CHAPTER 1 INTRODUCTION

1.1 Introduction

Transport plays a crucial role in the efficient functioning of the domestic economy as well as development of international trade due to dependence on both coal-based energy production and imports. However, the issues in the transport sector of Mongolia are mainly derived from the salient features of a landlocked country with a low population and a long distance between population centers.

A major characteristics of transportation in Mongolia is the collection and distribution by road of both passenger traffic and cargo transport from the north-south transport axis centering on Ulaanbaatar. The main north-south axis comprises both rail and road. Within road transport, the density of arterial road network remains very low and unpaved earth roads or multiple shifting tracks occupy a large portion of arterial roads. More than 30% of population and a half of national car ownership are concentrated in Ulaanbaatar City, while very low level of mobility is found in rural area because non-motorized traffic such as horse and cart prevails. Recently, such gap of mobility level is increasing.

Under such circumstances, in response to the request of the Government of Mongolia (hereinafter referred to as "GOM"), the Government of Japan decided to conduct the Feasibility Study on Construction of Eastern Arterial Road in Mongolia (hereinafter referred to as "the Study"), in accordance with the relevant laws and regulations in force in Japan.

Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, dispatched the preparatory study team headed by Mr. Ken-ichiro OI in December 2000 to have a series of meetings with related agencies of GOM. As a result of these meetings, GOM and JICA have agreed the scope of work for the Study.

In March 2001 JICA instructed the study team headed by Mr. Kenji MARUOKA to conduct the Study based on the agreed scope of work.

Due to the road construction work in between Erdene and Baganuur which is being undertaken by GOM, the agreed scope of work was amended in September 2001 to exclude the area where GOM commenced the road construction work. Accordingly, the work items such as preliminary design, construction plan and cost estimation were carried out excluding the road section between Erdene and Baganuur. However, the Study incorporates the work items such as environmental impact assessment, road maintenance plan, economic and financial analysis and implementation plan as these have a close relationship to the study context as a whole.

1.2 Study Objectives

The objectives of the Study are as follows;

(1) to carry out a feasibility study on construction of the Eastern Arterial Road; and

(2) to transfer technology to Mongolia counterparts.

1.3 Scope of the Study

1.3.1 Study Area

The study road of the Eastern Arterial Road is the road section from Erdene to Undurkhaan on State Highway No. 0501, approximately 250 km in length as shown in Figure 1-3-1. The area influenced by the study road consists of four eastern provinces of Tuv, Khentii, Dornod and Sukhbaatar as well as the Kherlen river basin.

1.3.2 Target Year

The target year of the plan is the year 2015, which accords with that of relevant studies and projects implemented by the Government of Mongolia.

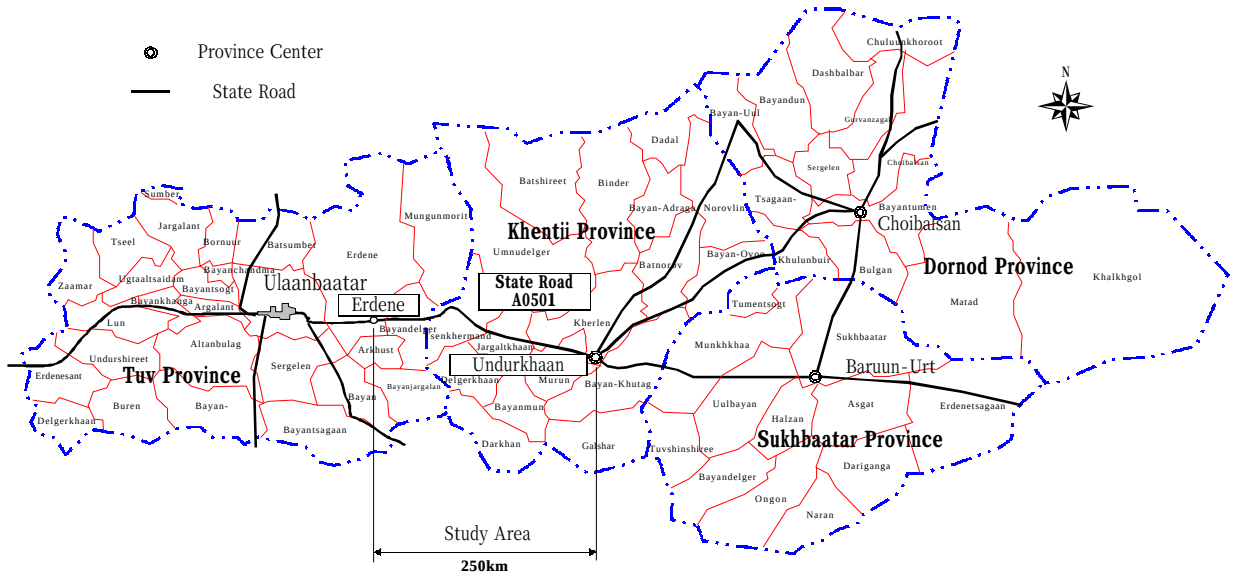


Figure 1-3-1 Study Area

CHAPTER 2 NATURAL CONDITIONS AND ROAD TRANSPORT

2.1 Natural Conditions

2.1.1 Topography

The western half and northeast of the Mongolian territory is classified a mountainous region, while wide plains including the Govi Desert covers the remaining parts. The Mongol Altai Mountains and the Khangai Mountains are the highest parts of the country, having high peaks and ridges ranging from 3,000m to 4,000m in altitude. The Khentii Mountains is situated in the study area and is characterized by their gentle relief. The Khentii Mountains slope gently southward and eastward and contact with the plain area.

The study road runs in the boundary area between the Khentii Mountains and the plain area, and its elevation varies from 1,000m at Undurkhaan to 1,600m at the Dutluur pass.

2.1.2 Meteorology

The temperature ranges from –43°C to +38°C and observed daily precipitation varies from 38 mm to 97 mm at the maximum as shown in Tables 2-1-1 and 2-1-2.

Table 2-1-1 Temperature in the Study Area (°C)

	Month	Jan.	Feb.	Mar.	Apl.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Ulaanbaatar	Ex.Max.T	-2.6	8.5	15.5	23.6	30.8	34.5	38.1	34.6	28.8	21.7	10.6	-2.4
	Ave.MaxT.	-7.4	-1.2	9.7	20.6	29.3	30.6	32.1	29.1	25.3	16.5	6.01	-5.2
	Ave.Min.T.	-33.3	-27.7	-23.0	-12.3	-4.7	1.9	6.5	4.9	-3.6	-15.4	-25.9	-31.0
	Ex.Min.T.	-38.8	-31.4	-26.6	-15.6	-8.2	-2.7	4.0	2.2	-6.5	-17.5	-29.7	-34.5
Baganuur	Ex.Max.T	-3.2	8.3	15.5	24.5	31.6	35.3	35.6	33.6	26.2	21.2	8.8	-0.7
	Ave.MaxT.	-9.5	-0.25	8.8	19.6	28.1	30.2	30.7	27.8	24.0	17.6	5.2	-5.3
	Ave.Min.T.	-38.3	-33.2	-28.2	-15.6	-7.9	-1.3	4.4	1.6	-6.9	-19.2	-31.1	-34.6
	Ex.Min.T.	-43.7	-39.6	-37.0	-20.0	-11.5	-6.1	1.6	-0.5	-10.6	-25.5	-35.8	-40.3
Undurkhaan	Ex.Max.T	-3.0	7.4	19.0	27.5	34.2	35.9	38.6	38.1	32.3	24.8	13.5	0.7
	Ave.MaxT.	-8.7	-3.8	11.1	22.5	30.7	33.7	33.7	31.4	28.1	19.8	8.2	-3.2
	Ave.Min.T.	-36.0	-32.6	-27.7	-14.8	-5.7	1.8	6.8	4.9	-4.6	-17.8	-29.8	-33.6
	Ex.Min.T.	-39.5	-37.0	-35.3	-19.3	-10.4	-1.5	3.1	2.5	-8.9	-25.4	-38.1	-37.6

Note: Data of temperature are collected for ten years from 1991 to 2000.

