up any direction in the first quadrant depending on the nature of cargo to be transported. The line "forecast" in Fig. 5-3-2 B is placed to have a half extent of the slope of "reduction" but moving upward, under the assumption that transport volume will be different but grow in the new developing economic system in the future. The slope is also different among transport modes and categories. In each category the slope is determined by regression analysis with the data in 1989-93/94, whose parameters are examined and decided what are to be used in the future. Details are in Appendix 5 of this chapter.

2) However, when changes of transport volumes in some categories during the reforming period 1989-93/94 were in substantially large or in modest change and not adequate to use the regression analysis for the estimate of demand in the future, the half slope degree assumption is not adopted. Instead the forecast slope in the future is decided separately by taking in consideration those factors shown under:

- Demand in domestic or international market
- Production plan and other factors
- Adoption of growth forecast in other categories

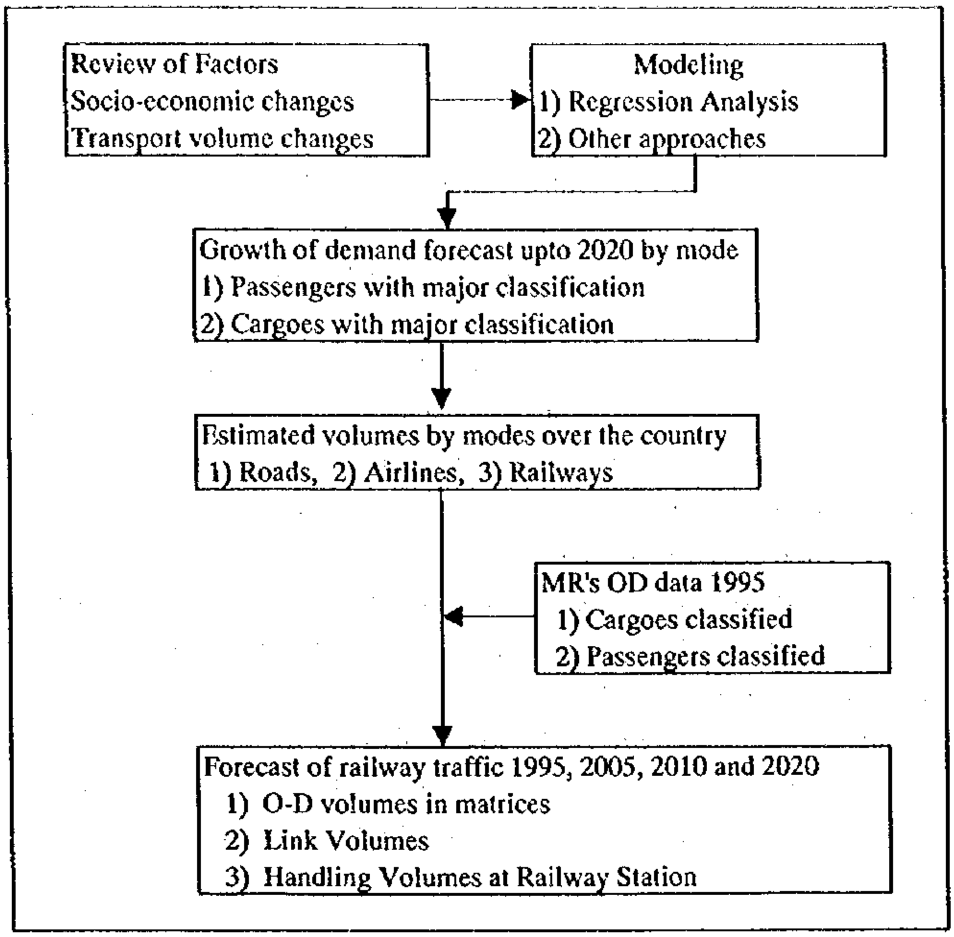


Fig. 5-3-1 Flowchart of Demand Estimate on Transport Models

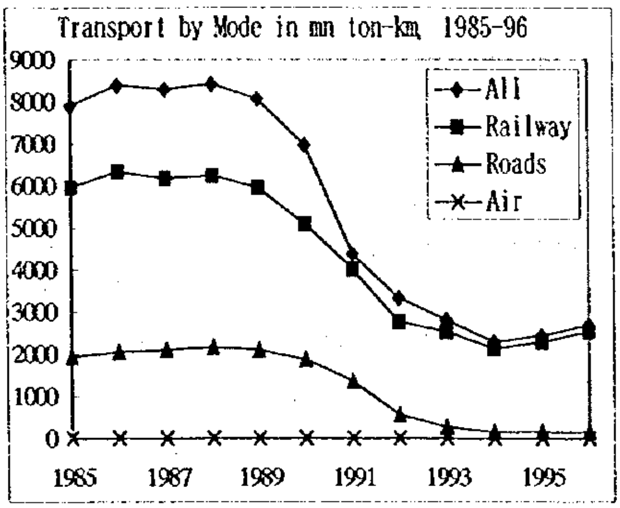


Fig. 5-3-2 A

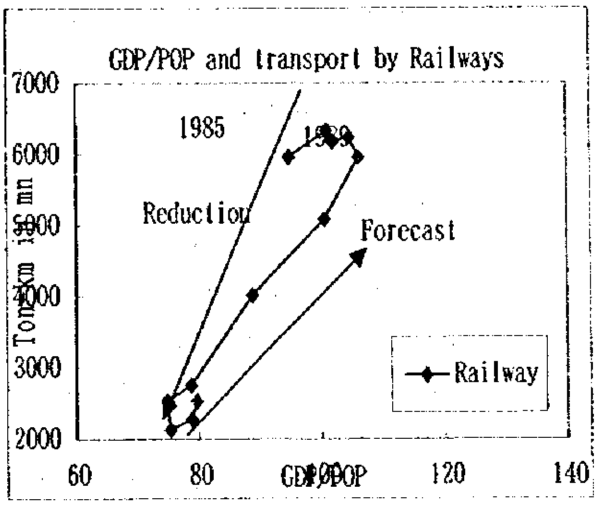


Fig. 5-3-2 B

Fig. 5-3-2 Changes in the Past, 1985-95

(2) Passengers

1) Roads

a) It should be noted domestic passenger-km on railways had increased through the years from 1989 to 1995, while those on roads and airlines decreased in the same period. Traditionally the socialist government of Mongolia had controlled buses not to compete on the surfaced road sections against the railways from Ulaan- baatar to Altanbrag at the Russia border. This policy seems maintained at present, although irregular private bus service is coming in and take part in competition with railways in this corridor. Unfortunately, no data are available of those private movement. Under the same competition restraint policy no regular air-flight is in operation from Ulaan-baatar to cities along the railways. The growth of domestic rail passengers has been thus protected in modal competition.

b) Road Transport volumes are reviewed in the ton-km data, vehicle registration, and petrol import data. Traffic counting conducted in August 1996 indicates a 8% growth per annum from 1993 between Ulan-baatar and Russian boarder of 340 km paved roads; vehicles registered increased by 10% per annum for 1987-96. Considering that a half of the above rates (1/2*(10+8)) would be rather in short term tendency, a 5% per annum growth rate is used for years unto 2005, 4% to 2010, and 3 % to 2020 for the cases of cargoes and passengers. The forecast figures are in Table 5-3-1.

2) Airlines

Air transport of cargo and passengers reduced the volume in 1989-95. The service is influenced by windy climate, cold winter and other factors. Under the circumstances a 2 % per annum rate is assumed for years to 2010 for cargoes and passengers and 1% per annum beyond 2011. The forecast figures are In Table 5-3-1.

3) Passengers on Railways

a. Domestic

Volumes of passengers did not decrease during the reform years. Passengers on the railway increased from 407.9 mn pass-km (1989) to 601.4 mn pass-km (1995). The above figures indicate 6 % per annum growth in those years. For the future a half of it, 3 %, is used for the forecast domestic passenger movement from 1996 to 2005. Then, 2 % for 2005 - 2010 and 1 % for 2010 - 2020 are assumed.

b. Going Out

The volumes of movement are influenced by the market in Russia and China. They decreased from 83.5 mn pass-km (1989) to 46.0 mn pass-km (1995), indicating an average reduction rate of -9.4 % per annum. However, cultural and economic relationship with Russia and China need be strengthened for the development of the country. Demand for business, trade, tourism, study abroad, etc. are thought to increase at an approximated reversal of a half of 9.4%; the annual average growth of 5 % for years 1996 - 2005 and 4 % for 2005 - 2010, and 3 % for 2010 - 2020.

c. Coming In

They are much dependent on the development of GDP in Mongolia. Data of passenger movement showed a large fluctuation such as 51.7 mn pass-km (1989) to 24.2 mn pass-km (1995), an average rate of -14 % per annum. Transport volumes in those years are hard to use for the estimate in the coming years. For example, if a half of it 7% is used for the growth rate, it is thought too high compared to other categories. For this group the same rates of increase of domestic passengers are adopted.

d. Transit

Cargoes and passengers in this category depend on the socio-economy of outside foreign countries. International train operation of Russia and China in the past years showed the volume decreased unto 1995. It is assumed no change in the future years.

e. Passengers in Total

Passenger-km in total on railways are in Table 5-3-1. Average rate of increase will be 3% per annum for 1995-05, 2% for 2005-10 and 1% for 2010 - 20.

Table 5-3-1 Passenger-km Summaries for 1995-2020

	1995	2005		2010		2020	
	Pass-km	Pass-km	Ratio 05/95	Pass-km	Ratio 10/05	Pass-km	Ratio 20/10
1. Railways							
Domestic	601.4	808.2	1.34 (1.03)	892.3	1.10 (1.02)	985.7	1.11 (1.01)
Going Out	46.0	74.9	1.63 (1.05)	91.2	1.22 (1.04)	122.5	1.34 (1.03)
Come in	24.2	32.5	1.34 (1.03)	35.9	1.10 (1.02)	39.7	1.11 (1.01)
Transit	9.4	9.4	1.00 (1.00)	9.4	1.00 (1.00)	9.4	1.00 (1.00)
Total	681.0	925.0	1.31 (1.03)	1028.8	1.14 (1.02)	1157.3	1.11 (1.01)
2.Road in mn pass-Km							
Roads	424.3	691.2	1.63 (1.05)	841.0	1.22 (1.04)	1130.2	1.34 (1.03)
3.Air in mn Pass-Km							
Air System	320.2	390.3	1.21 (1.02)	430.9	1.10 (1.02)	476.0	1.11 (1.01)
Total mn pass-Km	1425.5	2006.5	1.41 (1.04)	2300.7	1.15 (1.03)	2763.5	1.20 (1.02)

Ratio : Upper figures are ratio of increase from the previous year

: Lower ones in ( ) means the average annual rate of increase.

(3) Cargoes

1) Roads

Statistical transport data on roads by cargo trucks are scarce. As in the previous sub-section of 1) Roads in (2) Passengers in Table 5-3-1, the growth of overall road traffic was assumed applicable also in cargo transport. The forecast is shown In Table 5-3-2.

2) Airlines

The growth forecast of passengers on airlines are described in 3) Airlines of (2) Passengers In Table 5-3-1. The same rate is adopted for cargo traffic on the airlines and shown in Table 5-3-2.

3) Railways

a. Domestic Other Cargoes

They had a large decrease from 4,613 tons (1989) to 1,005 (1994) and a small increase in 1995. A regression analysis was conducted with data in those years and parameters are calculated. A growth line is assumed to have a half degree of the slope of the regression line as discussed in Appendix 5-3. The result is that transport volumes of this category by MR will increase by 6% up to 2005, 4% per annum up to 2010 and 2% per annum up to 2020. The results are in Table 5-3-2.

b. Coal

The master plan study of the coal industry development was conducted by JICA which shows a plan for years up to 2010. The plan is utilize in this forecast, being summarized also in Appendix 5-2. The total coal transport volume by railways will increase two times in the years, 1995-2010. The average rate of increase is tabulated to have mostly the same figure as in a. other domestic cargo above. Table 5-3-2 shows the forecast for the domestic demand of cargoes including the coal.

c. Export

Copper and Fluorite

The export is subdivided to copper and others, where the copper category includes fluorite mines to Russia.. Possibility of production expansion of copper was examined in various sources, but as the main markets in Russia and China are unstable and no definite plan was identified. Price fluctuation of copper is notorious, and a long term investment plan of those mines are yet drafted. The export is assumed to grow by a modest constant rate from the 1995 level in this study, although statistical data showed reduced outputs since 1990 to 1995.

Others

Export of others showed a steady reduction of volume in 1990 - 1994, and a modest increase in 1995. The market spreads outside the country among which the majority is Russia followed by China. The growth of miscellaneous cargoes is assumed to grow at rates same as outgoing passengers. Table 5-3-2 shows the total of copper and others.

d. Import

Import commodities showed reductions in similar way as registered in 1989 - 94. They are related to GDP/POP and regression analysis is conducted. The process is briefed in Appendix 5-4. The estimated volumes are also in Table 5-3-2.

e. Transit

Operation of transit trains is determined either by Russian railways or by Chinese one, which made us difficult to forecast. Travel through Mongol are assumed no change.

Table 5-3-2 Freight ton-km Summaries by model for 1995-2020

		1995	2005		2010		2020	
		Ton-km	Ton-Km	Ratio 05/95	Ton-Km	Ratio 10/05	Ton-Km	Ratio 20/10
1. Railway	Domestic	1271.9	2162.2	1.70	2616.2	1.21	3046.5	1.17
				(1.06)		(1.05)		(1.02)
	Import	322.0	547.7	1.70	642.0	1.17	725.4	1.10
				(1.06)		(1.03)		(1.01)
	Export	541.3	640.0	1.19	711.0	1.10	888.1	1.20
				(1.02)		(1.02)		(1.02)
	Transit	148.6	148.6	1.00	148.6	1.00	148.6	1.00
				(1.00)		(1.00)		(1.00)
Total		2283.8	3498.5	1.53	4117.8	1.17	4808.6	1.17
				(1.05)		(1.04)		(1.01)
2.Road	Road Transport	152.9	249.1	1.63	303.0	1.22	407.2	1.34
				(1.05)		(1.04)		(1.03)
3.Air	Air Transport	4.5	5.5	1.22	6.1	1.10	6.7	1.11
				(1.02)		(1.02)		(1.01)
4.Total		2441.2	3753.1	1.53	4426.9	1.17	5222.5	1.13
				(1.05)		(1.03)		(1.01)

Ratio : Upper figures are ratio of increase from the previous year

: Lower ones in ( ) means the average annual rate of increase.

4) Others

Domestic cargo movement can be classified as coal and others, where the coal occupies 80% of the domestic cargo movement in tons in 1995 and 96(Ap Table 2-2-4.) The coal transport demand is estimated by referring to "Coal Development Master Plan", and the estimate of transport by MR is described in Appendix 5-2. "Transport Rehabilitation Project (Transurb & Hickling, 1995), a study supported by the World Bank, was reviewed also. These two studies have no substantial difference in the summary of the forecast volume, and the former is quoted in this study.

Export of copper and fluorite mines are assumed no change since they did not fluctuate largely in recent years and demand from Russia and China are hard to determine.

Production companies wish to maintain the current output level for some years and are not likely to speak out a long range development plan under the present circumstances.

5-3-2 Results of the Forecast

(1) Passengers

In summary passenger movements on three modes are forecast to grow by 4% per annum up to 2005, 3% up to 2010 and 2% up to 2020. A stable demand increase at a 3% per annum for passenger service by railways is expectable for the future 1995-05; 2% for 2005 - 2010 and 1% for years 2010 - 2020. Table 5-3-3 is the summary of the overall passenger movements by three modes.

(2) Cargoes

In summary cargo movements on three modes are forecast to grow by 5% per annum up to 2005, 3% up to 2010 and 1% up to 2020. All cargo transport demand on railways will increase by 5 % p.a. up to 2005 and 4 % p.a. up to 2010 and 3% p.a. up to 2020. Table 5-3-3 is the summary of the overall cargo movements by three modes.

Table 5-3-3 Summary of Demand Forecast by Modes, 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 47.8% (1.03)	424 29.7% (1.05)	320 22.4% (1.02)	1,426 100% (1.04)
2005	925 46.1% (1.02)	691 34.4% (1.04)	390 19.4% (1.02)	2,007 100% (1.03)
2010	1029 44.7% (1.01)	841 36.5% (1.03)	431 18.7% (1.01)	2,301 100% (1.02)
2020	1,157 41.9% (1.00)	1,103 39.9% (1.00)	476 17.2% (1.00)	2,764 100% (1.00)

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 93.5% (1.05)	153 6.3% (1.05)	4.5 0.2% (1.02)	2,441.5 100% (1.05)
2005	3,499 93.2% (1.04)	249 6.6% (1.04)	5.5 0.1% (1.02)	3,753.0 100% (1.03)
2010	4,118 93.0% (1.03)	303 6.8% (1.03)	6.1 0.1% (1.01)	4,427.0 100% (1.01)
2020	4,809 92.1% (1.00)	407 7.8% (1.00)	6.7 0.1% (1.00)	5,223.0 100% (1.00)

5-3-3 Modal Service and Competition

Current status of modal competition and supplementary service of roads and railways in the country's transport system were discussed in Chapter 2. The spatial distribution of services network indicates rather supplementary relationship each other than modal competition. The corridor from Ulaan-baatar to Altanbrag has paved road of 350 km and railways of about 400 km in which modal split can occur. Fig. 5-3-3 is a conceptual spatial distribution of roads and railways, a duplicated presentation of Fig. 2-2-4. The following are points to be noted:

a. Passengers

Regular daily bus service of two round trips are nominally in operation between Ulaan-baatar and Darkhan, while there are four trains each way to Darkhen and Sukhu-baatar. It is said people prefer the railways with larger capacity, regularity, comfort and safety. No other official regular bus service are admitted on the corridor, while private service buses are running in non-regular frequency daily. Fees per passenger are shown in Appendix 5-8-20 for comparison. Rail fares are found lower than busses for longer distances more than 200 km according to this comparison.

b. Cargoes

There are no specific regulation of truck service on roads. When the vehicle owner agrees with the fee and other conditions with the cargoes consignor, they can go any cities. The nominal freight charges by truck and the railways shown by MOT are in Appendix 5-8-21 which also indicates substantially lower fees of railways. But, actual fares negotiated with private truck owners are hard to know. Rail cargoes often require supplementary transport by vehicles to/from the station, but those disadvantageous transfer cost and time are not shown explicitly in volumes by statistical data.

c. Forecast in Modal Competition

The current transport service in the corridor seems advantageous for the railway service. However, it is likely private vehicle ownership increases along with the normalization of the economy, and the nation-wide service depends on road network. though volumes are modest. These factors are considered in the growth forecast of overall rail and road transport, in which no drastic reduction of rail transport share is considered. The main reason is that, the coal has to depend on rail service because of bulky volume, poor road facility and cost efficiency. Changes of the share in the country can tabulated as shown in Table 5-3-4.

There will be a lot of problems to be solved if possibilities of international direct haulage by vehicles are considered. Problems are, for example, customs procedure, axle weight limit, traffic rules, and so on. No direct international vehicle road transport is assumed in this study.

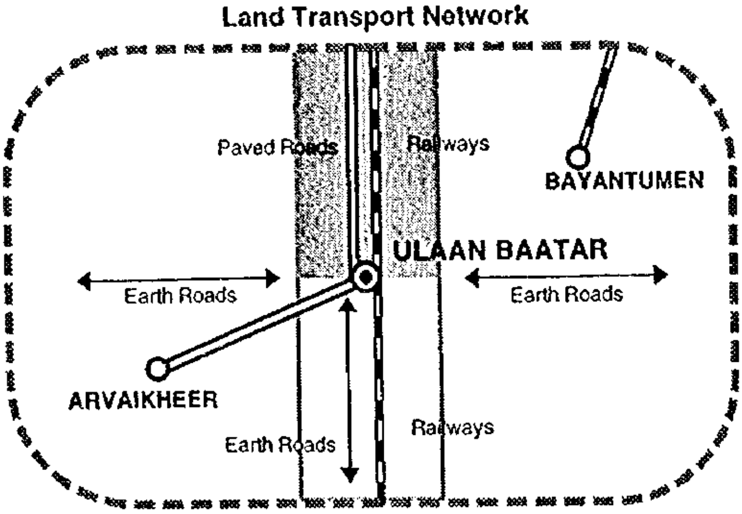


Fig. 5-3-3 Spatial Distribution of Modal Service

Table 5-3-4 Modal Share between Railways and Roads

	1995		2005		2010		2020	
	Rail	Rds	Rail	Rds	Rail	Rds	Rail	Rds
Passenger Pass-km (%)	681.0 (62)	424.3 (38)	925.0 (57)	691.6 (43)	1,029.0 (56)	841.0 (45)	1,157.0 (51)	1,103.0 (49)
Cargo Ton-km (%)	2,284.0 (94)	152.9 (06)	3,499.0 (93)	249.3 (07)	4,118.0 (93)	304.1 (07)	4,809.0 (92)	407.0 (08)

5-4 Railway Traffic (OD data)

Aimag zones are grouped to the representative railway station, which are 21 in total, being coded in Table 5-4-1.

Table 5-4-1 Representative Station and Zone

	Railway Station	Zone	Stations codes included in Chapter 6
1	0	Russia, etc.	00
2	10	Sukhe-baatar	1 - 5
3	70	Darkhen	6 - 8
4	71	Sharingol	A1
5	90	Salkhit	9 - 10
6	91	Erdenet	B1-B6
7	130	Zuumharaa	11 - 14
8	170	Mandal	15 - 17
9	220	Tolgoit	18 - 22
10	221	Songino	C1-C2
11	230	Ulaan-Baatar	23 - 25
12	270	Bayan	26 - 28
13	310	Bagakhangai	29 - 32
14	311	Baganuur	E1-E3
15	350	Choir	33 - 37
16	390	Airag	38 - 39
17	391	Borondor	F1
18	410	Sain shand	40 - 42
19	411	Zuun-bayan	G1
20	450	Zamin-uud	43 - 45
21	460	China	46

5-4-1 Passengers

The files of passengers in 1995 was not edited and those in the beginning six month of 1996 are available in MR. They are edited in an origin and destination table and adjusted to the total passenger volume of 1995. The total of this consolidated O-D tables in 1995 showed a movement of 2.58 million persons being classified in Table 5-4-2.

Table 5-4-2 Passengers OD Summaries on Railways for 1995-2020

(In persons)

	1995	2005		2010		2020	
	Persons	Persons	Ratio 05/95	Persons	Ratio 10/05	Persons	Ratio 20/10
Domestic	2,427,932	3,264,374	1.34 (1.03)	3,604,382	1.104 (1.02)	3,983,520	1.105 (1.01)
Going Out	62,281	101,451	1.63 (1.05)	123,434	1.22 (1.04)	165,885	1.34 (1.03)
Coming in	82,965	111,498	1.34 (1.03)	123,105	1.104 (1.02)	135,982	1.105 (1.01)
Transit	8,468	8,468	1.00 (1.00)	8,468	1.000 (1.00)	8,468	1.000 (1.00)
Total	2,581,646	3,385,791	1.31 (1.03)	3,859,389	1.140 (1.02)	4,293,855	1.105 (1.01)

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

5-4-2 Cargoes

Mongolian railways have a computerized file of movements of cargoes among the stations. It is said the filing firstly completed with data of cargo in 1995. They are summarized and edited here to the movements of origin and destination among the representative 21 stations on the main line in a format of spread sheets. The movements on the eastern section are excluded because they are outside of this project study. The volumes of movements are summarized in Table 5-4-3, where the total cargoes carried in 1995 was 7.3 million tons.

Table 5-4-3 Freight OD Summaries on Railways for 1995-2020

(In '1,000 tons/ year)

	1995	2005		2010		2020	
	1,000 tons	1,000 tons	Ratio	1,000 tons	Ratio	1,000 tons	Ratio
Domestic	5,460.3	9,265	1.70 (1.06)	11,185.0	1.20 (1.05)	12,646.0	1.17 (1.02)
Coal	4,340.5	7,367	1.70 (1.06)	8,822.0	1.20 (1.04)	9,704.0	1.10 (1.01)
Others	1,119.8	1,898	1.70 (1.06)	2,363.0	1.20 (1.05)	2,942.0	1.24 (1.02)
Import	868.6	1,476	1.70 (1.06)	1,771.0	1.20 (1.05)	2,007.0	1.13 (1.01)
Petrol	328.3	591.0	1.80 (1.06)	726.0	1.23 (1.05)	864.0	1.18 (1.02)
Others	540.3	885.0	1.65 (1.06)	1,045.0	1.18 (1.05)	1,143.0	1.10 (1.01)
Export	845.4	1,009.0	1.19 (1.02)	1,100.0	1.10 (1.02)	1,277.0	1.17 (1.01)
Copper & F	585.8	586.0	1.00 (1.00)	586.0	1.00 (1.00)	586.0	1.00 (1.00)
Others	259.6	423.0	1.63 (1.05)	514.0	1.22 (1.04)	691.0	1.34 (1.03)
Transit	133.8	133.8	1.00 (1.00)	133.8	1.00 (1.00)	133.8	1.00 (1.00)
Total	7,308.1	11,883.8	1.53 (1.05)	14,189.8	1.22 (1.04)	16,063.8	1.13 (1.01)

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

5-4-3 Demand Forecast of Railway Transport

(1) OD data by station are summarized to the representative stations by classified passengers and cargoes. Using the estimated growth ratios by commodity type, the matrix of 1995 is expanded into the future years by using the Fratar method.

(2) Train speeds are assumed to have no change in the future even with the completion of the projects. The project scale is planned modest in cost at each spot. The cost in economic study does not include other improvement concepts such as purchase of locomotives and rolling stock, construction to dual carriageways, improvements of signal, and station facilities.

(3) The summary of the categorized forecast, being classified in Table 5-4-2 and 5-4-3, is made equal to the forecast total of overall passenger-km and ton-km since the growth ratios in Tables 5-3-1 and 5-3-2 are used to produce trip tables in spread sheet.

5-4-4 Estimated Results

The estimated total volumes of each OD table in passenger trips and cargoes in tons are summarized in Table 5-4-4. In the case of cargoes the annual averaged growth rate of all categories are 5 % per annum unto 2005, 4 % per annum upto 2010 and 1 % per annum upto

2020. In the passenger volumes, 3 % per annum upto 2005, 2 % per annum upto 2010, and 1 % per annum upto 2020. A main reason of the difference comes from the larger growth rate of coal transport in the first stage.

The link volume between the railway stations is shown in Appendix Table 5-8-23 and the volume of departure and arrival by station are in Appendix Table 5-8-24. Fig. 5-4-1 is the visual presentation of link volume estimates for selected years from 1995 and 2020, (Ap Table 5-8-23) through which it is found cargo tons would increase by the minimum 65%, the maximum 167% and the average by 93% for 15 years upto 2010. Passenger volumes by link suggest increases by 47% to 68% and the average by 50%, in the same period. Fig. 5-4-2 shows the total of departure and arrival of passengers and cargo by station in 1995 and 2020 (Ap Table 5-8-24).

Table 5-4-4 Link Volume between the Stations, Passengers and Cargoes, 1995-2020

A. Passengers

Direction			N to S				S to N				Total			
Year			1995	2005	2010	2020	1995	2005	2010	2020	1995	2005	2010	2020
Link		km	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000
Project sections	00 - 10	18	67.5	89	97.9	107.7	64.2	101.9	123.1	163.9	131.7	190.9	221.0	271.6
	10 - 70	104	217.8	289.9	318.8	350.8	262.8	365.0	411.0	477.5	480.6	654.9	729.8	828.3
	70 - 90	30	300.1	401.4	442.1	487.5	272.8	378.4	425.7	492.0	572.9	779.8	867.8	979.5
	90 -130	74	440.5	590.6	651.2	718.7	393.3	539.5	602.8	685.9	833.8	1130.1	1254.0	1404.6
	130-170	83	547	736.7	814.3	900.9	563.5	772.3	862.2	975.1	1110.5	1509.0	1676.5	1876.0
	170-220	81	558.7	752.7	832	920.6	606.6	831.2	927.6	1048.0	1165.3	1583.9	1759.6	1968.6
	220-230	7	572.5	771.6	853.1	944.0	696.8	954.1	1064.4	1200.2	1269.3	1725.7	1917.5	2144.2
	230-270	48	305.1	408.1	449.8	496.2	358.4	479.5	528.2	582.5	663.5	887.6	978.0	1078.7
Non-project sections	270-310	59	276.1	368.5	405.7	447.2	354.3	473.8	521.8	575.3	630.4	842.3	927.5	1022.5
	310-350	140	221.1	294.8	324.5	357.5	299.6	400.4	440.9	486.0	520.7	695.2	765.4	843.5
	350-390	103	195.7	260.6	286.7	315.8	272.9	364.5	401.2	442.1	468.6	625.1	687.9	757.9
	390-410	124	174.7	232.3	255.5	281.3	256.5	342.2	376.6	417.7	431.2	574.5	632.1	699.0
	410-450	235	149.1	197.9	217.5	239.2	213.4	284.5	312.9	344.5	362.5	482.4	530.4	583.7
	450-460	2	6.6	7.6	8.9	10.5	23.9	31.0	33.7	36.8	30.5	38.6	42.6	47.3
Project aver.in1,000persons		445	376.0	504.4	556.6	614.7	392.2	538.7	602.3	685.5	768.1	1043.1	1158.9	1300.2
Oth Sect aver.in1,000persons		663	186.1	247.7	272.5	300.0	260.0	347.1	382.0	421.6	446.1	594.8	654.5	721.6
All Sect. aver.in1,000persons		1108	262.9	351.5	387.3	427.3	313.4	424.6	471.1	528.3	576.3	776.1	858.4	955.6

B. Cargoes

Direction			N to S				S to N				Total			
Year			1995	2005	2010	2020	1995	2005	2010	2020	1995	2005	2010	2020
Link		km	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000	Total '000
Project sections	00 - 10	18	908.9	1458.1	1725.6	1944.9	631.9	666.7	686.6	724.9	1540.9	2124.8	2412.1	2669.8
	10 - 70	104	980.5	1575.3	1873.5	2145.4	714.1	889.6	962.3	1031.9	1694.5	2464.8	2835.8	3177.3
	70 - 90	30	1837.5	2471.6	2871.4	3339.1	717.6	929.3	1016.0	1092.5	2555.1	3400.9	3887.4	4431.6
	90 -130	74	1412.8	1893.0	2208.4	2605.6	483.9	879.3	1052.9	1181.6	1896.7	2772.3	3261.3	3787.2
	130-170	83	1398.8	1886.7	2203.8	2604.9	510.2	930.6	1115.3	1246.8	1909.0	2817.3	3319.1	3851.6
	170-220	81	1408.6	1903.6	2224.9	2631.9	542.8	988.7	1184.3	1323.5	1951.4	2892.3	3409.2	3955.3
	220-230	7	1271.2	1699.8	1987.5	2380.4	946.1	1994.4	2434.3	2725.9	2217.3	3694.2	4421.9	5106.3
	230-270	48	488.8	715.1	843.5	1044.9	3502.9	6543.1	7946.4	8759.2	3991.6	7258.2	8789.9	9804.0
Non-project sections	270-310	59	473.3	688.3	810.3	1003.7	3510.3	6556.7	7959.8	8774.1	3983.6	7245.0	8770.1	9777.8
	310-350	140	500.4	730.6	861.4	1061.8	563.2	1604.9	1972.9	2180.5	1063.6	2335.5	2834.3	3242.3
	350-390	103	548.2	1036.8	1248.1	1477.9	285.0	385.2	438.4	491.6	833.2	1422.0	1686.5	1969.5
	390-410	124	463.9	716.3	845.9	1034.5	186.9	307.3	373.2	437.9	650.8	1023.5	1219.1	1472.4
	410-450	235	420.5	599.4	701.1	874.6	93.6	151.7	179.5	196.5	514.1	751.0	880.6	1071.1
	450-460	2	347.2	475.7	547.5	686.1	93.8	151.3	179.1	196.0	441.0	627.0	726.6	882.1
Project aver.in '000 tons		445	1233.3	1737.1	2036.8	2385.3	914.0	1522.0	1794.4	1976.1	2147.3	3259.1	3831.2	4361.4
Oth Sect aver.in '000tons		663	465.5	708.0	835.6	1025.9	539.0	1089.9	1323.7	1467.0	1004.5	1797.9	2159.3	2492.9
All Sect. aver.in '000tons		1108	775.9	1124.1	1321.3	1575.5	690.6	1264.6	1514.0	1672.8	1466.5	2388.7	2835.3	3248.4

Section	TOTAL BOTH DIRECTIONS ('000 pass) 1995	2005	2010	2020	TOTAL OF BOTH DIRECTIONS ('000 tons) 1995	2005	2010	2020
00 Ruslan Side – (International Border) – 10 Sukhe-baatar	131.7	190.9	221.0	271.6	1540.9	2124.8	2412.1	2669.8
10 Sukhe-baatar – 70 Darkhan (71 Sharyn-gol)	480.6	654.9	729.8	828.3	1694.5	2464.8	2835.8	3177.3
70 Darkhan – 90 Salkhit (91 Erdenet)	572.9	779.8	867.8	979.5	2555.1	3400.9	3887.4	4431.6
90 Salkhit – 130 Zuunharaa	833.8	1130.1	1254.0	1404.6	1896.7	2772.3	3261.3	3787.2
130 Zuunharaa – 170 Mandal	1110.5	1509.0	1676.5	1876.0	1909.0	2817.3	3319.1	3851.6
170 Mandal – 220 Tolgoit (221 Songino)	1165.3	1583.9	1759.6	1968.6	1951.4	2892.3	3409.2	3955.3
220 Tolgoit – 230 ULAAN-BAATAR	1269.3	1725.7	1917.5	2144.2	2217.3	3694.2	4421.9	5106.3
230 ULAAN-BAATAR – 270 Bayan (Nalaikh)	663.5	887.6	978.0	1078.7	3991.6	7258.2	8789.9	9804.0
270 Bayan – 310 Bagakhangay (311 Baga-nuur)	630.4	842.3	927.5	1022.5	3983.6	7245.0	8770.1	9777.8
310 Bagakhangay – 350 Choir	520.7	695.2	765.4	843.5	1063.6	2335.5	2834.3	3242.3
350 Choir – 390 Airag (391 Borondor)	468.6	625.1	687.9	757.9	833.2	1422.0	1686.5	1969.5
390 Airag – 410 Sain-shand (411 Zuun-bayan)	431.2	574.5	632.1	699.0	650.8	1023.5	1219.1	1472.4
410 Sain-shand – 450 Zamyn-uud	632.5	482.4	530.4	583.7	514.1	751.0	880.6	1071.1
450 Zamyn-uud – (International Border) – 460 China Side	30.5	38.6	42.6	47.3	441.0	627.0	726.6	882.1