Table 2-1-2 Observed Daily Precipitation

Location	Altitude (m)	Max. (mm)	Ave. (mm)	Note
Ulaanbaatar-A	1350	51.7	26.6	1970-2000
Ulaanbaatar-B	1350	56.3	26.6	1983-2000
Ulaanbaatar-C	1350	60.1	25.8	1975-2000
Terelj	1800	55.5	38.8	1986-2000
Baganuur	1350	62.5	31.4	1991-2000
Mungun Morit	1450	38.3	28.9	1989-2000
Undurkhaan	1050	97.8	30.7	1970-1998

2.1.3 River and Hydrological Conditions

There are four major rivers and these are the Togos, Kherlen, Tsenkher and the Murun. The study road crosses these major rivers and their tributaries.

The design discharge of the Kherlen River is estimated based on a probability of 100 years due to the large catchment area, while a probability of 50 years is adopted for other major rivers as shown in Table 2-1-3.

A return period of 20 years is applied to other minor rivers such as Khujirt, Khutsaa and Urt Valley and streams for all box culverts.

Table 2-1-3 Design Discharge

Name of River	Catchment Area (km^2)	Proposed Value (m^3/s)	Return Period
Togos	460	250	1/50
Kherlen	7350	1,100	1/100
Tsenkher	790	300	1/50
Murun	3160	350	1/50

2.1.4 Geology and Sub-surface Soil Conditions

Intrusive rocks such as granite, grano-diorite, diorite, and syenite are widely distributed along the route of study road. The intrusions into the area occurred in Proterozoic, Paleozoic, and Mesozoic periods and the intrusions in the Paleozoic period were very active. The intrusive rocks form ridges and peaks of mountains along the route. In general, the surface of rocks has been weathered until it is extremely friable and crumbly.

Proterozoic and Paleozoic sedimentary rocks such as shale and sandstone are sporadically distributed. Shale predominates among the sedimentary rocks along the route. Due to the effect of the repeated intrusions and tectonic movements, shale has many fissures and planner schistosity structure. This kind of shale is typically observed on the east of the Duut pass. The following mountainous areas are made up mostly of the sedimentary rocks;

- South of the Togos river
- West bank of the Tsenkher river (between Mandal mountain and the existing Tsenkher river bridge
- Between the Kherem steppe and the Chandgana steppe

Cretaceous sedimentary rocks such as sandstone, shale, compacted sand and clay, and coal underlie the Nuga steppe and Nariin steppe in Baganuur, the Kherlen steppe at Jargaltkhaan, Chandgana steppe, and a shallow basin situated between the Oont pass and the Duut pass. Small hills located in these flat areas are also formed by these rocks. The Bagaunur and Chandgana coal deposits belong to this formation.

Cambrian volcanic rocks including tuff, porphyry, andecite and quartzite form mountains situated to the northeast of Murun and the northwest of Undurkhaan.

The Jargaltkhaan mountain consists of basalt which erupted in the Cretaceous period. Basalt hills are also scattered between Murun and Undurkhaan.

Low-lying areas including steppe and bottom of valleys are covered by Quaternary deposits. Terraces, taluses and fans developed along toe of slopes are also underlain by Quaternary deposits. The talus deposits even cover the top of the gentle hills. Fluvial sand and gravelly soils have accumulated along rivers. These deposits mainly consist of coarse particles. Organic or silty fine soils are distributed along the bottom of valleys and backmarshes formed along rivers. The earth hammocks are formed at these fine soil areas with high groundwater table. Reddish brown to dark brown silty and very fine sand to sandy silt with grassroots are thinly mantled over the study area with a thickness of 15 to 50cm. These soils are mainly aeolian deposits.

2.2 Road and Road Transport

2.2.1 Road Network

Roads in Mongolia are administratively classified into two (2) categories, namely State road and Local road.

The State Road network comprises six (6) major state roads radiating from Ulaanbaatar, the capital city, and serves for collecting and distributing traffic to provincial centers as shown in Figure 2-2-1.

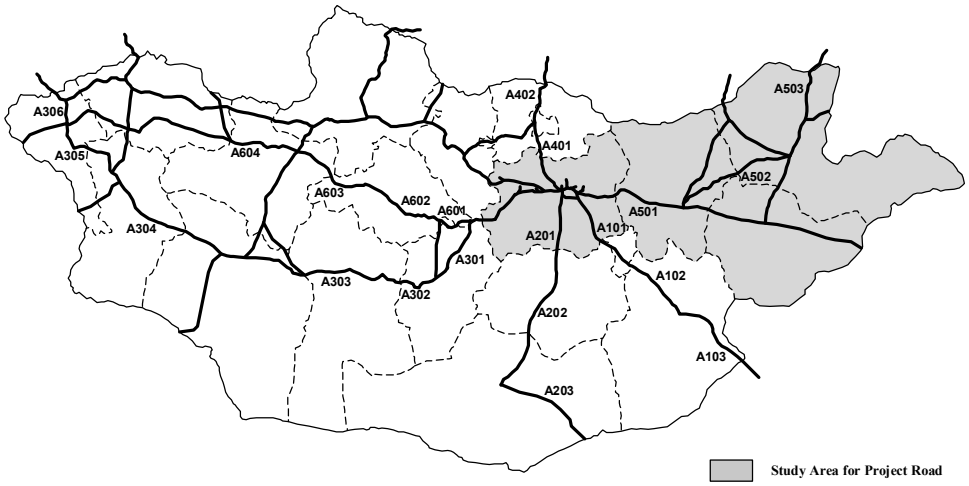


Figure 2-2-1 Road Network

2.2.2 Road Length

Excluding the Community Roads, the total road length in Mongolia is 49,250 km, of which State Road accounts for 22.5% or 11,063 km and Local Road for 77.5% or 38,187 km. Roads in the study area accounts for 20.3% or 9,975 km of all non-community roads in Mongolia and these can be divided into State Road of 3,055 (27.6%) and Local Road of 6,920 km (18.1%) as shown in Table 2-2-1. Tuv province has the longest length of State Road, and the percentage of State Road is high in Khentii province and low in Sukhbaatar.

Table 2-2-1 Road Length by Each Province (2000)

	State Road		Local Road		Total	
Unit	Km	%	Km	%	Km	%
Dornod	871.0	33.3	1,748.0	66.7	2,619.0	100.0
Sukhbaatar	535.0	17.8	2,477.0	82.2	3,012.0	100.0
Tuv	1,010.0	29.4	2,430.0	70.6	3,440.0	100.0
Khentii	639.0	70.7	265.0	29.3	904.0	100.0
Total in 4 provinces	3,055.0	30.6	6,920.0	69.4	9,975.0	100.0
Total in Mongolia	11,063.0	22.5	38,187.0	77.5	49,250.0	100.0

Note : The above Table excludes Community Roads

2.2.3 Traffic Characteristics

The existing traffic characteristics in the study area are as follows:

(1) Public Transport

Bus transport accommodates three services such as inter-city, intra province and urban transit. Long distance inter-city buses are operated in many routes with low frequency. Out of a total of 39 routes, there are four long distance inter-city along the study road.

Railway services are limited to the northeastern part of the study area. Passenger service is operated twice a week and cargo service is on demand basis. The share of railway transport is very low compared to road transport.

(2) Analysis of Traffic Survey

The result of traffic count survey conducted in 2001 was not reliable due to the influence of the recent "Foot and Mouth disease" As shown in Figure 2-2-2, daily traffic volumes on the study road ranged from 125 to 377 vehicles. Due to this anomaly, the number of daily traffic volume has been increased up to the year 2000 level.

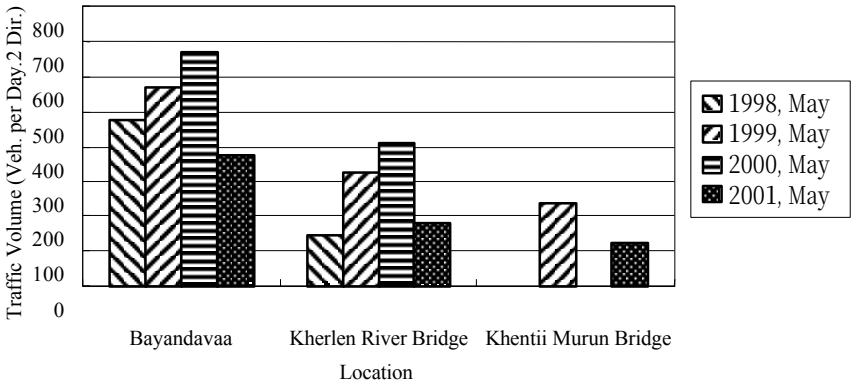


Figure 2-2-2 Comparison of Daily Traffic Volume by Year

The share of cars is high at about 52%, while the share of trucks is 21%. Hourly traffic variation patterns shown three peak periods, while the percentage of total traffic volumes in 12 hours and 24 hours vary from 46% to 60% on average.

The share of private matters trips is higher at 65% than business trips, and the share of private matters trips and business trips in the type of Trucks are almost half the total number.

Top three items of goods are i) machinery, transport equipment, manufactured products and others, ii) human food and livestock feed and iii) crude, manufactured minerals and building material. The average loading factor is about 61%.

Average numbers of passenger by vehicle types are: cars - 4.1 persons; bus - 7.5 persons; small truck - 3.4 persons; medium truck - 3.5 passengers and large truck - 2.6 persons. The share of private ownership is high at 74.8%, while the share of company owned is 24.9%.

The highest share in OD pairs is observed between Ulaanbaatar and Baganuur (27.7%), followed by Ulaanbaatar - Undurkhaan (10.1%), Ulaanbaatar - Umnudelger sum (Khentii province) (5.5%) and Ulaanbaatar - Dornod province (5.4%).

Directional average travel speeds by vehicle types are; car (32.7-33.2km/h), bus (28.3-29.0km/h). The average travel speed among different types of vehicles varies by about 4km/h.

Table 2-2-2 Main OD Pairs

No.	OD Pair	Share (%)
1	Ulaanbaatar - Baganuur	27.7%
2	Ulaanbaatar - Undurkhaan	10.1%
3	Ulaanbaatar - Umnudelger sum(Khentii province)	5.5%
4	Ulaanbaatar - Dornod province	5.4%
5	Ulaanbaatar -Sukhbaatar province	4.7%
6	Baganuur - Tsenkhermandal sum (Khentii province)	3.9%
7	Darkhan sum (Khentii province) - Undurkhaan	3.9%
8	Ulaanbaatar - Tsenkhermandal sum (Khentii province)	2.9%
9	Murun sum (Khentii province) - Undurkhaan	2.6%
10	Bayanmunkh sum (Khentii province) - Undurkhaan	2.5%
	Other 61 pairs	30.8%
	Total	100.0%

Source: JICA Study Team, 2001

(3) Existing OD Conditions

Daily traffic volume surveyed in 2001 was not reliable due to the recent livestock disease and therefore the interview data in 2001 was expanded using 2000 data in order to generate the average daily OD table.

For the economic analysis, the average annual daily traffic (AADT) figure is needed to reflect average traffic conditions throughout the year, including seasonal variations. 0.95 of the weekly variation factor and 0.97 of the average monthly variation factor were applied for estimates of AADT.

Existing OD matrices was constructed after expanding to AADT. Total traffic volume related the study road between Ulaanbaatar and Undurkhaan is 959 trips per day.

Figure 2-2-3 Desire Line of Existing OD Pairs

2.3 Conditions of Existing Road Facilities

2.3.1 Road Conditions

(1) Road Surface Type

Table 2-3-1 shows the road length by type of road surface in the study area. Of total length in Mongolia, paved road occupies only 3.5% or 1,714 km in length, that is to say that almost all roads are still unpaved. The road length by surface type in the study area is: paved 725.5 km (7.3%), gravel road 607.3 km (6.1%), improved earth road 310.2 km (3.1 %) and earth road 8,332.0 km (83.5%). More than 90% of roads are unpaved.

Table 2-3-1 Length by Type of Road Surface by Province (2000)

	Unit	Paved Road		Gravel Road		Improved Earth Road		Earth Road		Total
		State Highway	Local Road	State Highway	Local Road	State Highway	Local Road	State Highway	Local Road	
Dornod	km	10.0	7.3	267.0	10.0	136.0	0.0	458.0	1,730.7	2,619.0
	%	0.4	0.3	10.2	0.4	5.2	0.0	17.5	66.1	100.0
Sukhbaatar	km	0.0	2.8	4.6	0.0	0.0	4.0	530.4	2,470.2	3,012.0
	%	0.0	0.1	0.2	0.0	0.0	0.1	17.6	82.0	100.0
Tuv	km	523.4	1.4	7.7	0.0	95.7	0.0	383.2	2,428.6	3,440.0
	%	15.2	0.0	0.2	0.0	2.8	0.0	11.1	70.6	100.0
Khentii	km	2.0	178.6	271.0	47.0	74.5	0.0	291.5	39.4	904.0
	%	0.2	19.8	30.0	5.2	8.2	0.0	32.2	4.4	100.0
Total in 4 provinces	km	535.4	190.1	550.3	57.0	306.2	4.0	1,663.1	6,668.9	9,975.0
	%	5.4	1.9	5.5	0.6	3.1	0.0	16.7	66.9	100.0
Total in Mongol	km	1,316.8	397.3	1,379.2	497.9	1,407.6	516.0	6,959.5	36,775.8	49,250.0
	%	2.7	0.8	2.8	1.0	2.9	1.0	14.1	74.7	100.0

The road lengths by surface type in the study area are: cement concrete paved 1.0 km (0.4%), asphalt concrete paved 17.7 km (6.7%), bituminous surface treatment 1.2 km (0.5%), gravel 32.0 km (12.1%), improved earth road 77.5 km (29.4%) and earth road 129.6 km (49.1%). More than 90% of roads are unpaved even though half of the roads in the study area have been improved.

(2) Pavement Conditions

The type of road surface in the study area consists of cement concrete paved, asphalt concrete paved, double bituminous surface treatment, gravel, improved earth and earth.

Many potholes and cracks are observed on the cement concrete paved, asphalt concrete paved and double bituminous surface treatment due to age, low quality of construction, poor maintenance and the severe climate. The surface of pavement is especially damaged by cold weather-induced cracking and frost action of frost susceptible soil due to the freeze-thaw cycle. Due to these weather patterns, all kinds of pavement defects take place. Gravel road is no longer flat due to tracking of vehicle's vibration. Therefore, most drivers avoid driving on the existing gravel road because it gives no comfort and does not permit high speed moving. Moreover, it is obvious that vehicles scatter fine particles from the gravel roads under the dry climate in Mongolia. It is

necessary that the pavement design should be made considering such pavement characteristics.

(3) Surface Conditions by Roughness

Figure 2-3-1 gives an average IRI of 13.8, where IRI value varies from 6 to 20 (m/km). For example, location ① is a typical rocky mountain pass, where large rocks are exposed on the road surface and riding condition is extremely poor, while location ② has an asphalt concrete surface, which is old with a poor smoothness for such a paved road.