Fig 5-4-1 Link Volumes of Main Line for Future Years

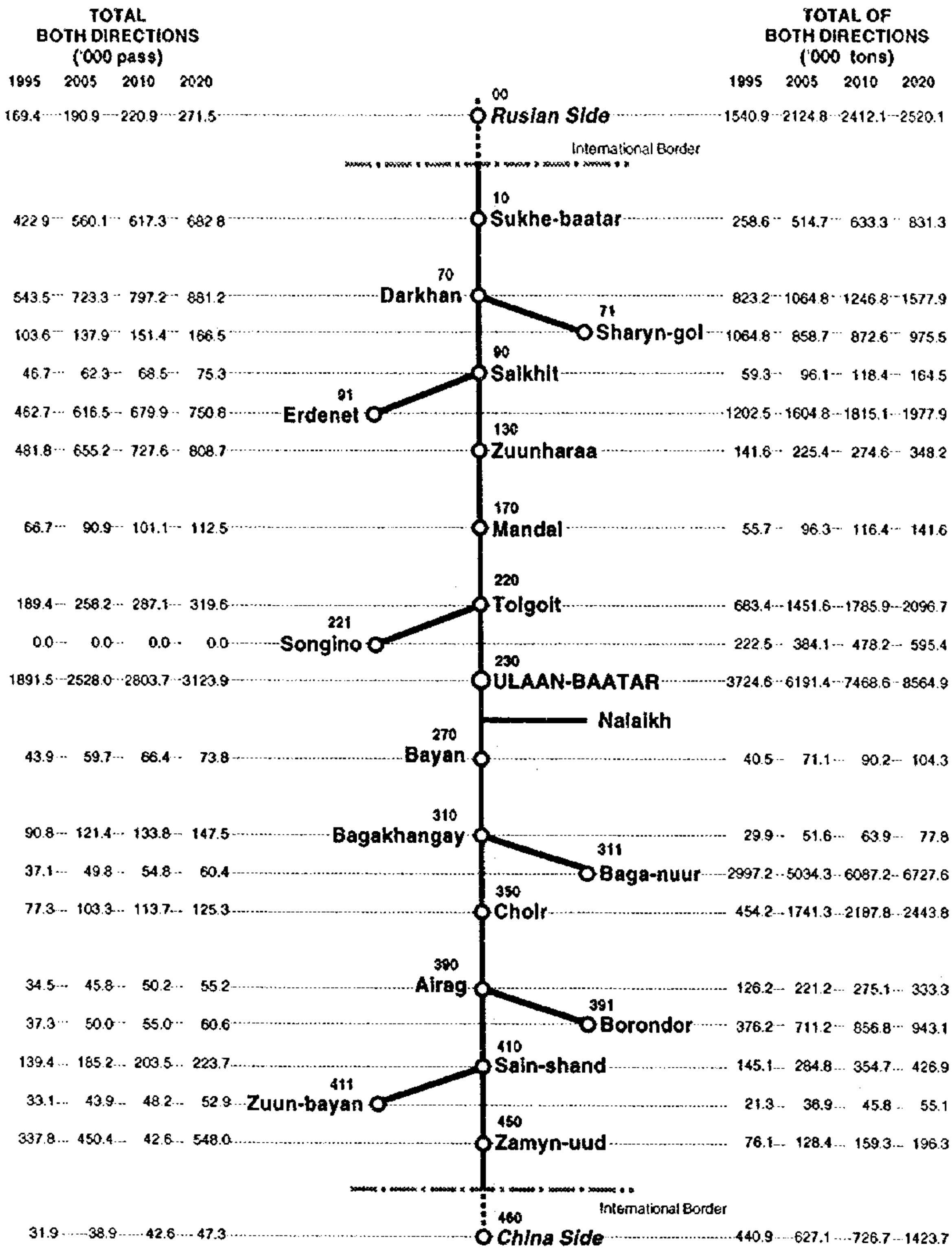


Fig. 5-4-2 Handling Volumes by Railway Station for Future Years

CHAPTER 6

TRANSPORT AND ROLLING STOCK PLANNING

Chapter 6
Transport and Rolling Stock Planning

6–1 Existing Traffic Conditions

(1) Railway line and Layout of Stations

The Mongolian Railway (MR) lines include the 1,108 km main line from Sukhe-baatar on the Mongolian-Russian border to Zamyn-uud on the Mongolian-Chinese border. Other rail lines include branches from the main line, as shown in figure 6–1, and other lines located in the eastern part of the country. Commercial distance of all lines is 1,805 km (including the lines on the two borders).

On the main line there are 45 general stations or passenger stations (interchange stations, sidings). The number of general stations handling freight totals 25. The average distance between stations is 25 km, and there are 40 between-station stops . All these stations, including 14 stations on branch lines, are under the control of eight major stations.

The number of employees at all stations, except for those at branch lines in the east, totals approximately 1,470.

(2) Passenger Traffic

1) Changes in Passenger Traffic Volume

The passenger traffic volume decreased briefly in 1993, as shown in Table 6–1, but it was increased in 1995 to 110% that of 1991. The average annual number of passengers is 2.83 million. Domestic traffic passengers number 2.63 million, or 93% of the total traffic volume. The average trip distance is 240 km.

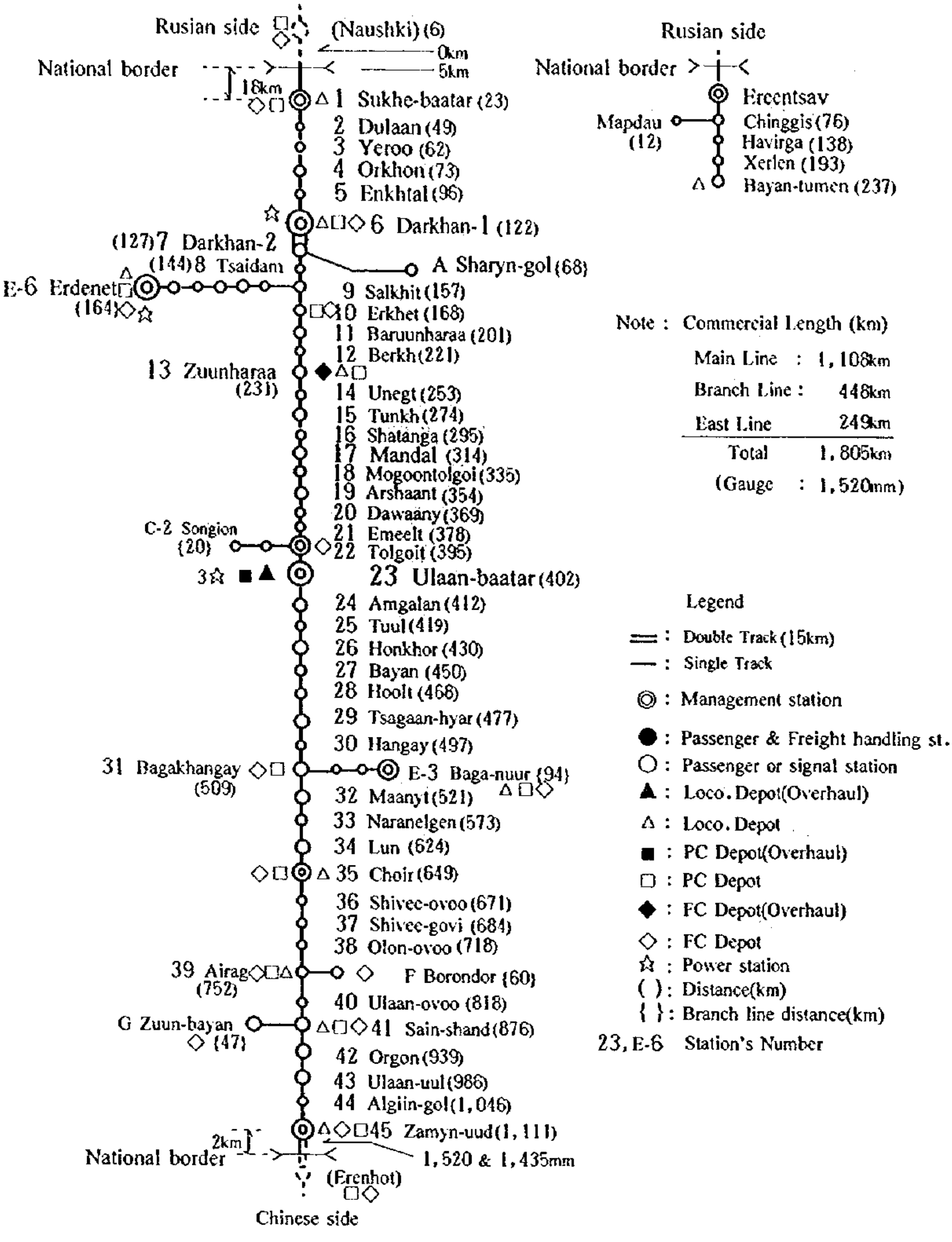


Fig. 6-1 Railway Line of Mongolian Railway

Table 6 - 1 Transition of Passenger traffic volume

#	Year			1991	1992	1993	1994	1995	%
A1	No. of passenger (×1000 person)	Arive	from Russia	105.3	123.1	98.2	96.3	61.5	2.2
A2			from China	11.6	24.2	41.6	48.7	22.7	0.8
A3			Total	116.9	147.3	139.8	145	84.2	3.0
A4		Depert	to Russia	194.9	171.8	138.0	117.7	60.9	2.2
A5			to China	42.1	46.1	57.1	38.8	39.6	1.4
A6			Total	237.0	217.9	195.1	156.5	100.5	3.6
A7		Transit	to Russia	13.8	17.9	10.5	6.8	4.1	0.1
A8			to China	27.3	17.9	10.2	8.9	4.4	0.2
A9			Total	41.1	35.8	20.7	15.7	8.5	0.3
A10		Domestic		2,141.3	2,170.3	1,893.4	2,567.4	2,634.3	93.2
A11	G.Total			2,536.3	2,571.3	2,249.0	2,884.6	2,827.5	100.0
	Traffic volum (%)			100	101	89	114	111	
B1	person・km (mill. km)		Come in	45.3	55.1	46.8	53.8	24.2	3.6
B2			Go out	96.4	94.2	85.3	58.5	46.0	6.8
B3			Transit	45.5	39.9	23.0	17.4	9.4	1.4
B4			Domestic	409.1	447.0	427.6	659.1	601.4	88.3
B5			Total	596.3	636.2	582.7	788.8	681.0	100.0
	person・km (%)			100	107	98	132	114	
C	Average travel km		(km)	235.1	247.4	259.1	273.5	240.8	
D	Train-km		(1000 km)	2,220	2,159	2,193	2,310	2,439	
E	Car - km		(mill km)	24.1	22.0	22.9	24.2	25.6	
F	Loco.total km		(1000 km)	2,311,534	2,237,118	2,251,633	2,378,676	2,574,145	
G	Loco.Train km		(mill km)	2,252	2,188	2,211	2,334	2,518	
H	Loco.operat days		(days)	4,359	3,812	3,495	3,822	4,337	
J	Loco.-km/day/Loco.		(km/day)	516.6	574.0	632.5	610.7	580.6	
K	Aver.Formation		(car/train)	10.9	10.2	10.4	10.5	10.5	
L	Used No. of Loco.		(Loco./day)	12	10	10	10	12	

Notes: Based on the data of the MR
C=B5/A11, J=G*1000/H, K=E*1000/D, L=H/365

2) Boarding Efficiency and Rolling Stock Utilization

Passenger cars are operated in 14 formations (184 carriages), as shown in Appendix 6–1 From the boarding efficiency of 1995, it can be seen there were no trains in excess of 100% and the average efficiency was 80%. Traffic fluctuation against the annual average traffic volume was recorded as being 81% in April and 119% in August.

Trains are operated without significant delays, even if the route is affected by frequent floods. Delays were not recorded for 860 trains per month, or 93% of the total 1994 monthly average of 930 trains. The average delay time for the delayed trains was 9 minutes. However, an average delay of 16 minutes was recorded in August (refer to Appendix 6–5).

(3) Freight Traffic

1) Changes in Freight Traffic Volume

Freight traffic volume decreased in 1995 to 71% of the volume in 1991. Domestic traffic amounts to 75% of the total. Domestic freight of 5.46 million tons includes 4.35 million tons of coal, or 80% of the total, followed by copper ore, and petroleum products. Copper ore is exported to Russia from Erdenet, and petroleum products are imported from Russia and distributed to various places of the country. Since only petroleum tank cars are allowed to enter into Russia, MR cars are used for this purpose. Russian freight cars are used for the export and import of goods to and from Russia.

Table 6 - 2 Transition of Freight traffic volume

#	Year			1991	1992	1993	1994	1995	%
A1	Traffic	Domestic	Coal	4,910	4,698	4,541	4,330	4,351	59.4
A2	volume		Others	2,203	1,195	1,073	1,011	1,109	15.1
A3	(×1000ton)		Total	7,113	5,893	5,614	5,341	5,460	74.5
A4		Inter-national	Export	1,707	1,372	993	879	862	11.8
A5			Import	1,281	943	946	886	869	11.9
A6			Transit	169	309	303	171	134	1.8
A7			Total	3,157	2,624	2,242	1,936	1,865	25.5
A8		G.Total		10,270	8,517	7,856	7,277	7,325	100.0
	Traffic volume (%)			100.0	82.9	76.5	70.9	71.3	
B1	Traffic	Domestic	Coal	1,145	1,100	1,107	1,000	1,011	44.3
B2	ton-km		Others	452	249	191	225	261	11.4
B3	(mill.ton.km)		Total	1,597	1,349	1,298	1,225	1,272	55.7
B4		Inter-national	Export	761	687	490	477	541	23.7
B5			Import	468	382	404	259	322	14.1
B6			Transit	187	344	336	190	149	6.5
B7			Total	1,416	1,413	1,230	926	1,012	44.3
B8		G.Total		3,013	2,762	2,528	2,151	2,284	100.0
	ton-km (%)			100.0	91.7	83.9	71.4	75.8	
	Average traffic km		(km)	293	324	322	296	312	
C	Train-km		(1000 km)	3,387	2,970	3,217	2,301	2,399	
D1	Car - km	Loaded	(1000 km)	63,448	54,357	47,061	39,778	43,360	
D2		Empty	(1000 km)	47,819	40,863	37,015	31,453	32,313	
D3		Total	(1000 km)	111,267	95,220	84,076	71,231	75,673	
E	Loco.total km		(1000 km)	5,140,295	4,369,782	4,075,417	3,694,602	3,782,219	
F	Loco.Train km		(1000 km)	4,195	3,603	3,350	3,008	3,072	
G	Loco.operat days		(days)	13,495	9,720	8,033	7,431	7,552	
H	Loco..-km/day/loco.		(km/day)	310.9	370.7	417.0	404.8	406.8	
J	Used No.of Loco.		(Lo./day)	37	27	22	20	21	
K	Average Formation		(car/train)	33	32	26	31	32	
L	No.of loaded cars		(car/train)	19	18	15	17	18	
M	No.of empty cars		(car/train)	14	14	12	14	13	

Notes : Based on the data of the MR

H=F*1000/G, J=D3/C, L=D1/C, M=D2/C

2) Transport Efficiency of Freight Train

The average number of freight cars used is 1,500 per day. The number of loaded cars is 830 per day. Thus, empty car ratio is around 43%.

The number of turnaround days that represents transport efficiency of freight cars is 4.3 days (refer to Appendix 6–7).

Empty car ratio is approximately 40% for the main line and 50% for the branch lines, according to the operating record of freight trains (from July 20 to 26, 1996), classified into the main and branch lines (assumed that is mainly used for exclusive freight trains). Load factor per wagon is assumed to be 80% for the main line and 90% for the branch lines (see Tables 6–3 and 6–4).