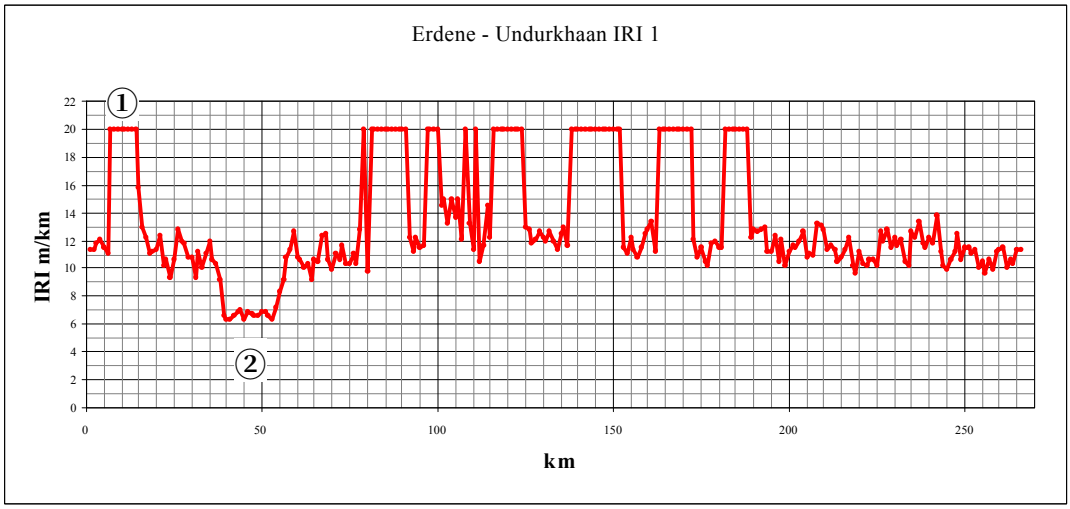


Figure 2-3-1 Result of IRI measurements between Erdene and Undurkhaan

2.3.2 Bridge and Structure Conditions

(1) Condition of Existing Bridges

There are five bridges on the study road and these can be classified into three types, namely one RC slab, three wooden bridges and one RC- T shape girder. These bridges were constructed in the 1960s and 1970s by Russian or Mongolian contractors.

(2) Evaluation of Existing Bridges

The evaluation of the existing bridges is summarized as shown in Table 2-3-2.

It is recommended that Br.No.1 (Khujirt River) be replaced because it has inadequate river section for the design discharge; is under strength according to the Japanese live loading standards; and shows deterioration due to its advanced age. The bridge should not be used in the long term for the future Millennium International Road.

Three timber bridges Br.No2 (Khutsaa River), Br.No.4 (Tsenkher River) and Br.No.5 (Murun River) should be replaced with permanent type reinforced concrete structures.

Br.No.3 (Kherlen River) is also recommended for replacement and/or reinforcement due to poor evaluation result on most points.

Table 2-3-2 Overall Evaluation Results for Project Bridges

	Exising Bridge / Category	Br.No1 Khujirt River	Br.No.2 Khtsaa River	Br.No.3 Kherlen River	Br.No.4 Tsenkher River	Br.No.5 Murun River	Remark
Scale of Bridge	Bridge Length	9.2m	14.7m	268.8m	30.7m	19.6m	Total length
	Width	6.7m	5.6m	7.0m	5.6m	5.6m	Carriageway width
	Type:Superstr.	RC slab	Wooden slab	RC T girder	Wooden slab	Wooden slab	Super structure
	Type:Substr.	RC wall	Wooden pile	RC wall	Wooden pile	Wooden pile	Sub structure
	River	W:8m, H:2.7m	W:15m, H:2.8m	W:270m, H:4.2m	W:30m, H:1.2m	W:20m, H:1.3m	W:width, H:clearance
Conditions (A:Soundness)	Durability (super)	**3**: Leaked	**4**: Damaged	**3**: Cracks, Gaps	**4**: Broken	**4**: Damaged	Degree of Damage, defect
	(sub)	**2**: Carbonated	**4**: Broken	**2**: Deteriorated	**4**: Settled	**4**: Inclined	good:1- bad:4
	Load Capacity	**1**: 8.4%	**1**: 4.8%	**1**: 4.8%	**1**: 4.8%	**1**: 7.8%	Ratio of Heavy Vehicle
	(Vehicle 12 ton base)						10%: less:1- more:3
	Function:						
	Constructed year	**3**: 1970s	**1**(3): 1995y	**3**: 1974y	**3**: 1962y	**3**: 1962y	25year:less:1- more:3
	Carriage width	**1**:6.7m(improve)	**3**: 5.6m	**3**: 7.0m	**3**: 5.6m	**3**: 5.6m	8m:enough:1- short:3
	River section	**3**: 15m required	**3**: 17.5m required	**3**: 350m required	**3**: 52.5m required	**3**: 52.5m required	section:enough:1- short:3
Conditions (B:Structural Study)	Applied Mongolian Live Load	Slab:Over Stress Wall:Allowable (for Abutment & Pier) **Not stable**		Girder:Allowable Slab:Over Stress Pier:Allowable **Not stable**			
	Applied International Live Load	Slab:Over Stress Wall:Over Stress (for Abutment) **Not stable**	Temporary Wooden Type **Dangerous**	Girder:OverStress Slab:Over Stress Pier:Over Stress **Not stable**	Temporary Wooden Type **Dangerous**	Temporary Wooden Type **Dangerous**	
Overall Evaluation	Soundness Survey	**3**	**4**	**3**	**4**	**4**	Rank of Evaluation **D**:Sound, stable (1) **C**:Fairy Sound & Fairy stable (2)
	Structural Calculation (capacity)	**3**	**4**	**3**	**4**	**4**	**B**:Unsound & Not stable, Repair or Replace(**3**)
	Overall Rank	**B**	**A**	**B**	**A**	**A**	**A:**Dangerous, Replace(4)

(3) Concrete Culverts

There are many crossing culvert structures along the study road. The types of culverts are: pre-cast concrete pipe, pre-cast concrete square type and steel pipe.

The pre-cast concrete pipes in Baganuur are observed to have almost no defects or damage. Other crossing culverts along the study road are in poor condition and they are damaged and defective enough not to be used for the project.

CHAPTER 3 SOCIOECONOMIC CONDITIONS AND TRAFFIC DEMAND FORECAST

3.1 General Situation of Mongolia

(1) Population

1) Current Condition

The population of Mongolia has increased from 2,050,000 in 1990 to 2,407,500 in 2000. Although the annual growth rate in population varied between 2.7 and 2.9% up until 1989, the average growth rate during the past decade from 1990 was approximately 1.5%. About 50% of provinces have had declining populations during the past 5 years, and only Ulaanbaatar has seen a significant increase. This is seemingly mainly due to the transfer of residents toward Ulaanbaatar. The populations from 1990 to 2000 are show in Table 3-1-1.

Table 3-1-1 Current Population by Provinces and Capital City

Unit: Persons

Provinces & Capital Cit		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*
Total Mongolia		2,050,044	2,256,982	2,253,632	2,218,246	2,221,285	2,234,386	2,245,492	2,270,208	2,290,839	2,373,493	2,407,500
1	Arkhangai	87,354	96,296	102,728	102,716	100,196	100,842	98,441	95,910	96,753	97,091	97,500
2	Bayan-Ulgii	98,105	102,817	92,989	75,043	79,284	82,259	83,562	85,441	87,341	91,068	94,600
3	Bayankhongor	76,389	81,584	83,675	85,301	82,677	86,025	86,824	87,812	88,627	84,779	85,300
4	Bulgan	55,734	60,976	62,456	60,999	61,439	60,546	61,180	63,798	64,093	61,776	62,600
5	Govi-Altai	63,299	69,840	71,703	71,528	72,236	72,921	69,012	70,249	70,442	63,673	63,600
6	Dornogovi	55,180	49,999	49,861	47,773	45,985	45,734	46,575	47,097	47,739	50,575	51,100
7	Dornod	74,787	86,909	87,048	83,722	81,915	79,869	76,403	74,475	73,813	75,373	74,200
8	Dundgovi	51,324	56,195	55,705	51,291	50,882	50,511	50,431	51,402	52,081	51,517	51,300
9	Zavkhan	91,960	99,371	102,824	101,697	103,150	101,443	102,341	102,242	100,905	89,999	87,200
10	Uvurkhangai	97,805	105,296	111,719	109,387	109,818	111,561	111,045	113,408	113,476	111,420	113,000
11	Umnugovi	41,932	44,923	46,993	45,014	42,839	43,551	44,324	44,594	45,102	46,858	46,900
12	Sukhbaatar	52,466	57,408	56,066	56,084	57,546	55,850	56,534	55,731	55,523	56,166	55,900
13	Selenge	88,927	95,883	93,725	90,690	95,725	93,270	95,507	97,771	98,389	99,950	100,900
14	Tuv	103,943	110,503	112,855	108,210	105,741	103,721	104,238	104,592	103,537	99,268	98,000
15	Uvs	90,154	98,702	100,096	98,197	98,756	99,624	98,625	94,734	94,834	90,037	86,800
16	Khovd	78,663	89,365	89,029	87,171	88,421	88,494	90,083	91,339	90,855	86,831	87,800
17	Khuvsgul	104,140	113,849	119,133	116,867	117,391	117,678	113,312	116,120	117,123	119,063	119,800
18	Khentii	72,622	76,973	77,631	73,096	72,639	70,267	71,212	71,519	70,164	70,946	71,400
19	Darkhan-Uul	80,140	90,547	91,292	91,303	85,808	87,084	87,368	87,767	89,114	83,271	84,800
20	Ulaanbaatar	536,594	600,985	575,000	588,000	596,000	612,100	624,896	638,442	652,231	760,077	786,500
21	Orkhon	48,526	57,054	59,138	62,868	61,640	59,105	61,495	63,541	66,616	71,525	76,000
22	Govi-Sumber	-	11,509	11,966	11,289	11,197	11,931	12,084	12,224	12,072	12,230	12,300

Source: Mongolian Statistical Yearbook, 2000

* denotes that the original figures in the statistical yearbook are shown in thousand persons.

2) Employed Population

The annual growth rate of employed population in total Mongolia is approximately 0.42% and the annual growth rates of provincial employed population have varied between - 4.96% and 3.14%. Table 3-1-2 shows the growth rate and share of employed population in total Mongolia. As shown in Table 3-1-3, the share of employed population in total Mongolia is stable at 34% approximately, and the growth rate of employed population based on logarithmic regression formula using ratios of 1990 to 2000 is about 0.42%.

Table 3-1-2 Employed Population by Provinces During Past Decade

Unit: Persons

	Provinces & Capital City	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000*
	Total Mongolia	783,579	789,800	806,025	765,364	759,760	767,638	769,618	765,092	792,570	813,559	809,000
1	Arkhangai	34,746	35,805	36,157	38,322	38,691	38,864	39,499	37,321	37,317	38,125	38,600
2	Bayan-Ulgii	30,246	28,066	26,700	22,037	23,150	23,397	23,188	23,465	29,244	30,924	29,100
3	Bayankhongor	28,435	28,874	28,388	29,854	31,532	35,085	33,518	34,105	35,053	34,211	34,600
4	Bulgan	22,191	21,604	22,503	21,370	25,027	24,279	23,156	21,275	22,681	22,719	22,700
5	Govi-Altai	22,861	25,335	26,882	25,300	26,425	26,887	28,996	29,485	30,414	30,031	28,500
6	Dornogovi	22,400	19,546	19,180	17,078	16,502	16,777	15,531	16,815	16,120	17,162	17,400
7	Dornod	26,845	27,328	30,797	27,623	22,890	22,501	18,066	18,184	15,467	16,991	16,700
8	Dundgovi	17,929	20,510	21,601	19,874	21,043	22,114	21,598	21,737	22,027	22,136	21,800
9	Zavkhan	33,965	37,303	38,784	38,409	41,436	42,770	43,677	43,489	42,033	41,693	37,400
10	Uvurkhangai	37,496	39,060	40,456	40,826	41,843	43,404	43,018	45,984	47,221	49,521	49,700
11	Umnugovi	16,444	18,016	17,878	17,422	15,683	16,371	16,529	16,754	18,848	19,971	20,100
12	Sukhbaatar	18,114	19,534	18,373	17,051	21,686	20,649	21,681	20,458	21,317	21,674	22,400
13	Selenge	33,720	31,751	34,242	27,260	28,933	26,102	25,438	26,249	28,801	31,750	30,700
14	Tuv	41,350	38,953	38,377	34,681	34,128	34,365	35,523	33,727	35,389	35,836	37,600
15	Uvs	31,085	34,719	35,112	33,708	33,424	35,157	34,779	33,454	34,466	31,311	32,700
16	Khovd	28,458	29,344	32,598	32,595	32,897	32,749	36,430	31,390	32,470	32,826	32,400
17	Khuvsgul	39,681	39,411	40,919	39,584	40,509	42,060	41,921	42,353	44,026	46,555	46,300
18	Khentii	28,271	28,562	29,026	25,473	24,132	25,877	25,105	22,710	22,548	22,865	23,600
19	Darkhan-Uul	30,076	32,081	28,383	26,941	25,719	29,120	28,525	25,323	25,273	27,224	20,600
20	Ulaanbaatar	217,254	203,741	206,279	195,848	194,410	186,738	182,628	191,994	201,714	209,838	215,500
21	Orkhon	22,012	25,405	28,586	30,105	16,818	19,341	28,104	26,243	26,716	26,663	27,000
22	Govi-Sumber	-	4,852	4,804	4,003	2,882	3,031	2,708	2,577	3,425	3,533	3,600

Source: National Statistical Office, 2001, Mongolian Statistical Yearbook, 2000

* denotes that the original figures in the statistical yearbook are shown in thousand persons.

Table 3-1-3 Growth Rate and Share of Employed Population in Total Mongolia

Provinces & Capital City	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Population	2,050,044	2,256,982	2,253,632	2,218,246	2,221,285	2,234,386	2,245,492	2,270,208	2,290,839	2,373,493	2,407,500
Employed Population	783,579	789,800	806,025	765,364	759,760	767,638	769,618	765,092	792,570	813,559	809,000
Employed Population Rates	38.2%	35.0%	35.8%	34.5%	34.2%	34.4%	34.3%	33.7%	34.6%	34.3%	33.60%

Source: JICA study team, National Statistical Office, 2001., Mongolian Statistical Yearbook, 2001

(2) Gross Domestic Product (GDP)

1) Current Condition

GDP composition by sector in Mongolia during the past 10 years is shown in Table 3-1-4. The share of industry in 1990 was about 36%, it has, however, decreased gradually since then and by 1999 it had declined to approximately 20%. On the other hand, the share of agriculture has increased to about 35% since 1993 due to the change to a market economy. The share of trade, material and technical provision in 1994 also declined, however, it recovered to 21% by 1997.

Table 3-1-4 GDP Composition by Sectors in Mongolia

sectores	Year (GDP: %)									
	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1. Industries	35.7	32.0	30.9	30.5	25.9	18.5	24.0	18.3	19.9	17.4
2. Agriculture	15.2	30.2	35.1	37.0	37.0	42.0	34.3	35.7	34.5	33.4
3. Construction	5.0	1.9	1.6	2.1	1.7	2.8	2.2	2.5	2.3	2.3
4. Transport/ communication	12.0	5.5	4.6	5.8	6.4	7.4	7.7	8.8	8.7	9.5
5. Trade/ material/ technical provision	19.4	15.4	16.0	11.7	17.0	16.7	21.0	21.1	20.6	21.6
6. Services	11.5	12.9	9.5	10.5	11.9	12.4	10.6	13.3	13.7	15.5
7. Others	1.2	2.1	2.3	2.4	0.1	0.2	0.2	0.3	0.3	0.3

(3) External Trade

1) Value of Imports and Exports

The major export commodities in Mongolia are mainly goods from the primary sectors and they are therefore easily influenced by fluctuation of international market prices. In 1996, due to decline of international market prices for materials such as copper, molybdenum, gold and cashmere, the value of major exports were down to 90% of the previous year's value. The trade balances after 1996 indicate trade deficit conditions. The volume of imports and exports of goods since 1993 is shown in Table 3-1-5.