Traffic fluctuation of freight trains per month reaches nearly 120% of the annual average in winter months, from November through March, but tends to drop in the summer to 80% (refer to Appendix 6–7)

Table 6 - 3 Empty car ratio per Freight train &Load factor per Freight car (Main Line) (1996.7.20~26)

Date		Transport (km)	Load (ton)	Total (ton)	Loaded (Wagon)	Empty (Wagon)	Total (Wagon)	Emp.ratio %	Load factor %
7.20	Sat	4,460	26,038	43,277	490	183	673	27.2	77.7
21	Sun	4,010	29,754	53,356	596	358	954	37.5	75.0
22	Mon	5,431	37,129	65,941	688	441	1,129	39.1	81.6
23	Tue	5,468	29,752	62,468	507	601	1,108	54.2	87.9
24	Wed	4,811	31,798	57,505	593	507	1,100	46.1	82.1
25	Thu	4,680	25,911	51,150	549	478	1,027	46.5	79.9
26	Fri	5,396	31,297	55,887	870	334	1,204	27.7	75.1
Ave rage		4,894	30,240	55,655	613	415	1,028	39.8	79.9

Table 6 - 4 Empty car ratio per Freight car train & Load factor per Freight car (Branch Line) (1996.7.20~26)

Date		Transport (km)	Load (ton)	Total (ton)	Loaded (Wagon)	Empty (Wagon)	Total (Wagon)	Emp.ratio (%)	Load factor (%)
7.20	Sat	2,518	13,227	22,312	200	176	376	46.8	93.5
21	Sun	848	4,581	8,085	75	74	149	49.7	85.3
22	Mon	2,295	8,576	16,467	126	202	328	61.6	101.9
23	Tue	1,652	11,090	17,397	162	87	249	34.9	98.4
24	Wed	1,618	5,804	11,383	115	124	239	51.9	76.8
25	Thu	2,163	8,688	17,432	131	226	357	63.3	95.2
26	Fri	2,584	14,985	23,130	222	180	402	44.8	90.7
Ave rage		1,954	9,564	16,601	147	153	300	50.4	91.7

Coal, which accounts for 80% of the total domestic traffic volume, is carried mainly by dedicated trains from Baga-nuur to Ulaan-baatar. (2~4 round trips/day)

The coal mine in Baga-nuur has a production capacity of 15 thousand tons per day at present, and a further increase in production is possible. The coal from this mine is all carried by the railway to the power stations in Ulaan-baatar.

In Ulaan-baatar, there are the Second, the Third, and the Fourth Power Stations. The largest one is the Fourth Power Station which consumes 5,000 to 9,000 tons of coal per day by itself.

The volume of coal which can be stored at each power station is equivalent to the volume consumed in 2 to 4 days. Since coal transport for the power stations is entirely dependent on the railway, it can be said that the railway is playing an important role in energy supply in Ulaan-baatar.

The hauling capacity and operating time of freight trains are shown in Appendix 6-8.

(4) Number of Trains Operated

In order to meet the passenger transport demand, two kinds of passenger trains are operated : trains operated every day ; and those operated specific days of the week. All of the freight trains are irregular trains operated depending upon the transport demand. According to the survey on actual results in July 1996, the number of freight trains operated is as shown in Table 6-5.

The section with the largest number of passenger trains operated is the single-track parallel section between Darkhan-1 and Darkhan-2. The total number of passenger and freight trains on the section is 20 to 26 per day.

Although there are established diagrams, the cases where freight trains are operated just as scheduled in the diagrams are rare except exclusive trains. Freight trains are mostly operated according to the volume of collected freight to be carried.

A section with many freight trains operated is the section between Ulaan-baatar and Bagakhangay where coal is carried. On this section, 8 to 13 freight trains are operated per day, and the total number of passenger and freight trains is 17 trains per day.

Table 6-5 Number of Passenger and Freight trains by Section

(Sukhe-baatar~Zamin-uud : Up and Down Total/day)

Station		1 SB – 6 Da1	6 Da1 – 7 Da2	7 Da2 – 9 Sa1	9 Sa1 – 17 Man	17 Man – 23 U.B.	23 U.B. – 29 Tsa	29 Tsa – 31 Bag	31 Bag – 35 Choi	35 Choi – 39 Aira	39 Aira – 41 Sain	41 Sain – 45 Z.U
1	PC	8	16	12	9	11	5	5	4	2	2	2
Mon	FC	5	10	10	5	5	10	9	4	5	4	3
Total		13	26	22	14	16	15	14	8	7	6	5
2	PC	7	14	10	8	10	4	4	4	4	3	4
Tue	FC	8	9	11	8	9	9	8	3	4	2	4
Total		15	23	21	16	19	13	12	7	8	5	8
3	PC	6	13	9	7	9	4	4	3	3	4	4
Wed	FC	4	6	6	7	7	8	4	5	4	2	3
Total		10	19	15	14	16	12	8	8	7	6	7
4	PC	6	14	10	8	10	8	8	7	5	5	4
Thu	FC	5	8	8	4	8	8	8	5	7	4	2
Total		13	22	18	12	18	16	16	12	12	9	6
5	PC	6	13	9	7	9	4	4	4	4	3	4
Fri	FC	7	7	7	6	7	13	13	8	7	3	3
Total		13	20	16	13	16	17	17	12	11	6	7
6	PC	7	14	10	8	10	4	4	3	3	4	4
Sat	FC	6	4	4	8	9	8	9	3	2	4	3
Total		13	18	14	16	19	12	13	6	5	8	7
7	PC	7	14	10	8	10	7	7	5	5	5	4
Sun	FC	6	6	8	5	6	3	2	1	4	4	2
Total		13	20	18	13	16	10	9	6	9	9	6
Average		12.6	21.1	17.6	14.0	17.1	13.6	12.7	8.4	8.4	7.0	6.6

Note: Number of passenger trains are based on the timetable (1996.5.15~10.1) of MR.

Number of Freight Trains are based on the train operation surveying of one week from 1996.7.20.

(5) Operating Time

Operating time required for major passenger trains and freight trains between sections is as shown in Appendix 6-6.

(6) Business and Fare System

1) Business System

The responsibilities for work-site operations are shared by the station staff, who sell passenger tickets and handle freight. Passenger tickets for those who board trains from stops without attendants are handled by passenger conductors.

2) Fare and Charge Systems

Fare and charge systems are classified into international rates and domestic rates that comprises basic fares and additional charges, including the use of sleepers.

Basic fares are classified into soft seat fares and the hard seat fares (equivalent to first and second classes) on a declining metered rate system. An additional charge is imposed for the use of a sleeper (two-bed or four-bed). International fares and charges are determined separately by Russian and China, and are shown in Swiss francs 1US$=1.46 SwF=450 Tug as of August 1996). For example, fares Ulaan-baatar - Mosskow are paid according to travel distance in each country (the second class fare : Mongolia = 396 km : 17.55 SwF, Russia = 5,908 km : 73.13 SwF). Sleeper charges are paid to the country that owns sleeping cars used (at the rate of 72.04 SwF for the second class 4-bed sleeper).

Domestic freight fare is classified into consolidation cargo and exclusive use of the car. Nineteen different fares are provided for the exclusive use of car, including containers, depending on the type of goods and distance.

International freight fare is also roughly classified into three categories. The fare is agreed upon based on the distance. A special transshipment charge is added to the basic fare for all goods passing through Zamyn-uud on the Mongolian-Chinese border (refer to Appendix 6-9).

(7) Operational Safety System

Operational safety facilities such as the "block system" and the "signaling system" that composes the operational safety system are old, but have reached a highly advanced level. The maximum speed of trains is limited to 90 km/hr for passenger trains (revised on June 1,1997) and 80 km/hr for freight trains.

The block system is non-automatic, but is a "tokenless block system." As track circuits are laid out without breaks within stations, the tokenless block system is highly advanced.

The signaling system uses the colors of G (proceed aspect) -Y (caution aspect) - R (stop aspect) in a multiple-color light signal system that operates as one of the speed control signal systems.

The interlocking system is a total control type relay interlocking system on the main line, except for the electric interlocking system that handles turn-outs on site at Zamyn-uud station in the south. The permissible train speed at entering stations is 70 km/h (increased from 50 km/h on June 1,1997) for main tracks and 25 km/h for sub-tracks. The interlocking system allows the concurrent entry of trains, but it can be assumed that this system is not particularly dangerous because the effective length of tracks is long.

Automatic train stop (ATS) has not been provided as an operational safety system, but the operation of locomotive by engine drivers is strictly regulated and radios are effectively used for communication with the stations.

The operational safety system is highly advanced as an integrated system because radios are used together with shunting indications for shunting of cars.

At level crossings in urban areas, total barrier or semi-barrier level crossing signals are installed. Great efforts are taken to prevent railway accidents, with fences installed along the entire railway to prevent the entry of livestock and watchmen assigned at some sites to prevent disastrous damage.

(8) Traffic Control System

The traffic control system is maintained by a dispatching engineer, two train dispatchers (one each for north and the south), and a locomotive dispatcher assigned at the dispatching room (on 12-hour shifts). A centralized telephone (direct call to all stations) is provided in the dispatching room. The train diagram covers a 24-hour time period from 17:00 to 17:00. Actual diagram is based on the operation plan prepared by the dispatcher. However, train dispatchers keep records of the train diagram based on telephone information received from all stations. This practice could become very difficult if the number of trains increases. Therefore, preliminary control mission to regulate train operations and proper judgment can be spoiled when the number of trains increases significantly in the future.

(9) Track Capacity

Existing railway lines are all single track, except for the double-track sections at Darkhan–I (122 km) and Darkhan–II (127 km). Estimations of track capacities are not used to determine maximum values, but rather standard values. It can be presumed from a rough estimation that, at present, there are no significant sections that could become a problem. The method of obtaining track capacity by the MR is similar to that of the Japanese railway companies (JR). Rough estimation of track capacities is shown in Appendixes 6–10 and 6–19 together with the number of operated trains.

Track capacity is obtained by the following equations.

MR method: $$N = \frac{(1{,}440 - 60) \times 0.96}{T_1 + T_2 + t}$$

Where, N = track capacity,

60 = maintenance time interval,

0.96 = track utilization ratio,

T_1 = maximum operating time of odd number freight trains between stations,

T_2 = maximum operating time of even number freight trains between stations,

and t = blocked handling time (5 minutes).

JR method: $$N = \frac{1{,}440 \times f}{T + t}$$

Where, f = track utilization ratio (0.6 as a standard),

T = average operating time between stations,

and t = blocked handling time (3 minutes but 1.5 minutes as specified by JR companies).

Hauling capacity of freight trains is specified for each section. It is 1,400 tons for 18‰ of the sections, but increases to a maximum of 4,500 tons for other sections. When hauling capacity is specified, balancing speed for sections with grades can become a problem. This can be estimated to be about 20 km/h, both for the passenger trains and freight trains from the performance of locomotives being used (2M62) (refer to Appendix 6–11).

(10) Operating Accidents

Operating accidents including derailments, have tended to decrease, with 1993 as a peak. The number of accidents is shown in the three categories of serious accidents, moderate damage, and slight carriage failure (refer to Appendix 6–12). Serious collision accidents occurred eight times in the past six years. Category II rolling stock derailments and accidents due to signal negligence occurred 85 times, and minor operating incidents occurred 190 times at an annual average. The rate of accidents, including derailments, averages approximately

0.27 per every million kilometers for the past six years, which is not a significant accident rate.

Table 6 - 6 Number of Operating Accident & Incident

	1990	1991	1992	1993	1994	1995	Total
I Train derailment etc.	0	1	1	2	3	1	8
II Wagon derailment etc.	83	76	84	85	98	81	507
III Loco. breakdown etc.	79	90	216	283	247	222	1,137
Total	162	167	301	370	348	304	1,652

6 - 2 Condition of Existing Rolling Stock and Depots

(1) Passenger Cars and Coach Depots

1) Specifications and Number of Passenger Cars

The number of passenger cars in service totals 233, as shown in Table 6 7, most of which include sleepers. These include 30 new cars which were purchased in 1996.

Table 6-7 Passenger car's Specification (PC)

Type / Item	Sleeping (4pers.)	Sleeping (4pers.)	Dining	Seat (Urban)	Seat	Goods	Mail	Special	Total
Number of Car	123	9	6	7	73	10	2	3	233
Maker's name	East Germany			Russia				E. G. & Ru	
Max. speed(km/h)	160			120	160		120	160	
Number of seat	2/36	2/18, 28	{43}	1/68	2/54, 81	[2/2]	[1/1]	{2/9}	
Weight(ton)	56	56	66	54	54	51	52	54	
Height(mm)	43, 500								
Width (mm)	3, 134								
Length(mm)	23, 950{Coup ler:24, 540}								
Age of Car 30~				7		2	2		11
〃 25~29	2				10	1	0		13
〃 25~29	10	3	1		4	2		1	21
〃 25~29	27	4	1		5	1		2	40
〃 25~29	18		3		37				58
〃 25~29	66	2	1		17	1			90

Notes: Compiled on the basis of data provided by the MR
2/36:2 Staff & 36passengers
[2/2]: 2Staff & 2beds

2) Coach Depot and Its Operation

The coach depot is located at the Ulaan-baatar station. Passenger cars are periodically inspected based on the inspection and repair standards. Strengthening and expansion of the existing inspection and repair shop is under way by the MR. Major overhaul is normally performed in Russia.

Maintenance cycle of passenger cars is shown in Table 6-8 and the track layout for the coach depot is shown in Appendix 6-13(1). The number of employees assigned at the Ulaan-baatar coach depot totals approximately 1,100, including inspectors and conductors (80 personnel).

Table 6 - 8 Passenger car's Maintenance Cycle

Kind of inspection	Required Days	Maintenance Cycle		Remarks
		Domestic Train	International	
Overhaul	22 days / car	5 years	4 years	Ulaan-baatar & Russia
Yearly Maintenanc	8 days / car	1 years	1 years	Important parts
Technical Maintenanc	8hours / car	6 months	6 months	
Daily Inspection	-	daily	daily	On departure at main station

(2) Freight Cars and Wagon Depot

1) Specifications and Number of Freight Cars

There are ten different types of freight cars. Major specifications are shown in Table 6–9.

Table6–9 Freight Wagon's Specification (FC)

Type / Item	Gondla	Box	Flat	Container	Tank Fuel	Tank Water	Hopper Cement	Hopper Gravel	Dump	Freez	Total
No. of wagon	1,591	367	116	70	36	10	87	198	27	11	2,513
Maker's name	Russia										
Max. speed:km/h	100~120 km/h					120	~120	120		100	
Pay load :ton	60~70	60:68	60:70	60~68	50:68	60	62:65	65	60	40	
(Average)	68.0	66.4	64.6	65.7	58.5	60.0	64.8	65.0	60.0	40.0	
Car weight:ton	21~24	22:27	21:22	21~24	25	24.5	23	23	27	32	
(Average)	22.3	23.9	21.1	23.1	25	24.5	23	23	27	32	
Axle load :ton	22.6	22.6	21.4	22.2	20.8	21.1	21.9	22.0	21.8	18.0	
Height (mm)	2,365	2,860	500	400	2,510	2,380	2,390	2,380	970	2,390	
Width (mm)	2,918	2,764	2,870	2,870	3,260	2,620	3,155	3,155	3,210	2,670	
Length (mm)	12,750	15,724	13,350	18,400	11,194	13,000	9,620	9,620	10,610	13,070	
Age of car30~	65										76
〃 20~29	342	57	21								420
〃 15~19	497	132	52				7	49			737
〃 5~14	387	178	43	20	19		80	149	27		903
〃 0~ 4	300			50	17	10					377

Notes: Compiled on the basis of data provided by the MR.

2) Wagon Depot and Its Operation

The freight car inspection and repair shop is located at Zuunharaa (231 km) where all freight cars are inspected and repaired. An track layout of the wagon depot is shown in Appendix 6–13(2). Maintenance cycle is shown in Table 6–10. The number of employees engaged in inspection and repair of freight cars totals nearly 500, including inspectors assigned to the Zuunharaa Wagon Depot (nearly 160) and those assigned to 26 stations (for inspection of passenger and freight cars). For freight trains, conductor attendance system has been omitted. Thus, brake-vans are not coupled any more.

Table 6 - 10 Freight car s Maintenance Cycle

Wagon Type	Depot (Maintenance by Year)		Workshop (Overhaul)
	Newly purchased	After overhaul	After Overhaul
Box wagon	3 years	2 years	12 years
Gondola wagon	3 years	2 years	12 years
Flat wagon	3 years	2 years	12 years
Tank wagon	3 years	2 years	13 years
Dump wagon	2 years	2 years	10 years
Hopper wagon	3 years	3 years	15 years

(3) Locomotives and Locomotive Depots

1) Specifications and Number of Locomotives

There are three different types of locomotives in service. Gauge size is 1,520 mm for all cars. Typical load curves of locomotives, models 2M62 and GE, are shown in Appendix 6-11.

Table6-11 locomotive's Specification

Item Type	2M62	M62	TEM2	GE	Total
Number of Loco.	64	13	28	2	107
Maker's name	Russia			U. S. A.	
Max. speed (km/h)	100	100	100	120	
Wheel Diam. (mm)	1, 050	1, 050	1, 050	1, 050	
Weight (ton)	240	120	120	135	
Axle load (ton)	20	20	20	22. 5	
Wheel arrange.	2*C-C	C-C	C-C	C-C	
Power (HP)	4, 000	2, 000	1, 200	3, 000	
Height (mm)	4, 615	4, 615	4, 915		
Width (mm)	2, 950	2, 950	3, 080		
Length (mm)	34, 800	17, 400	16, 970		
Age of Loco. 26~					
〃 21~25			5		5
〃 16~20	4		6		10
〃 11~15	35		13		48
〃 6~10	25	13	4		42
〃 0~ 5				2	2

Notes: Compiled on the basis of data provided by the MR.

2) Locomotive Depots and Their Operation

The main locomotive depot is located at Ulaan-baatar station. Inspection and repair equipment is being augmented and improved. Track layout of the depot is shown in Appendix 6 13(3). Daily level inspections are also performed at branch depots at Sukhe-baatar and Sain-shand, but major overhauls are performed in Russia. The typical maintenance cycle for locomotives is shown in Table 6-12. The number of employees at locomotive depots totals approximately 1,400, including Ulaan-baatar (730 personnel) and the nine branch depots. Approximately 600 locomotive engine drivers and assistants are included in the above number.

Table6-12 Locomotive's Maintenance Cycle

Kind of Inspection	Place	Maintenance Cycle		Remark
		2M62	TEM2	
TO-2	MR	24~36Hrs (2Hrs)	2days (2Hrs)	Check electric devices, bogie brake by observation.
TO-3		1.2mill-km (36Hrs)	2months (18Hrs)	Check and adjust above devices.
TP-1		5mill-km (36Hrs)	6months (36Hrs)	Inspect and repair of main parts such as engine etc.
TP-2		15mill-km (17days)	17months (6days)	Detailed inspection and repair of main parts.
TP-3		30mill-km (19days)	3years (9days)	Perfect repair of main parts.
KP-1	Russia	75mill-km	6years	Overhaul
KP-2		150mill-km	12years	Overhaul

Note: Numbers in parentheses indicate time required for inspection and repair.

6 - 3 Transportation Related Organizations and Systems

(1) Freight Transportation Department

The organization and employment system of the Freight Transportation Department are as shown in figure 6–2. Work-site operation departments mainly control stations and freight coach depots.

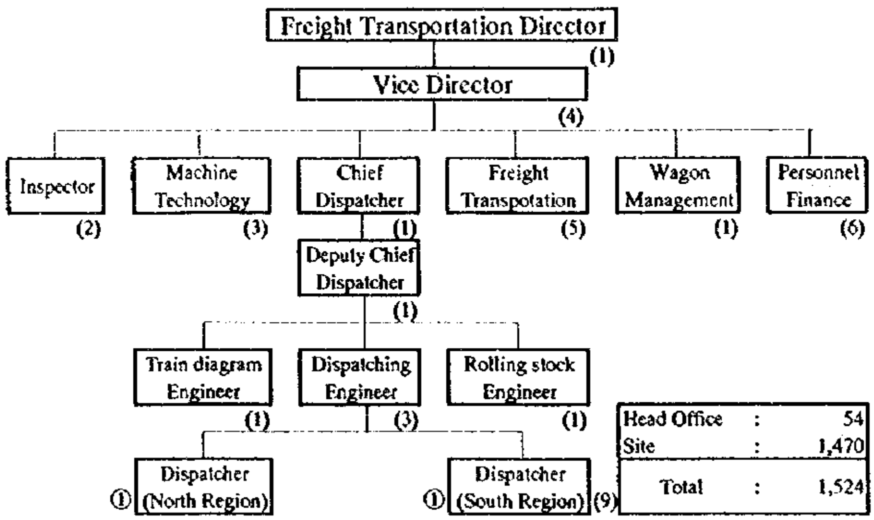


Fig. 6 - 2 Freight Transportation Department

(2) Passengers Transportation Department

The organization and employment system of the Passengers Transportation Department are as shown in figure 6–3. This organization controls passengers department and other departments including passenger coach depot and car service center at Ulaan-baatar station.

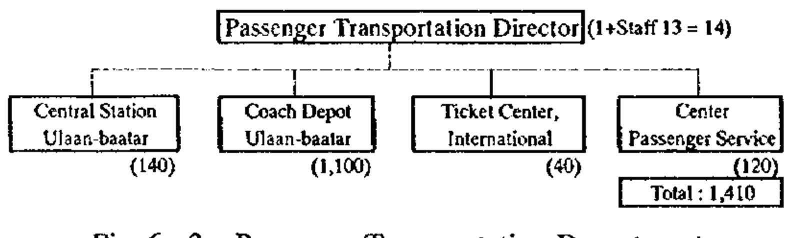
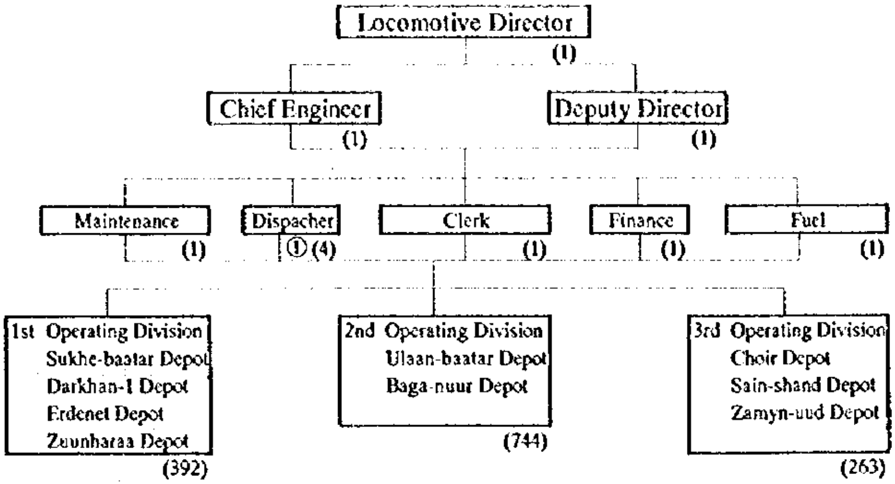


Fig. 6 - 3 Passenger Transportation Department

(3) Locomotive Facilities Department

The organization and employment system of the Locomotive Facilities Department are as shown in figure 6–4. This organization controls locomotive dispatching and operation sections divided into three sections by area covered.



Head ffice	:	11
Site	:	1,400
Total	:	1,411

	1st Ope.	2nd Ope.	3rd Ope.	Total
Management	25	74	30	129
Maintenance	47	248	60	355
Driver	244	240	112	596
Others	76	182	61	319
Total	392	744	263	1,399

Fig. 6 - 4 Locomotive Facilities Department

(4) Education and Training

Education and training for employees is normally provided as described below.

a. Employment: Graduates from the Railway College or high schools who have passed tests are employed.

b. The above employees are assigned to a site upon completion of training, which takes from one month to one year depending on the trade.

c. Two-hour on-the-job training is provided two times a week after normal work hours. It is imperative for all attendants to pass an annual test.

6 - 4 Problems Requiring Discussion, and Proposed Plan for Improvement

There are no significant problems in transportation and rolling stock related matters. Matters to be discussed, prior to the time when carrying capacity is increased and modernization of various systems are planned or carried out in the future, are described below as a guidance.

(1) Modernization of transport administration, etc.

① Review and improvement of train diagram and traffic control work

Train diagrams are achievements of railways, and it is necessary to conduct train operation administration (including command judgement and operational adjustment) in accordance with basic diagrams and daily "execution plan diagrams" as well. The execution plan diagram is used as a basis for operational adjustment and the like because all plans for the day (such as train operated and maintenance work) are described in it beforehand. Therefore, it is advisable to introduce train diagrams which cover the entire day from 0:00 to 24:00.

② Scheduling of regular freight trains

Just like passenger trains, the minimum number of regular freight trains should be separately scheduled to cope with traffic fluctuations. This will become a basis of freight transport modernization and lead to the increase in demand.

(2) Measures for Transport Modernization in the Future

① Operational safety system and management improvement

In MR, operational safety systems such as block, signaling, and interlocking systems are sophisticated, enabling smooth introduction of the Centralized Traffic Control (CTC) system and the like in the future. However, since facilities of these operational safety systems are superannuated, their replacement and improvement will become necessary with the increase in transport demand in the future. In the replacement and improvement, it is advisable to study such matters as the introduction of CTC and promote management improvement based on the study. Furthermore, the introduction of optical cables which is now in progress will become short in 2020, making it difficult to conduct adequate train scheduling. Therefor, the introduction of CTC will also effective in establishing unmanned signal stations (interchange facilities).

② Replacement and further introduction of rolling stock

In the future, it will become necessary to replace superannuated passenger cars, freight cars, and locomotives and also introduce further rolling stock. Especially, it is essential to study the performance of locomotives to be newly introduced, taking into consideration such factors as transport capacity reinforcement and speedup. The numbers of cars and locomotives which require replacement due to superannuation will be as follows, if the period during which the cars and locomotives can be operated is assumed to be 30 to 40 years.

Table 6 - 13 Rough Estimation of Deteriorated Cars Requiring Replacement Before 2020

Items	Present Number of Cars	2000	2005	2010	2015	2020	Estimated No. of Replacement Cars	%
PC	230	11	13	21	40	58	143	62
FC	2,513	76	220	200	737		1,233	49
Loco	107	5	10	48	42	-	105	98

Note: The operable life of cars is set to 35 years for passenger cars, 35 to 40 years for freight cars, and 30 years for locomotives.

6 - 5 Transport Plan

(1) Planning Concept

Make a transport plan following the procedures described below, based on Chapter 4 "Basic Concept of Design."

① Place importance on the assurance of safe and reliable transportation.

② Develop a new project to carry out an overall improvement plan to include a speed increases and modernization of various facilities. In this project, make a plan to limit the scope of work to securing the required transportation capacity. Train operation plan should be made based on current train diagrams.

③ Make plans separately for projects scheduled to be completed by 2005, 2010, and 2020.

④ Include estimated costs for replacement or upgrading of deteriorated cars for informational purposes.

(2) Conditions for Planning

① Planned Section and Railway Conditions

Develop a total plan for improvement of all railway sections, except those of the east line, as trains are operated through all sections, although this project is limited to the 430 km section between Sukhe-baatar and Bayan.

② Train Operation Safety System

The train operation safety system, as a basis of train operation, can be affected by actual railway conditions together with their reliability, transportation demands, and the train operation systems of adjacent countries. Since advanced systems, including a tokenless block system, have already been provided, it is necessary to make plans that will be compatible with various existing systems.

③ Motive Power

The motive power for operating trains on the project railway section should be diesel electric locomotives (DEL) as are currently being used. Plan separate projects for the electric drive system to be imported in the future.

④ Train Types and Other Requirements

a. Train types

Types of trains to be operated in various sections should include passenger trains (international and domestic trains) and freight trains, as a rule. These trains should be pulled by DELs. Plan all international passenger trains as express trains, and domestic passenger trains as express and a local stop trains. Plan freight trains as local stops, freight trains (including international freights) and as general and exclusive freight trains. It should be planned at the stage of project implementation that trains be pulled by single locomotive.

b. Train formation

Planned train formations should be based on the estimated demands, taking into account the present train formations. Plan the formation of long distance trains as sleepers, and short distance trains should be provided with increased seats. For freight trains, estimate the number of wagons to be formed for each hauling capacity, using load factors per wagon and empty car ratios. Use the hauling capacity currently used by the MR, and make uniform plans to be compatible with main freight hauling stations. The maximum number of freight cars making up a train should be limited to 55.

c. Maximum operating speed

Plan the maximum operating speed to be 80 km/hr, both for passenger and freight trains.

d. Operating times

Follow the operating times currently used.

⑤ Pulling System and Performance of Cars

Plan the motive system using locomotives, 2M62 (including GE), and those to be replaced and increased should also be model 2M62 or GE. Use passenger and freight trains of the types as same as the present types.

⑥ Transportation Demand

Make plans based on the results of predicted demands described in Chapter 5. Make plans for passenger and freight trains using the units of weekly traffic volume and the number of train operations for each section.

2) Various Factors for Planning Passenger Trains

① Boarding Efficiency

Set boarding efficiency to 80%, as a rule, because long distance transportation is prominent and because of actual line conditions.

② Train Formation and Nominal Passenger Capacity

Make plans based on the train formation and nominal passenger capacity described in Appendix 6 14 and the following conditions.

a. Sleepers should be 36 passengers for each car.

b. Cars without sleepers should have 81 seats for car.

③ Transport Fluctuation

Set transport fluctuation to 120%, taking into consideration the actual record of transportation.

3) Various Factors for Planning Freight Trains

① Load Factor per Wagon and Other Factors

a. Load factor per wagon

Select load factor per wagon based on specifications and service record of freight cars and from Table 6 14.

Table 6 - 14 Load factor per Freight wagon

Items		Average Weight (ton)	Load (ton)	Load factor (%)	Remarks
Exclusive	Coal	23	70	100	Include Copper etc.
	Fuel oil	25	58	100	
General		23	52	80	

b. Empty car ratio

Set empty car ratio as stated below, taking into consideration the service record of freight trains.

Exclusive freight train : 50%

General freight train : 40%

c. Transport efficiency (number of turnaround days)

Select the number of turnaround days of freight cars from Table 6-15, taking into consideration the service record of freight cars.

Table 6 - 15 Number of Turn around days of Wagon

Year		1996	2005	2010	2020
Exclusive goods	Coal	3.0	2.5	2.5	2.5
	Copper	9.5	9.0	8.5	7.5
	Fuel oil	4.3	4.0	4.0	4.0
General goods		9.5	9.0	8.5	7.5

Note 1: The number of turnaround days of all freight cars is 4.3 days on the average. If the number of turnaround days for coal (that covers 80% of the total freight) is assumed to be 3 days, that of general freight is 9.5 days. From this it can be predicted that traffic efficiency will increase in the future.

Note 2: Assume using freight cars as a gondola cars for transport of coal and copper, tank cars for petroleum products, and wagons for general freights.

d. Transport Fluctuation

Set transport fluctuation to 120%, the same as that of passenger trains.

e. Hauling Capacity (Gross Ton) and Transport Capacity of Freight Trains

Obtain relationship between hauling capacity and transport capacity by the following equation.

$A = (1 - e)X(G + T \cdot s) + e \cdot X \cdot G$...... (ton)

$N = T \cdot S \cdot X(1 - e)$........................ (ton)

Where, A = hauling capacity (gross ton),

N = transport capacity (net ton),

X = total number of freight cars (each train),

G = dead weight of freight car (ton/each),

T = loading weight (ton/each car),

s = loading efficiency, and e = empty car ratio.

- Coal trains: A = (1–0) X (23 + 70) .... X = A/93
- Copper and fluorite trains: ditto
- Petroleum trains: A = (1 – 0) X (25 + 58 x 1) .... X = A/83
- General freight trains: A = (1 – 0.4) X (23 + 65 x 0.8) + 0.4 • X • 23 ...... X = A/54

Hauling capacity and transport capacity obtained by the above method are shown in Appendix 6–16.

(3) Transport Plan

1) Passenger Train Operation Plan

Make a different passenger train operation plans for each year, based on the cross sectional transport volume per week. The number of trains to be operated, and train and car operation distances (in kilometers) are as shown in Table 6–16.

Table 6 - 16 Passenger Train - km & Car - km (×1,000 km)

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

The number of train operations, classified by section, is shown in Appendix 6–19 together with that of freight cars. Typical train diagram to be used in 2020 is also shown in Appendix 6–20 as guidance.

2) Freight train Operation Plan

Make different freight train operation plans for each year, similarly based on the cross sectional transport volume per week. The number of trains to be operated, and train and car operation distance (in kilometers) are as shown in Table 6–17.

Table 6 - 17 Freight Train - km & Car - km (×1,000 km)

Year	1996	(%)	2005	(%)	2010	(%)	2020	(%)
Train – km	2,732	100	3,480	127	4,084	149	4,778	175
Car – km	81,086	100	126,135	156	154,531	191	184,520	228

The operation distance of locomotives for pulling passenger and freight trains is shown in Table 6–18.

Table 6 - 18 Locomotive - km (×1,000 km)

Year	1996	(%)	2005	(%)	2010	(%)	2020	(%)
Loco. – km	5,747	100	7,477	130	8,319	145	8,940	156

(4) Rolling Stock Plan

1) Required Number of Cars

As a result of transport planning, the number of cars required for this plan is as shown in Table 6–19.

a. Required number of passenger cars

Table 6 - 19 Number of Required Passenger Car

Year	1996	2005	(%)	2010	(%)	2020	(%)
Sleeping Car (Increase)	132	132 (0)	29	132 (0)	28	132 (0)	24
Seat Car (Increase)	80	85 (+5)	20	85 (0)	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 (0)		238 (+3)	

Note 1: Short-distance cars are included in the seat car. The percentages indicate stand by factor.

Note 2: Increase in number of dining cars is not included in this project.

b. Required number of freight cars

The required number of freight cars has been obtained from the daily arrival and forwarding tonnage, multiplied by number of turnaround days and standby factor. The required number of freight cars obtained is shown in Table 6-20.

Table 6 - 20 Number of Required Freight Car

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 (0)	28.9	2,477 (0)	14.6	2,495 (+18)	5.0
Total (Increase)	2,513	2,595 (+82)		2,621 (+26)		2,666 (+45)	

Note: Percentages show standby factor.

c. Required number of locomotives

Use models 2M62, M62 and GE as locomotives for pulling trains. For shunting of trains at major stations, use locomotive model TEM2. Estimate the number of locomotives for pulling trains based on train diagrams and locomotive utilization charts. The train diagram for each different year includes trains that are operated only 3 times a week, and some allowances for change in schedule. Therefore, standby factor is set to 15%.