Table 3-1-5 Value of Imports and Exports in Mongolia (US $ million)

Total Value	761.6	614.5	888.6	875.2	919.8	848.4	871.1	1080.6
Exports	382.6	356.1	473.3	424.3	451.5	345.2	358.3	466.1
Imports	379.0	258.4	415.3	450.9	468.3	503.3	512.8	614.5
Trade Balance	3.6	97.7	58.0	-26.6	-16.8	-158.1	-154.5	-148.4

Source: Mongolian Statistical Yearbook, 2000

2) Goods Exported and Imported

The share of major goods exported and imported in Mongolia is shown in Table 3-1-6. Major goods exported in 2000 are textiles, mineral products, raw/ processed materials, livestock and base metals/ articles. These accounted for 41%, 40%, 9%, 5% and 1% respectively of total goods exported. With regard to commodities exported in the past few years, mineral products and base metal/ article show a gradual decline. On the other hand, textile and raw/ processed sectors are increasing in the period 1995-2000. Major goods imported are machinery/ electric equipment, mineral products, textile, auto/ air/ water transport and food products. These accounted for 22%, 19%, 13%, 11% and 7% respectively in 2000.

Table 3-1-6 Share of Major Goods Exported/Imported in Mongolia

Commodities	Goods Exported (%)				Commodities	Goods Imported (%)			
	1995	1998	1999	2000		1995	1998	1999	2000
Total Commodities	100.0	100.0	100.0	100.0	Total Commodities	100.0	100.0	100.0	100.0
1. Livestock	2.2	5.4	6.1	5.0	1. Food product	4.5	9.3	7.0	7.7
2. Mineral product	65.5	45.3	41.0	40.5	2. Mineral product	20.0	18.1	16.6	19.6
3. Raw and processed	5.0	8.0	8.4	9.1	3. Texitiles	6.8	6.3	9.0	13.0
4. Texitiles	17.1	22.6	35.5	41.3	4. Machinery/equipment electri	20.5	25.2	34.5	21.7
5 Base metals/articles	3.6	3.2	2.3	1.3	5. Auto/air/water transport	15.2	13.5	10.6	10.9

Source: Mongolian Statistical Yearbook, 2000.

3.2 Socioeconomic Conditions

The socioeconomic conditions in the study area are as follows:

(1) Resources in the Study Area

Mongolia has abundant natural resources. Mineral products were around 65% of total export values in 1995, but they declined to 40% in 2000 due to the steep drop in world prices. Most of the output from the mines is exported to countries such as Russia, China and Japan due to the small domestic market in Mongolia.

The major issue obstructing the promotion of development and trade is the high transport cost caused by insufficient internal transport infrastructure. Therefore, the construction of arterial roads and railway system will be the main factor for future development of new mines.

The eastern part of the study area has broad resources of minerals such as fluorspar, crude oil, lead, tungsten, molybdenum, gold, coal, construction material and salt. As shown in Figure 3-2-1, the mining resource area of about 100 km along both sides of the project road has high influence potential for vehicle generation. There are natural resources in about 120 deposits to be developed along the project road and in future, mining is very favorable industry to be developed. Obviously, the handling freight volume from the mining of such resources will be increased in future and this will lead to an increase in truck traffic.

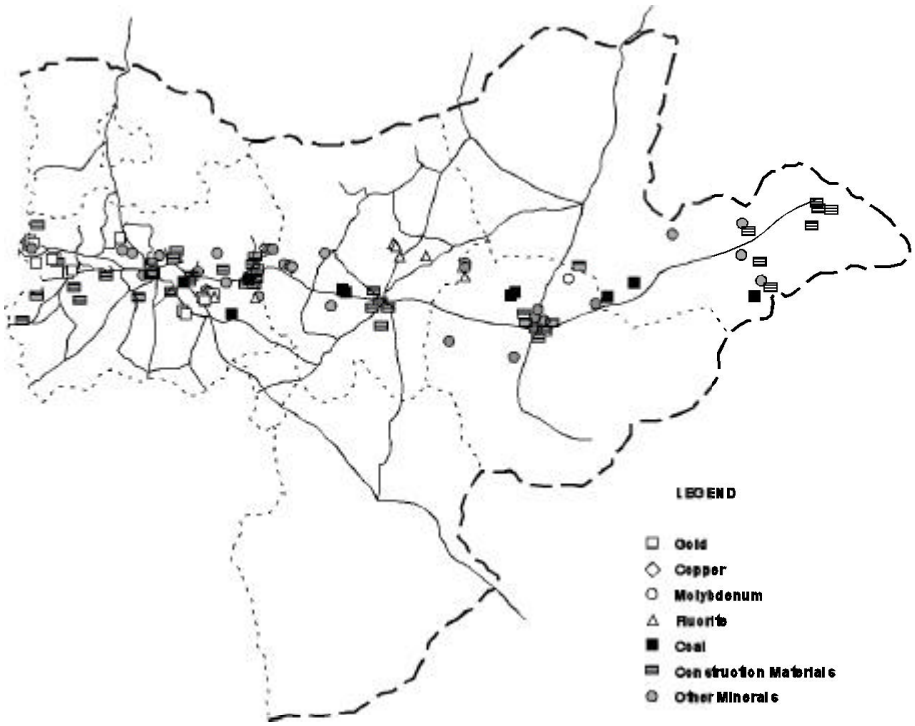


Figure 3-2-1 Mining to be Developed along the Project Road in Future

Agricultural goods and livestock are important commodity and in 2000, they had a share of about 33% of total GDP. However, products in Khentii province are increasing, and the share in 2000 is at 2% to 6% of total national tonnage. This apparently indicates the expansion of agricultural potential in Khentii province. Based on the eastern regional development plan, it is possible to increase the number of livestock intensively in Dornod and Sukhbaatar province. The eastern region is also comparatively rich with natural, historical and cultural heritage for development of tourism.

(2) Development Plan and Projects in the Study Area

The Government of Mongolia prepared a regional development plan of the eastern area. of Khentii, Dornod and Sukhbaatar province in 1996. In accordance with the regional

development plan, the Road Development Master Plan was formulated in 1994 under the donors group comprising the Asia Development Bank, the World Bank, Kuwait and Japan financing. The Road Development Master Plan identified the plan of construction and rehabilitation for the whole Mongolia up to the target year 2010.

The prospective population plan was formulated in the eastern regional development plan and the future regional population in 2000 and 2010 was estimated by net growth of residents of the sums and labor resources of major cities.

In accordance to the Law of citizen's right and Mongolian population settlement/ development general plan, the population settlement plan in 2010 has formulated in the eastern region as follows: 1 big city of Choibalsan, 3 small cities of Tamsagbulag, Undurhaan and Baruun-Urt, 11 urbanized sums and 42 rural sums by the classification of urban area.

The infrastructure development plan of road, railway and air transport has been planned in the eastern regional development plan. Major planned roads in the eastern region are international roads of approximately 900 km and state standard road of approximately 700 km. Regional railway network is proposed considering the possibilities of mining Tavantolgoi coal reserve of Omnogobi, oil reserve of Tamsagbulag, extension of relationship with Eastern-south Asian countries and participation in the international project of Tumengol. Besides, an international airport could possibly be constructed in Choibalsan city.

3.3 Socioeconomic Framework

The socioeconomic framework targeting for 2005, 2010 and 2015 has been formulated based on population data of the National Statistics Office of Mongolia (NSOM), the Eastern Region Development Plan and future GDP of the Ministry of Finance and Economy (MOFE).

The population of 2000-2015 is estimated by using average annual growth rates of 1999-2010, in accordance with the future projected population of the Eastern and Western Regional Development Plans. The future projected population in Mongolia is as follows: 2.7 million persons in 2005, 3.1 million persons in 2010 and 3.5 million persons in 2015.

Based on the proportion of the future provincial population, the future employed populations by provinces in 2005, 2010 and 2015 were estimated based on the growth rates of future provincial population. The share of employed populations in total Mongolia in 2015 was estimated at 40% approximately.

Gross regional domestic products (GRDPs) by provinces in Mongolia is not dealt with in the statistics, therefore, future provincial GRDPs for 2000, 2005, 2010 and 2015 were distributed from the national frame based on the provincial shares of future projected population.