Table 6 - 21 Number of Required Locomotive

Year	1996	2005	(%)	2010	(%)	2020	(%)
2M62, GE (Increase)	66	66 (0)	22	70 (+4)	15	74 (+4)	15
M62	13	13		13			
TEM2	28	28		28			
Total (Increase)	107	107 (0)		111 (+4)		115 (+4)	

Note 1: The number of operating locomotives, model M62, is 2.
Note 2: Assign model TEM2 at Sukhe-baatar and 14 other stations.
Note 3: Percentages indicate standby factor.

6–6 Transportation Related Employment Plan

(1) Business Personnel Employment

The number of current station employees totals 1,470 for 59 stations. It can be presumed that the present number of employees is sufficient, except for major freight handling stations. Since the volume of freight is increasing at major freight handling stations, it can be estimated that it is sufficient to handle increased freight if present number of employees is increased by 5% at year 2005, 2010, and 2020. However, it will be necessary to increase the number of crew members including passenger train conductors as the number of passenger trains is increased. For work-site operation departments, freight train dispatchers will be increased.

(2) Drivers and Maintenance Staff

It will become necessary to increase the number of drivers as the number of passenger train and freight train increases. Accordingly, the number of maintenance staff must also be increased. Estimate the number of drivers based on locomotive running kilometers, and maintenance staff on the number of locomotives. The results of this estimation is shown in Table 6–22 together with the number of station employees.

Table 6-22 Transport Personnel Plan

Item \ Year		1996	2005		2010		2020	
		Present	Persons	Increase	Person	Increas	Person	Increas
Headquarters:Dispacher		16	20	+4	24	+4	24	0
Station	Manage. staff	124	124	0	124	0	124	0
	Train operating	550	575	+25	600	+25	620	+20
	Freight	295	330	+35	375	+45	405	+30
	Rolling stock etc.	499	511	+12	521	+10	531	+10
	Total	1, 468	1, 540	+72	1, 620	+80	1, 680	+60
Coach-Depot	Maintenance	347	353	+6	353	0	357	+4
	Conductor etc.	110	116	+6	120	+4	124	+4
	Attendant etc.	698	733	+35	761	+28	775	+14
	Total	1, 155	1, 202	+47	1, 234	+32	1, 256	+22
Loco. Depot	Maintenance	355	375	+20	407	+32	419	+12
	Driver etc.	596	775	+179	858	+83	912	+54
	Total	951	1, 150	+199	1, 265	+115	1, 331	+66
Grand Total		3, 590	3, 912	+322	4, 143	+231	4, 291	+148
						Increas Total		+701

CHAPTER 7

NATURAL CONDITION AND ENVIRONMENT

Chapter 7
Natural Condition and Environment

7 - 1 Natural Condition of the Project Site

7-1-1 The Topography and Geology

(1) The Topography and Geology along the Railway Route

In the project site from Bayan to Sukhbaatar, the railway runs in the north to south direction. In the project site, the elevation of Ulaanbaatar is the highest at 1300 m, and grows lower in the northerly direction with Zuunhara (870m), Baruhara (800m), Darkhan (680m), and Sukhe-baatar (615m) along the railway.

The terrain along the railway from Ulaanbaatar to Baruhara is the Hentii Mountain Range which consists of hills and ridges with alluvial and aggravation plains between the mountains, and from Baruhara to Sukhe-baatar are the mountains, hummocks and broad valleys at the extension of spurs of the Hangai and Hentii Mountain Ranges. On both sides of the flat plains are the hills, ridges and slopes which rise into the hills and mountains. Many of the rivers flowing in this route are running in their original undeveloped river beds, and meander in their watercourses and are not well defined. Their poorly defined watercourses are reflected in the surface floods, the deposits of the river silt and corroded banks. The route of the railway generally follows the course of rivers and streams through the valley in the lower extremes of the hills. The formation of the railway consisting of a foundation on which the bridges and embankments are constructed are the remains of deposits left by the rivers overflowing their banks of sand, silt, and gravel. The underlying layers of the railbed change their composition from north to south. As the formation of the geology of Mongolia mountain ranges change in the east-west direction, there is a marked difference between the geology from the north to south. As a general rule, the formation of the geology of the north is much older than that of the south. The geology of the route of the railway can be classified for the various regions as follows:

Table 7-1-1 The Geology Along the Railway Route

District	The Geology
Russian Border to Shaamar	Sandstone, shale, tuff.
Shamaar to South Darkhan	Granite diorite, diorite, basalt, andesite
South Darkhan to Salkit	Sandstone, laceousdiorite, basalt, andesite
Salkhit to Baruhara	White granite, granite, diorite
Baruhara to Zuunhara	Granite diorite, granite
Zuunhara to south of Batsumber	Sandstone, shale, green schist
Batsumber to west of Ulaanbaatar	Siliceous schist
West of Ulaanbaatar to Bayan	Sanstone, schist, tuff, green schist

(2) The Foundations along the Railway Route

It is quite apparent that the flood deposits forming the base for the railway tracks have sufficiently strength to support the railway structures. There have been no reports of insufficient bearing strength and settling due to soft grounds for the embankments and bridge foundations, and attest to the fact that there are few soft grounds in the railway right-of-way. The alluvial plains in Mongolia consist of fluvial deposits of sand and gravel and are quite unlike the soft grounds that are encountered in Japan. The depth of excavations for bridge foundations of 2 meters indicate that there is a well compacted layer of sand and gravel in the river beds. This reliance on the good foundation for the railway structures on the other hand shows up heaving of footings and foundations in the cold season.

7-1-2 The Climate

The monthly temperature and precipitation for the last 10 years for the four sites of Sukhbaatar, Darkhan, Baruhara, and Ulaanbaatar are shown in Fig. 7-1-1 and Fig 7-1-2. Sukhbaatar is in the northermost area, Darkhan in the north-central part, Baruhara in the south-central part, and Ulaanbaatar in the south end of the railway sector being investigated, and this more or less gives an overall picture for the whole railway system.

(1) The Temperature

As shown in Fig. 7-1-1, the extreme low temperature for the sites are in January, with the maximum in July, and the average monthly temperature for the coldest month is -17.3 ~ -23.7°C, with Darkhan the lowest, and Sukhe-baatar the highest. The time when the average temperature is over goes over zero degrees centigrade are the 7 months from April to October for the whole country. The average differences in the yearly temperature is 40.9 ~ 43.3°C, and is the largest in Ulaanbaatar, and the smallest in Darkhan. The average daily difference in the temperature occurs in the coldest month of January is 9.3 ~ 15.3°C, and is the largest in Darkhan, and the smallest in Ulaanbaatar. The largest difference in the warmest day is July when the temperature is 12.4 ~ 14.3°C, and is the largest in Ulaanbaatar, and the smallest in Sukhe-baatar.

The temperature at the above four locations is generally about the same. In terms of latitude, Ulaanbaatar is the southermost and Sukhe-baatar is the northermost and the highest, however, the elevation of Ulaanbaatar is 1,300m, and Sukhe-baatar is 615m and the lowest, and they are compounded by the terrain, and the temperature distribution becomes complicated in making these comparisons.

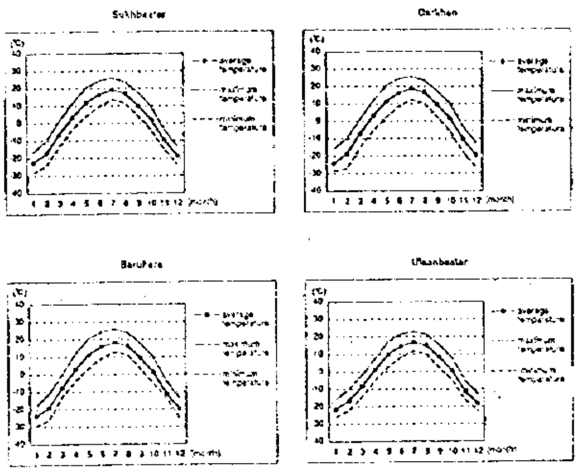


Fig. 7-1-1 Monthly Temperature for the Last 10 Years

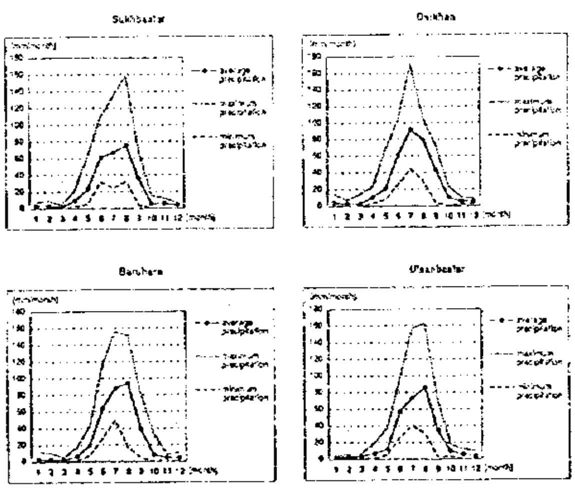


Fig. 7-1-2 Monthly Rainfall for the Last 10 Years

(2) Precipitation

In the last 10 years, the amount of rainfall for Sukhe-baatar was 293 mm/yr (maximum 429 mm/yr; minimum 188 mm/yr), Darkhan 338 mm/yr (max. 472 mm/yr, min. 196 mm/yr), Baruhara 338 mm/yr (max. 473 mm/yr, min. 179 mm/yr), and Ulaanbaatar 298 mm/yr (max. 396 mm/yr, min. 178 mm/yr). There is a wide variation in the yearly amount of rainfall, and this typical in the precipitation for the country. In the central of the area investigated at Darkhan and Baruhara, the amount of rainfall is much more than for the southern and northern extremes of Ulaanbaatar and Sukhbaatar. This variation in the precipitation depends on the elevation of areas and especially on the location of mountains in regard to moisture-bearing air currents. The heavy rainfalls which seem to have a bearing on the damages is the maximum rainfall (see Fig. 7-1-3) for the last 10 years are Sukhe-baatar 52 mm/dy (August 1990), Darkhan 48 mm/dy (July 1991), Baruhara 77 mm/dy (July 1991), and Ulaanbaatar 47 mm/dy (July 1993). These records show that they correspond from 14% to 23% of the yearly precipitation, and indicate that there was a torrential downpour. Fig. 7-1-4 gives the maximum daily rainfall for long periods of time. August is the month with the heaviest rainfall for all four sites, and changes to July, June, September and May. The three summer months of June, July and August is the season when 70% of the yearly amount of rainfall is experienced. The five months from May to September is when 90% of annual rainfall prevails.

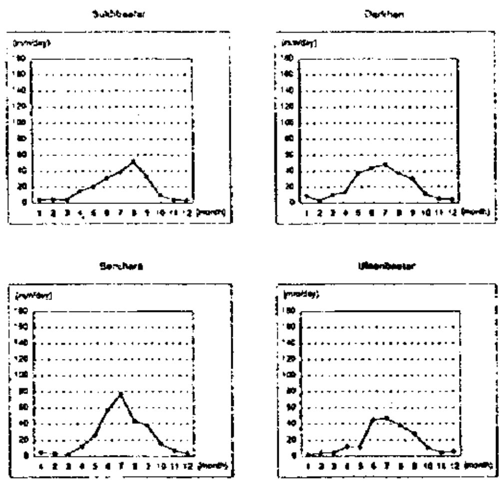
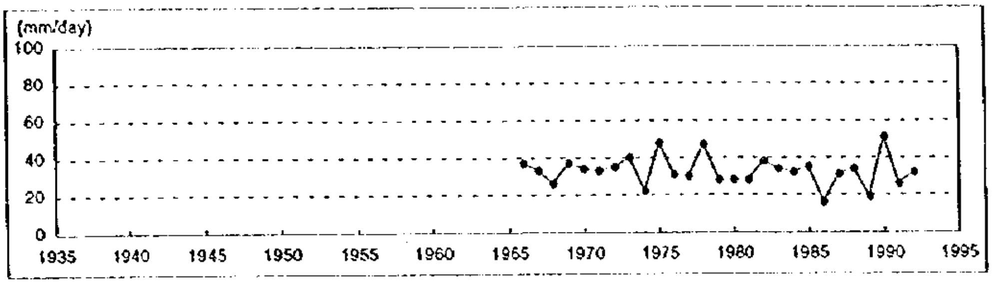
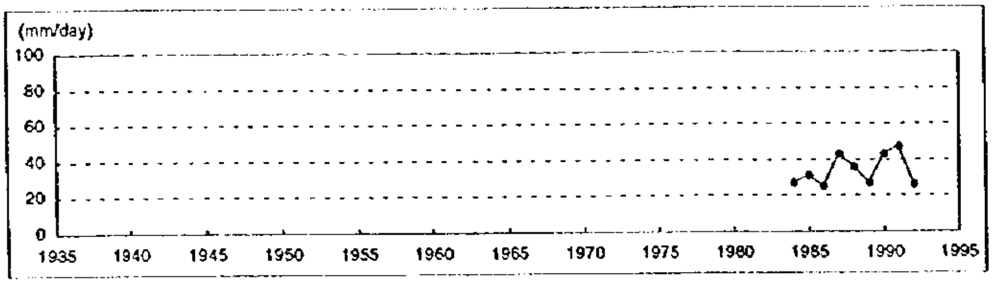


Fig. 7-1-3 Maximum Rainfall for the Last 10 Years

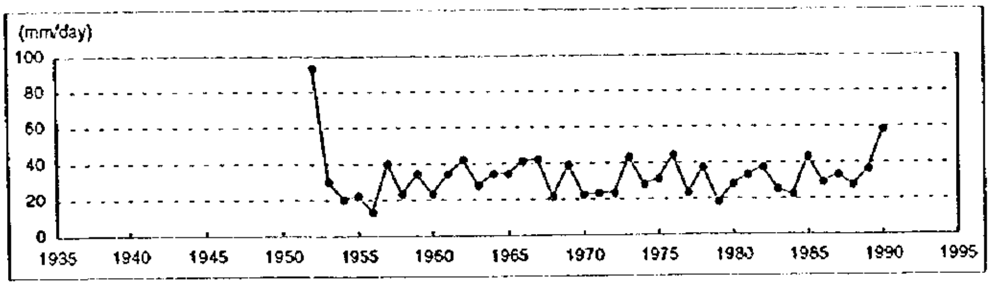
Sckhbaatar



Darkhan



Baruhara



Ulaanbaatar

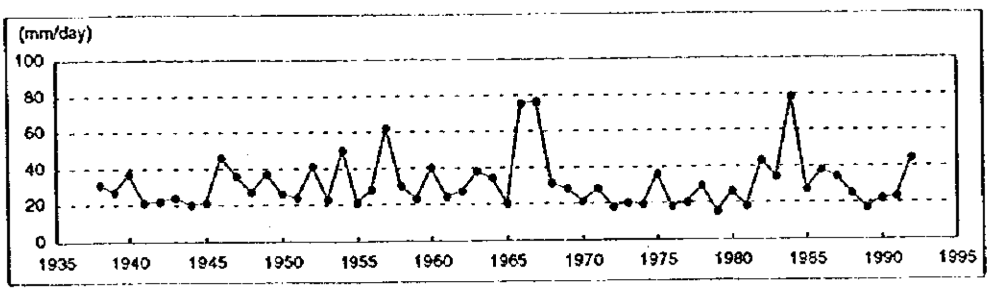


Fig. 7-1-4 Maximum Daily Rainfall for Long Periods of Time at Main Stations

(3) The Humidity and Winds

The monthly humidity for sites investigated are given in Fig. 7-1-5. Due to the low temperatures, the annual density ranges from 50 to 80%. When the temperature falls to its lowest in April to May, the humidity is approximately 50%, and when the temperature is the highest from December to January, on the other hand the humidity is about 80%. The record of winds are given in Fig. 7-1-6, and for all the railway sites, strong winds are recorded in early spring from April to June.

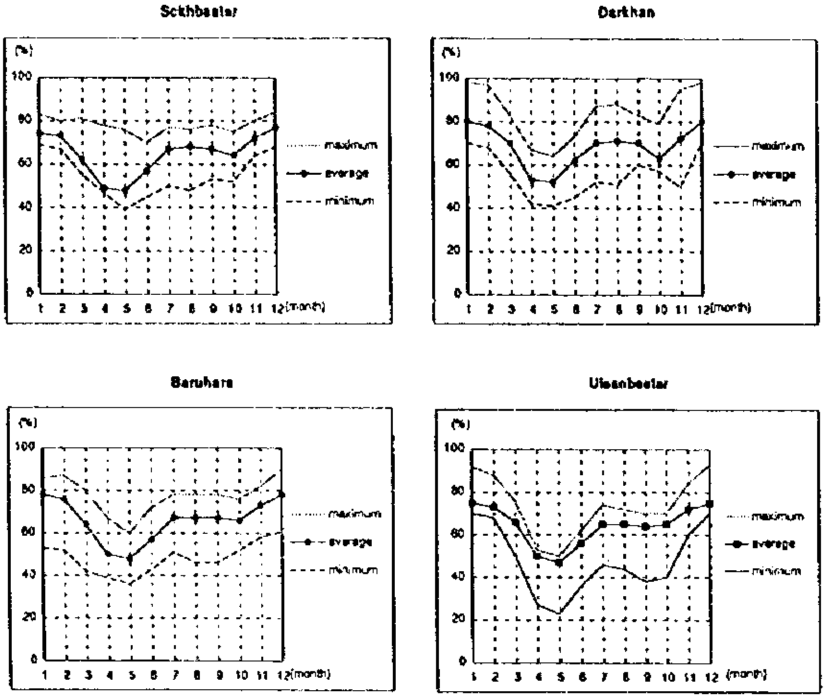


Fig. 7-1-5 Monthly Humidity at Main Stations

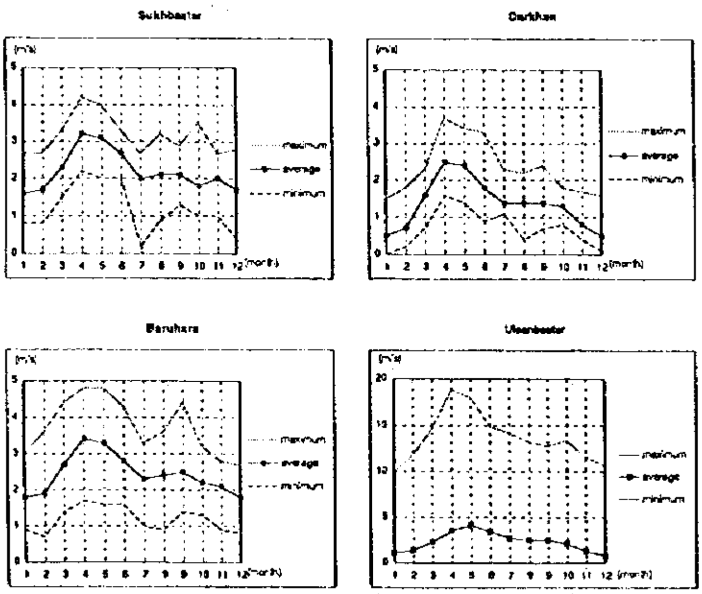


Fig. 7-1-6 Monthly Wind Speed at Main Stations

7-1-3 The Hydrology

(1) The Water Systems

The relation of main river system and railway system on projest site is shown in Fig. 7-1-7. The general site investigated comes within the Selenge River system. The Selenge River system has the largest amount of water in Mongolia, and many large rivers come within this basin. The railway is constructed along Hara river and most of confluences of rivers are concentrated at north side of Darkhan. Therefore a lot of flood occur between Darkhan and Sukhe-baatar.

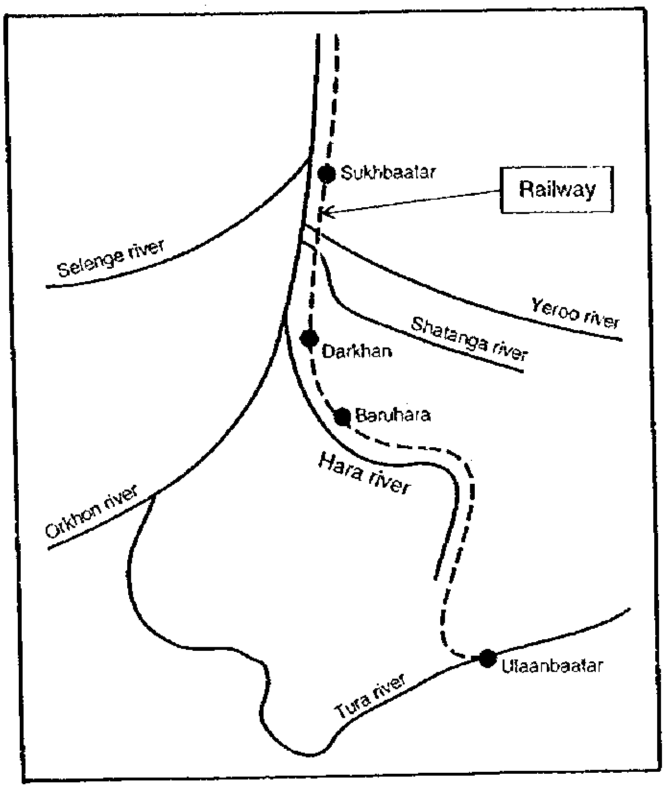


Fig. 7-1-7 The Relation of Main River System and Railway System

(2) The Flow Pattern

The peak flows occur when the frozen rivers thaw or combines with the falling rains and the overall flow is interrelated with the basic flow, which can be classified into three representative patterns: (a) when the peak flows of thawing snow combines with rainfall; (b) when the peak of rainfall precedes the peak of the thawing snow; (c) when there is no waters from thawing snow. Type (a) flows cause the heavy damages to the railway structures.

7-1-4 Railway Natural Disaster at Project Site

Past railway natural disasters at project site are shown in Table 7-1-2. Railway natural disasters in Mongolia are flood disaster, falling rocks from natural slope, and track bump by freezing of embankment. However most of natural disasters listed in Table 7-1-2 are flood disasters. Because no big trouble has been occurred by falling rocks from natural slope and track bumpy by freezing of foundation with routine careful inspection.

(1) The Flow of Large River

The large river systems in Mongolia generally have their peak flows that do not occur simultaneously. The site of the railways are in a sector that are subject to frequent floods, and are of subject to all 3 types of flood flows given in the figure. The thawing snow to the east of the Hentii Mountains, and the Hangai Mountains on the west have caused the rivers traversing the railways to flood. Flood waters from thawing snow have caused inundation of the railway facilities in 1993, 1986, 1972, 1967, 1966, 1940, 1938, and 1936. Inundation of the railway facilities from rainwaters during rainy season have occurred in 1984, 1977, 1975, 1973, 1969, 1966, and 1961.

As a general rule, the cycle of floods occurring during the rainy season are classified into small floods are said to occur on a cycle of 5 ~ 6 years, and larger floods are said to occur in cycles of 10 ~ 12 years, 24 ~ 26 years, 36 ~ 40 years. Floods that occur with the thawing snow are said to occur in a cycle of 4 ~ 6 years, 9 ~ 11 years, 22 ~ 26 years, and 40 ~ 50 years.

Table 7-1-2 Large Railway Natural Disasters in the Past

No.	Location			Year/Month	Train Stop Period	Rehbilitation Cost (Mil. Tg.)	Outline of the Disaster
	Section	Kilom.	Picket				
1	UB - Choir	413	1	1971.6	51.5 hours	200	Piers at east side of Ulaanbaatar were washed out.
2	Eroo - Orkhon	64	1 - 6	1973.1	11 days	500	Embankment (460m length) at Reoo station was washed out.
3	Sainshand - Zamynuud	915	4	1977.7	2 days	300	Passenger train was crushed due to washing out of embankment at south side of Sainshand by heavy rain.
4	Choir - Sainshand	564 - 587		1978.7	10 days	120	Embankment at 564-587, 4 bridges and curbart were washed out by flood.
5	Emeelt - Tolgoit	384	1	1978.7		2	Piers were washed out by flood.
6	Salhit - Erdenet	130	1	1979.6	15 hours	0.7	Piers were washed out by flood.
7	Salhit - Erdenet	67	3	1979.7	10 hours	1	70m length ballast was washed out by flood.
8	Salhit - Erdenet	98	4 - 6	1980.6	20 hours	2	Ballast was washed out by flood.
9	Salhit - Erdenet	861 - 889		1980.8		20	20 km length embankment was washed out by flood.
10	Sainshand - Zuunbayan		5 - 7	1987.7		0.5	Piers were washed out by flood.
11	Emeelt - Tolgoit	383 - 385		1987.7	15 hours	1.5	Piers were washed out by flood.
12	SB - Baruunharaa	31	6	1987.7	20 hours	2	Railway was submarged by flood.
13	Salhit - Erdenet	32 - 34		1987.7	13 hours	1.5	Piers were washed out by flood.
14	Salhit - Baruunharaa	170		1987.8	15 hours	1.5	Embankment and ballast were washed out by flood.
15	Sainshand - Zuunbara	30	10	1987.8	22 hours	3	Embankment on the back of abut was washed out by flood.
16	Salhit - Erdenet	112 - 115, 123 - 125		1988.7	10 hours	1	Embankment and ballast were washed out by flood.
17	Rashaant - Emeelt	360 - 365		1991.6	15 hours	0.5	
18	Sainshand - Zamynuud	1,014 - 1,015		1992.7	24 hours	2	Railway was submarged by flood and embankment was washed out.
19	Salhit Station			1992.7		0.2	Railway was washed out by flood.
20	Honkhor - Bayan	422, 425, 429, 434, 438		1993.7	20 hours	250	Embankment and curbart were washed out by flood.
21	Choir - Sainshand	865	4	1993.7	14 hours	2	Embankment on the back of abut was washed out by flood.
22	Airag - Bor Undur	52, 57		1994.7	4 days	6.3	Embankment was washed out by flood of Urtyngol.
23	Darkhan - Baruunharaa	195	2	1994.7	1 days	3	Embankment (230m length) was washed out by flood .
24	Salhit - Tsaidam	150	1	1994.8	1 days	60	Embankment was washed out by flood and the train derailed .
25	Salhit - Erdenet	59 - 60		1994.6	22 hours	1	Ballast was washed out by flood.
26	Salhit - Erdenet	114	4	1994.7	19 hours	20	Embankment was washed out by flood of Orkhon.
27	Airag - Borondor	43	4	1995.7	5 hours	0.7	The small river run over the railway embankment because the capacity of curbart of embankment was not enough.
28	Choir - Sain Shand	675	3	1995.7	5 hours	1.7	The bridge was washed out by heavy rain.
29	Tolgoit [illegible]			1995.8	-	12	The branch line was washed out.
30	Amgalan - Tuul - Honkhor			1996.6	5 hours	10	The railway facilities at 419km, 431km were washed out by momentaly heavy rain and the flood run over the railway.
31	Berendalai - Orkhon tuul			1996.6	12 hours	15	The embankment at 57km, 62km, 63km and railway facilities at 57km, 60km were washed out.

(2) The Flow Characteristics of Medium and Small Rivers

The rivers given in Fig. 7-1-7 all freeze in winter and reduce their flows, but in the rainy and dry season there is almost constant flow of water. In addition to these rivers there are many minor rivers that have flows from the thawing snow and flowing water in the rainy season but go dry, and they all flow into the main river. Floods caused by the large rivers cause railway bridges to be washed away, but floods caused by the medium and small rivers can cause the embankments of railway bridges to be washed away. The floods caused by the medium to small rivers are as follows. The thawing snow waters and heavy rains during the rainy season supply large amounts of water to the hill and plain areas. It is surmised that the layers more than 3.0m under the surface between Ulaanbaatar to Sukhebaatar to have permafrost. The lower layers are in a frozen state until early spring, and the thawing snow waters and rain waters cannot infiltrate into the lower layers and flow down the slopes into the medium and small rivers in the plains (dry streams) or into the depressions. As the amount of infiltration into the ground is small, the ratio of waters flowing into the rivers increase, and the time of flow is small, the flooding at peak times is large. The lack of vegetation give rise to causing further flooding. These rivers which are almost bone dry in the dry (winter) season become torrents in the snow thawing and rainy season and their flows cannot be controlled, and to this day there has been no flood control measures taken. In the almost flat plains the railway line becomes the only obstruction, and become a dam to the medium to small rivers racing to join with the main river flows. There are channels provided at many places in the railway embankment to allow the river water flows to flow through the obstruction, but their capacity to allow the flood waters pass through are inadequate and are causing floods and loss of the railway embankments.

(3) Flood disaster

A lot of railway bridges and embankment are washed away by flood. There are 3 patterns of flood disaster on railway in Mongolia.

a) Embankment on back of abut, piers, and bridges are washed out by large river flooding.

b) Small river is flooded at waterway of embankment and the embankment is washed away.

c) The embankment is eroded by large river's meander.

(4) Falling rocks

Railway operation is sometimes obstructed by falling rocks because the railway is constructed as threading its way through mountains and some rock slope is hanging over the railway. There are some possibility of derailment by train running on the rocks which diameter is about 1m.

(5) Track bump by freezing of embankment

Track bump is occurred by freezing of embankment on the damp ground in the winter. At the result 10mm/day dump and 40 – 50mm/year dump are occurred and it urges train to drive slowly.

7 - 2 Soil Investigation

7-2-1 Objectives

Rehabilitation of old railway bridges and construction of new bridge are planned on this project. Prior to detailed design, bearing capacity, consolidation, and permeability of foundation are checked for basic design of bridge. On the project area, frost heave is occurred due to severe cold in Winter, and rail is raising partially and regularity of railway is spoiled. Therefore soil investigation at frost heave point is also required on this study.

7-2-2 Methodology

Soil investigation carried out at 21 points at which MR plans to construct bridges and 4 points at which frost heave is occurred. Required test items for each site are described bellow and location of soil investigation is shown in Fig. 7-2-1. There is no testing equipment suitable to ASTM (American Society for Testing and Materials) and JIS (Japanese Industrial Standards) in Mongolia, and Russian equipment is used for the investigation.

(1) Bridge construction points (Survey Type 1)

- Boring / Sampling
- Standard penetration test
- Permeability test
- Plate bearing test
- Physical properties test (specific gravity, water content, grain size analysis, plastic / liquid limit)
- Mechanical properties test (compression, consolidation)

(2) Frost heaving points (Survey Type 2)

- Boring / Sampling
- Permeability test

- Physical properties test (specific gravity, water content, grain size analysis, plastic / liquid limit, compaction)

7-2-3 Outline of the Result

Detailed test result at each location is shown on "REPORT ON GEOTECHNICAL INVESTIGATION". Outline of the result is described as follows.

(1) Classification and identification of soils

Typical soil layer on study area is 30 - 50 cm top soil, 2 - 3 m sandy loam and over 10 m sand with gravel. Specified depth of seasonally freezing is around 3 m below the ground. Character of each soils as follows.

Layer 1 : Top soil (Humus soil)

Layer 2 : Sandy loam yellow color, quasi-plastic consistency

Gradation of Soil : Sand 70% - 85%, Silt 10% - 25%, Clay 2% - 5%

Dry unit weight : 1.6 - 1.8 t/cu.m

Permeability coefficient : 60 - 100 m/day

Angle of internal friction : 28 - 30 degree

Layer 3 : Sand with gravel yellow brown color

Gradation of Soil : Pebbles and Gravel : 50% - 60%, Sand 30% - 50%, Silt 1% - 10%, Clay 1% - 5%

Dry unit weight : 2.0 - 2.1 t/cu.m

Permeability coefficient : 100 m/day

Angle of internal friction : 40 - 45 degree

(2) Bearing capacity as foundation of bridge

N value of Standard Penetration Test is useful for judging bearing capacity. Generally speaking, at least N=20 for clay and N=30 for sand are required as spread foundation of bridge. Through the soil investigation, N=20 for clay and N=30 for sand are cleared at most of the survey points. In fact, every foundation of bridge is spread foundation.

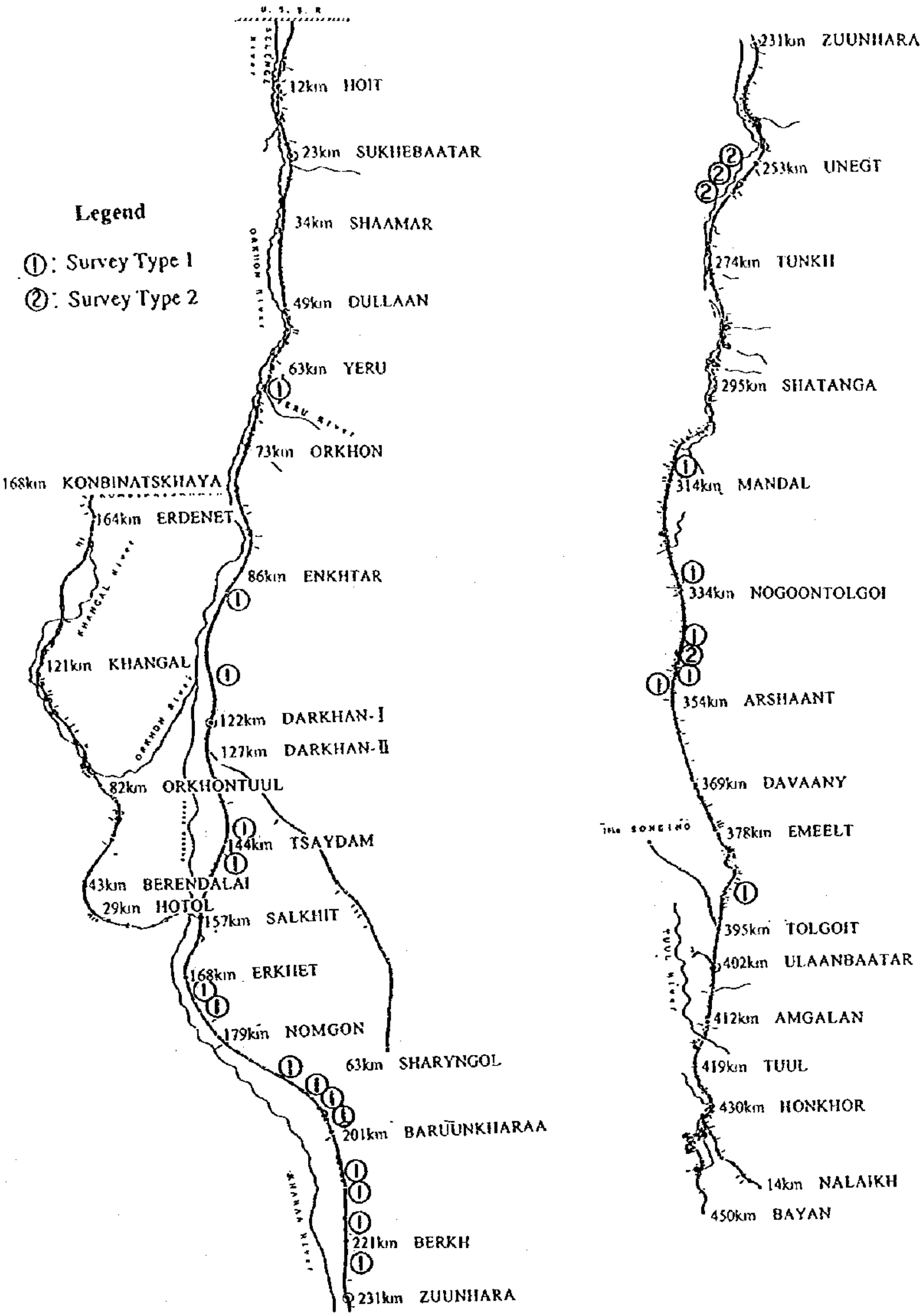


Fig. 7-2-1 Boring Location Map

(3) Consolidation properties

The ground on the study area consist alluvial soil and sand, but the component of sand is big enough comparing that of soil. So consolidation problem such as differential settlement will seldom occur.