The study area is divided into the total of 66 traffic zones. Socio-economic frame classified into population, employed population and gross regional domestic products (GRDPs) in 2005, 2010 and 2015 are distributed between the traffic zones.

3.4 Traffic Demand Forecast

The several socioeconomic indicators such as population, employed population and GRDPs by sectors were applied for the traffic model analysis. Future OD tables were estimated mainly by using the socioeconomic indicators of GRDPs and population by traffic zone. Future OD tables were projected for five types of vehicles namely cars, buses, small trucks, medium trucks and large trucks.

The future traffic volumes were assigned to the future road network. Traffic variables of capacity (Q) and velocity (V) for each link are arranged by Q-V pattern. The traffic assignment was implemented by a computerized application system known as 'JICA STRADA'. The future traffic volumes on the projected roads were forecast based on the traffic assignment results. Traffic volumes on the project roads in 2005, 2010 and 2015 were 453-835 vehicles/day, 656-1,063 vehicles/day and 994-1,417 vehicles/day, respectively.

Table 3-4-1 Traffic Demand Forecast by Year

Year	Section	Vehicle Type (Vehicle per Day)						Passenger
		Car	Bus	Small Truck	Medium Truck	Large Truck	Total	Car Unit
2000	Erdene - Baganuur	357	155	14	123	40	689	957
	Baganuur - Jargaltkhaan	216	72	11	95	32	426	611
	Jargaltkhaan - Murun	144	57	9	82	24	316	467
	Murun - Undurkhaan	156	57	9	86	24	332	487
2005	Erdene - Baganuur	430	187	18	150	50	835	1,163
	Baganuur - Jargaltkhaan	308	113	20	140	49	630	910
	Jargaltkhaan - Murun	201	84	14	119	35	453	674
	Murun - Undurkhaan	222	84	14	125	35	480	707
2010	Erdene - Baganuur	548	237	25	188	65	1,063	1,480
	Baganuur - Jargaltkhaan	437	168	30	204	68	907	1,312
	Jargaltkhaan - Murun	286	127	21	174	48	656	976
	Murun - Undurkhaan	324	127	21	184	48	704	1,034
2015	Erdene - Baganuur	716	325	33	250	93	1,417	1,986
	Baganuur - Jargaltkhaan	640	256	41	317	98	1,352	1,965
	Jargaltkhaan - Murun	428	192	30	275	69	994	1,484
	Murun - Undurkhaan	496	192	30	289	69	1,076	1,580

CHAPTER 4 SELECTION OF ALTERNATIVE PLANS AND PRELIMINARY DESIGN

4.1 Establishment of Design Criteria

4.1.1 Design Criteria for Road

(1) General

The study road is the Eastern Arterial Road and is a part of the "Millennium Road". This road strategically important for hastening socio-economic and regional development and improving the foreign relationship with neighboring countries. The "Millennium Road" is expected to fulfill an international standards such as loading specifications, geometric criteria and so forth. Therefore, it is imperative to establish the geometric design standard for the Study taking into consideration the above viewpoints.

The policy of AASHTO is applied to establish the design criteria for the study road.

(2) Geometric Design Criteria for the Eastern Arterial Road (EAR)

The following design elements are adopted in the study.

- Functional Classification : Category III (as per Mongolian Standard) and Rural Arterial Road with the primary road function of mobility and the priority given to motorized vehicles.

- Design Speed

Design speed is to be determined logically with respect to the terrain, adjacent land use, type of road and the design speed of adjoining section.

Flat Terrain	:	100 km/h
Rolling Terrain	:	80 km/h
Mountainous Terrain	:	60 km/h

- Horizontal and Vertical Clearances

Horizontal Clearance	:	outer edge of the shoulder
Vertical Clearance	:	4.3 m

Table 4-1-1 summarizes the geometric design criteria for the Eastern Arterial Road.

(3) Cross Sectional Configuration

Figure 4-1-1 shows proposed typical cross section for the Eastern Arterial Road.

Table 4-1-1 Summary of Geometric Criteria for the Eastern Arterial Road

Item		Unit	Design Criteria		
0.	Terrain	-	Flat	Rolling	Mountainous
1.	Design Speed	km/h	100	80	60
2.	Traveled Land Width	m	3.5		
3.	Shoulder Width	m	1.5 (0.5)		
4.	Marginal Strip Width	m	0.3		
5.	Crossfall of Traveled Way	%	2.0		
6.	Crossfall of Shoulder	%	4.0		
7.	Type of Pavement	-	Flexible Type Pavement		
8.	Stopping Sight Distance	m	205	140	85
9.	Maximum Superelevation	%	6.0		
10.	Minimum Horizontal Curve Radius	m	450	250	150
11.	Minimum Horizontal Curve Length	m	170* or 1,200/ θ	140* or 1,000/ θ	100* or 700/ θ
12.	Minimum Transition Curve Length	m	85	70	50
13.	Sharpest Curve without Transition Curve	m	1,500	1,000	500
14.	Sharpest Curve without Superelevation	m	5,000	3,500	2,000
15.	Max. Relative Slope for Superelevation Runoff	-	1:175	1:150	1:125
16.	Maximum Grade	%	4.0	6.0	7.0
17.	Minimum Vertical Curve Length	-	Refer to Table 4-1-2		
18.	Horizontal Clearance	-	Roadway Width		
19.	Vertical Clearance	m	4.3		
20.	Space between Safety Rest Area	m	40 to 60 km / Max. 100km		

Notes: θ shows intersection angle in degree for horizontal curve (min. 2 degrees).
The figure with * shows absolute value in case that θ is more than 7 degrees.
The figure in parentheses shows the value for bridge.

Table 4-1-2 Minimum Vertical Curve Length

Design Speed 100 km/h
Sight Distance 205 m

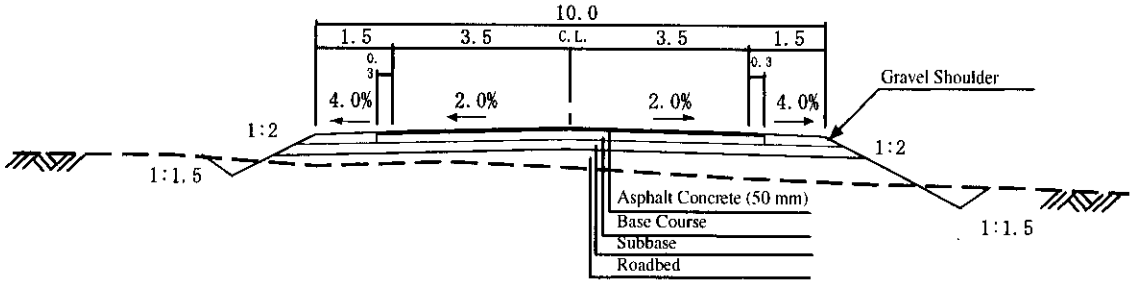
Algebraic Difference in Grade (%)	On Crest Curve			On Sag Curve		
	Rider Comfort	Sight Distance	Adopt Value	Rider Comfort	Sight Distance	Adopt Value
8.0	83	706	706	83	388	388
7.5	83	662	662	83	363	363
7.0	83	618	618	83	339	339
6.5	83	574	574	83	315	315
6.0	83	530	530	83	291	291
5.5	83	486	486	83	266	266
5.0	83	441	441	83	242	242
4.5	83	397	397	83	218	218
4.0	83	353	353	83	194	194
3.5	83	309	309	83	170	170
3.0	83	265	265	83	145	145
2.5	83	221	221	83	121	121
2.0	83	177	177	83	97	97
1.5	83	132	132	83	73	83
1.0	83	88	88	83	48	83
0.5	83	44	83	83	24	83