(4) Permeability properties

Permeability of the ground from 0 m to -3 m on the study area is 60 - 100 m/day. It has good permeability. There is no water movement under -3 m from the ground, because of permafrost existing.

(5) Frost heave

To frozen soil is result of heat conduction that top soil touch cold air and the top soil get chilly. Layer of Ice lens can be seen in section of frozen soil. The thickness of the layer is 1 mm - 3 cm approximately and the sum of the layer is increasing volume and frost heave height. Frost heave of railway embankment can be seen at the embankment around dump ground.

7-3 Environmental Law and Regulation in Mongolia

(1) Environmental Law in Mongolia

Mongolia is one of a few countries where natural ecosystem remain intact among the Northern Hemisphere. Since the transition to the newly introduced market economy in the beginning of 1990's, the Mongolian government has been actively developing a legal framework of environmental laws. Now Mongolia has the following environmental laws.

1) The Mongolian Law on Land: the purpose of this law is to regulate the possession, use, and other related issues of land by citizen, economic entities, and organization.

2) The Mongolian Law on Special Protected Areas: the purpose of this law is to regulate the use procurement of land for state special protection and the preservation and conservation of its original condition in order to preserve the specific traits of natural zones, unique formations, rare and endangered plants and animals, historic and cultural monuments, and natural beauty as well as research and investigation.

3) The Mongolian Law on Environmental Protection: the purpose of this law is the regulation of the interrelations between the State, citizens, economic entities and organizations in order to guarantee the human right to live in a healthy and safe environment, an ecologically balanced social and economic development, the protection of the environment for present and future generations, the proper use of natural resources and the restoration of available resources.

4) The Mongolian Law on Air: the purpose of this law is the regulation of the protection

and proper use of the atmosphere in relation to the human right to live in a health and safe environment, to provide environmental balance, and for the sake of present and future generations.

5) The Mongolian Law on Hunting: the purpose of this law is to regulate the protection and proper use of mammals, birds, and fish which have hunting significance.

6) The Mongolian Law on Water: the purpose of this law is to regulate the protection, proper use and restoration of water.

7) The Mongolian Law on Forests: the purpose of this law is to regulate the protection, proper use and restoration of forests.

8) The Mongolian Law on Natural Plants: the purpose of this law is to regulate the protection, proper use and restoration of natural plants except forests and cultivated plants.

9) The Mongolian Law on Protection from Toxic Chemicals: the purpose of this law is to regulate the production, export, import, storage, use and disposal of toxic chemicals.

Besides these laws, there are the Mongolian Laws on Hunting Reserve Use Payment, on Water and Mineral use Fees, on Fees for harvest of Forest Timber and Fuelwood and on Natural Plant Use Fees.

(2) Conventions

Mongolia participates as the following conventions:

1) Convention International Trade in Endangered Species of Wild Fauna and Flora (CITES)

2) Montreal Protocol on Substances that Deplete the Ozone Layer

3) Vienna Convention for the Protection of the Ozone Layer

4) Convention on Biological Diversity

5) Convention on Climate Change

(3) Executing Agency

Ministry for Nature and Environment (MNE) has the responsibility for the investigation, monitoring, conservation, and protection of the natural and environment. The structure of the MNE is shown in Fig.7-3-1.

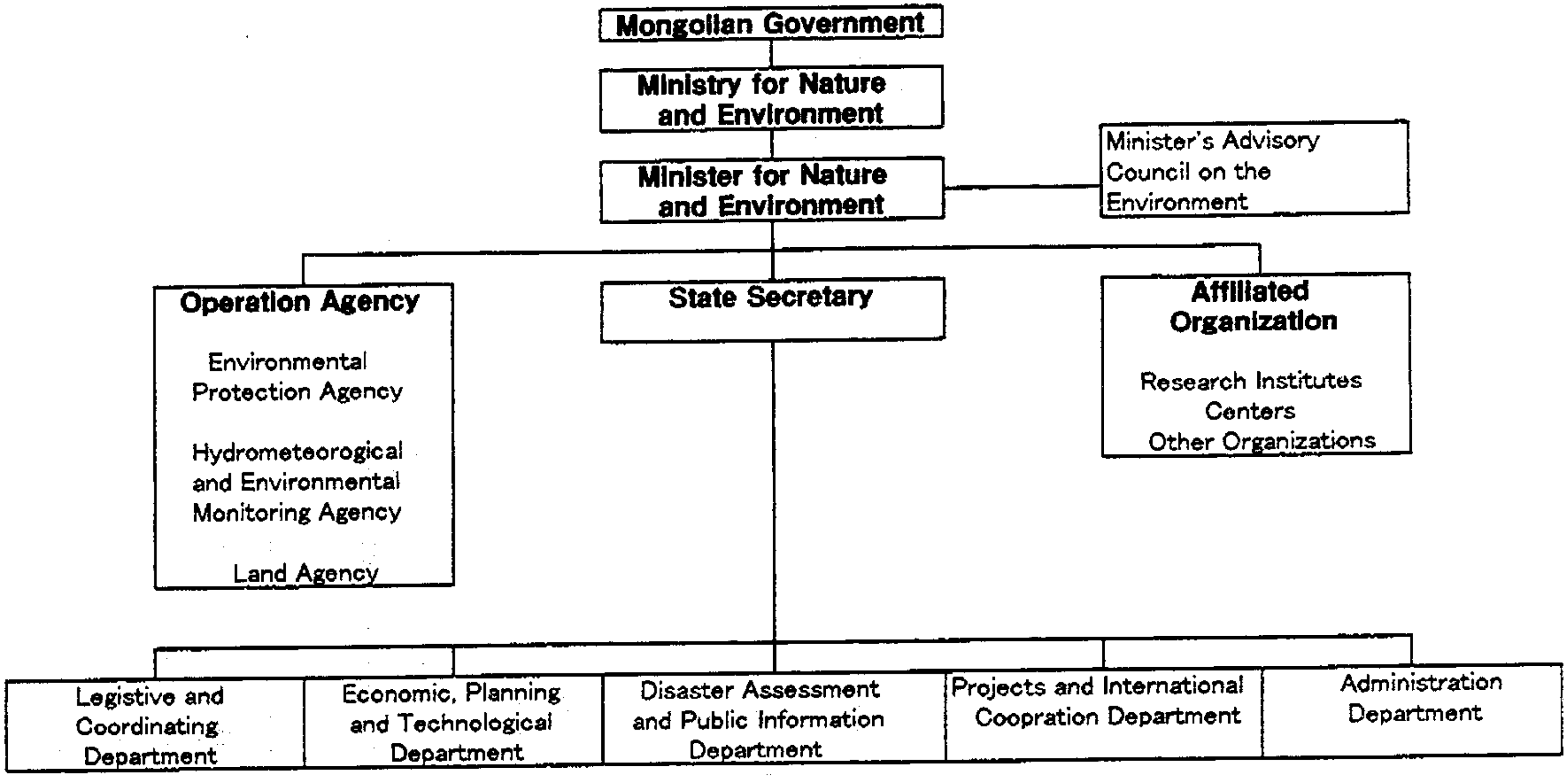


Fig.7－3－1　Structure of Ministry for Natural and Environment

7 - 4 Initial Environment Examination (IEE)

(1) Objective

This Initial Environmental Examination (hereinafter called "IEE") was conducted in the stage of Master Plan Study. IEE shall be carried out to clarify the environmental impacts that may be generated by this project on the basis of existing information and data in a short period at a low cost. IEE has the following two objectives:

1) To evaluate whether Environmental Impact Assessment (EIA) is necessary for the project and if so, to define its contents.

2) To examine, from an environmental view point, the measure for alleviating the impacts of the project which require the environmental consideration but not a full-scale EIA.

(2) Methods

Preliminary environmental examination, which was already conducted in the stage of Scope of Work Mission, suggested that this project would consider the following items as a component of IEE.

1) Hydrological situation

2) Fauna and flora

3) Resettlement

4) Water rights and rights of common

5) Soil erosion

The present environmental situation around study areas was investigated by hearing from related governmental bodies, collecting existing data and re-entrusting adequate local subcontractors with environmental investigation on

1) Fauna and flora

2) Aquatic biota

3) Water quality of rivers and ponds

4) Hydrology of rivers

The results of environmental investigation by local entrusted subcontractors are shown in an independent report (Report A).

(3) Results and Consideration

1) Fauna, Flora and Aquatic Biota

The fauna and flora were investigated at 27 sites along the railway in the study area of the rehabilitation project of the Mongolian Railway, and the aquatic biota was also studied if aquatic area existed. Investigated sites are shown in p6-p7 of the Report A.

All the railway in Mongolia is enclosed by a fence to prevent the intrusion of domestic animals. Species number and quantity of plant in the inside of the fence is more than those in a pasture around the railway. But a great part of plants in the inside of the fence are also cut down in autumn. And these fences are indicated to prevent the movement of large mammals.

Animals which are protected as a very rare or a rare animal among mammals, birds and fish are shown in Appendix 7-1 (very rare) and Appendix 7-2 (rare). And plants which are protected as a very rare or a rare plant are shown in Appendix 7-3 (very rare) and Appendix 7-4 (rare). Plants and animals being selected as a rare in Mongolian red data book, which was published in 1987 and is being revised in 1996, are shown in Appendix 7-5 and 7-6, respectively. Animals prohibited from internationally trading by Convention International Trade in Endangered Species of Wild Fauna and Flora (CITES) which Mongolia participates are shown in Appendix 7-7. The red list of the World Conservation Union (IUCN) relating to Mongolia is shown in Appendix 7-8.

Animals found in the study area along the railway are shown in the Report A (p117-p122). Among them, rare species are shown below.

1. Hunting Law: (Rare species) *Cervus elaphus* (Red Deer, mammal)
2. Mongolian Red Data Book: *Erinaceus dauricus* (Daurian Hedgehog, mammal), Hucho taimen (Taimen, fish)
3. CITES: *Milvus migrans* (Black Kite, bird), Accipiter *gentilis* (Northern Goshawk, bird), *Aquila chrysaetos* (Golden Eagle, bird), *Bubo bubo* (Eagle Owl, bird), *Felis manul* (Pallas' Cat, mammal), *Canis lupus* (Gray Wolf, mammal),
4. IUCN: *Parnassius apollo* (Apollo, insect)

Plants found in the study area along the railway are shown in the Report A (p86-p98). Among them, rare species are shown below.

1. Natural Plant Law: (Very rare species) *Gentiana macrophylla* (Macrophyllous Gentian), *Adonis mongolica* (Mongolian Adonis); (Rare species) *Stellaria dichotoma* (Dichotomous Starwort), *Stellaria media* (Chickweed), *Pinus sibilica* (Siberian Pine), *Hedisarum dauricum* (Daurian Sweetbech)Mongolian
2. Red Data Book: *Adonis mongolica* (Mongolian Adonis), *Caryopteris mongolica* (Mon-golian Bluebeard), *Hippophae rhamnoides* (Seabuckthorn), *Stellaria dichotoma* (Dichotomous Starwort)

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.

2) 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

Though the report A indicates that egg laying sites were not found at the investigation sites, the ecology of fish and other aquatic biota in the Selenge river basin should be studied to reduce impacts towards aquatic biota. But a section of this type of construction is so short compared to the river's part with the same environmental factors that the environmental impacts may be small.

3) Water quality of rivers

Water quality of rivers are shown in Table 3.15 of the report A (p.56). BOD data for small rivers in the southeast of Ulaan-baatar is higher than the standard value, because these small rivers are used as a watering place for domestic animals and polluted with their excreta. COD values near Ulaan-baatar, Zuunkharaa and Sukhe-baatar become higher with waste water from factory and domestic waste water.

4) Resettlement

Constructions which need a resettlement will not be done in this project.

5) Water Rights and Rights of Common

There are few families who support their life as a fisher and the rivers are not used as an irrigation system in the study area. Water rights and fishing rights are not important factor in this case. The new land law permits land privately used and farms producing crops, vegetables or hay have a high possibility to change to a private land, although it is said for pasture land to remain as state owned one. It is necessary to see how the land system will be changed.

6) 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.

New drainage facility constrictions also have a possibility of introducing soil erosion. It is necessary to try to minimize it.

7) Specially Protected Area

Since Bogt Khan Uul became a protected area in 1778, eleven places were named before 1980 and then 15 places were named in 1992 and 1993. The present protected areas and proposed protected areas are shown in Appendix 7-9 and 7-10, respectively. And the locations of these are shown in Appendix 7-11. The study area is only adjacent to Bogt Khan Uul, and constructions will not be done near there. Tujiin Nars (near Sukhe-baatar), one of proposed protected areas, is away more than 10 km from the study area.

8) Points to Notice for Each Type of Construction

- Revetment and Spur Dike along Track Embankment: There will be a little impact for aquatic biota. But it is necessary to get information on the aquatic biota in the Selenge river basin. At the same way, these constructions' products should not obstruct live-stock's access to a river.
- Short Cut of River Flow: On the occasion of construction, it is necessary to consider the reduction of impacts for aquatic biota. For example, a breeding season should be avoided if the construction site is breeding place of some species. Furthermore the result of these constructions should not obstruct live-stock's access to a river. The place where short cuts of river flow will be done is pasture land, so that the problem relating to the land ownership will not occur.
- Elimination of Weathered Rock Slope Surface: The results of environmental investigation by local entrusted subcontractors indicate that there are not for breeding of rare avian species in the investigated points. But if the breeding site exists, it is

necessary to avoid the construction from the breeding season.

- Track Raising: There are not great impacts toward the environment.
- Concrete Bridge Repair: It is necessary to avoid polluting rivers with toxic chemicals to be used in the construction.
- Concrete Bridge Replacement: It is necessary to avoid the outflow of a large quantity of earth and sand when the bridge replacement is done.
- New Drainage Facility construction and Increase Drainage Capacity: It is necessary to consider if natural disasters happen as a result of change of the flow path of water and mud in the case of inundation, especially in Sukhe-baatar flood control. The construction of new drainage facility will partially release the separation of the region, and give the region positive economic effects.
- New track construction: The results of environmental investigation by local entrusted subcontractors indicate that its impacts toward fauna and flora are not great. But if some rare plant species are distributed in the construction area or if some rare avian species breed there, it is necessary to mitigate these negative impacts. In the case of rare plant species, these plants should be transplanted. And in the case of rare avian species, it is necessary to avoid the construction from the breeding season. If the construction will include cutting down trees, it is necessary to consider if the erosion of soil occurs. Covering the land around the railway with natural plants will protect the land from the erosion of soil.
- Widening of Channel at 399 km: The construction site is in an industrial area and there aren't schools nor hospitals near there. And also there are not rare species including aquatic biota. But it is necessary to take consideration into the method of disposition of contaminated wasted soil which the construction will produce.

9) General Points to Notice during the Construction

- 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.
- Solid wastes that constructions produce should be brought to the nearest station, separated and treated.

- At the time of the melting snow in spring and at the time of a localized heavy rain in summer, it is necessary to select an appropriate place where workers stay at night in order to prevent from accidents.

10) Problems after the Construction

There is not a great difference relating to impacts toward the environment by the Mongolian railway between before and after this rehabilitation project.

(4) Conclusion

Environmental impacts that this project will produce are shown in Table 7-4-1. The following points shall be done in the secondary phase:

1) collecting some additional data on ecology of the aquatic biota in the study area, for example breeding season and place of each fish.
2) chemically and microbiologically analyzing the wasted sediment and soil which will be produced in the widening of channel at 399 km.
3) surveying whether natural disasters happen as a result of change of the flow path of water and mud in the case of inundation after a new drainage facility construction, especially in Sukhe-baatar flood control.

Table 7 – 4 – 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