Design Speed 80 km/h
Sight Distance 140 m

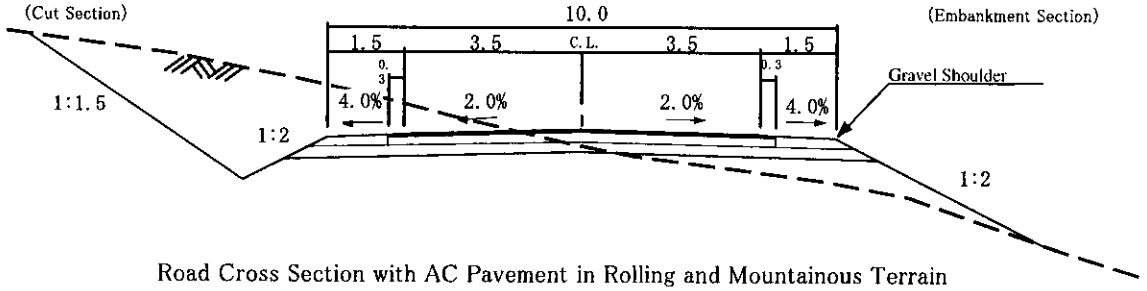
Algebraic Difference in Grade (%)	On Crest Curve			On Sag Curve		
	Rider Comfort	Sight Distance	Adopt Value	Rider Comfort	Sight Distance	Adopt Value
12.0	67	494	494	67	368	368
11.5	67	474	474	67	352	352
11.0	67	453	453	67	337	337
10.5	67	432	432	67	322	322
10.0	67	412	412	67	306	306
9.5	67	391	391	67	291	291
9.0	67	371	371	67	276	276
8.5	67	350	350	67	260	260
8.0	67	329	329	67	245	245
7.5	67	309	309	67	230	230
7.0	67	288	288	67	214	214
6.5	67	268	268	67	199	199
6.0	67	247	247	67	184	184
5.5	67	226	226	67	168	168
5.0	67	206	206	67	153	153
4.5	67	185	185	67	138	138
4.0	67	165	165	67	123	123
3.5	67	144	144	67	107	107
3.0	67	124	124	67	92	92
2.5	67	103	103	67	77	77
2.0	67	82	82	67	61	67
1.5	67	62	67	67	46	67
1.0	67	41	67	67	31	67
0.5	67	21	67	67	15	67

Design Speed 60 km/h
Sight Distance 85 m

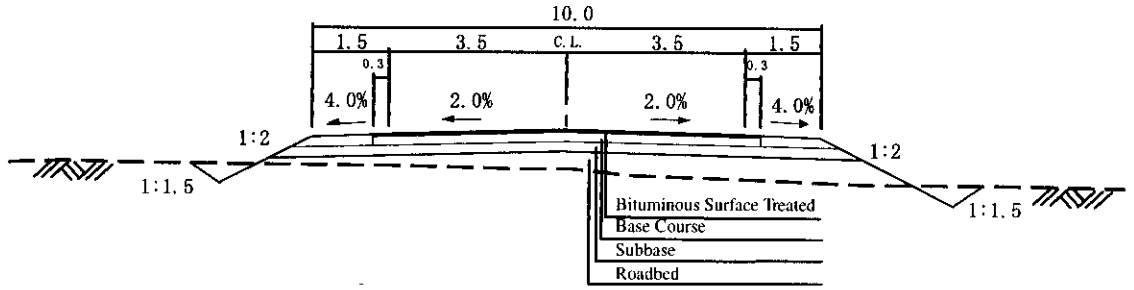
Algebraic Difference in Grade (%)	On Crest Curve			On Sag Curve		
	Rider Comfort	Sight Distance	Adopt Value	Rider Comfort	Sight Distance	Adopt Value
14.0	50	213	213	50	226	226
13.5	50	205	205	50	218	218
13.0	50	197	197	50	210	210
12.5	50	190	190	50	202	202
12.0	50	182	182	50	194	194
11.5	50	175	175	50	186	186
11.0	50	167	167	50	178	178
10.5	50	159	159	50	170	170
10.0	50	152	152	50	161	161
9.5	50	144	144	50	153	153
9.0	50	137	137	50	145	145
8.5	50	129	129	50	137	137
8.0	50	121	121	50	129	129
7.5	50	114	114	50	121	121
7.0	50	106	106	50	113	113
6.5	50	99	99	50	105	105
6.0	50	91	91	50	97	97
5.5	50	83	83	50	89	89
5.0	50	76	76	50	81	81
4.5	50	68	68	50	73	73
4.0	50	61	61	50	65	65
3.5	50	53	53	50	57	57
3.0	50	46	50	50	48	50
2.5	50	38	50	50	40	50
2.0	50	30	50	50	32	50
1.5	50	23	50	50	24	50
1.0	50	15	50	50	16	50
0.5	50	8	50	50	8	50



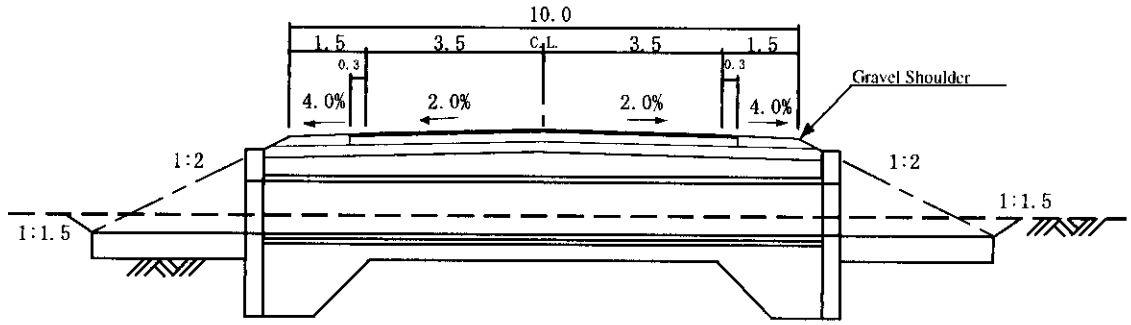
Road Cross Section with AC Pavement in Flat Terrain



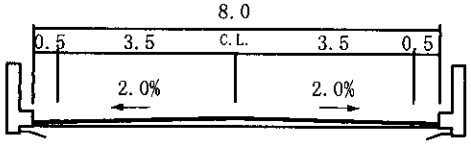
Road Cross Section with AC Pavement in Rolling and Mountainous Terrain



Road with Bituminous Surface Treated



Road with Culvert



Bridge Section

Figure 4-1-1 Proposed Typical Cross Section

4.1.2 Design Criteria for Bridge

(1) Application of Design Criteria

The design criteria for the Project bridges and culverts construction shall apply the following Specifications:

Design Standards, Mongolian Officials

Specifications for Highway Bridges, Japan Road Association, 1994-1996

Standard Specifications for Highway Bridges, AASHTO of American, 1995

(2) Design Condition

1) Scale of Bridge

a) Proposed Width of Bridge

The defined width in the Mongolia Standard is 4.5m for one lane, 6.5m and 8m for two lanes. The carriage way width of bridges including shoulders will be proposed as 8m to correspond with the Millennium Arterial Road as shown in Figure 4-1-2.

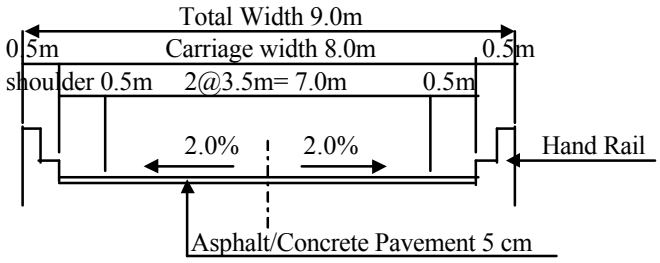


Figure 4-1-2 Proposed Standard Cross Section of Bridge

b) Scale of Bridge

The scale and type of planning bridges shall be determined taking account of topographic, geological conditions and characteristics of existing river or water way.

2) Design Standard

a) Material Strength

The materials and basic strengths to be adopted shall be those shown in Table 4-1-3.

Table 4-1-3 Materials and Basic Strength

PC girder	σck = 400kgf/cm^2	Abutment, Pier	σck = 210kgf/cm^2
RC girder	σck = 240kgf/cm^2	Approach Wall	σck = 210kgf/cm^2
RC Slab, Cross Beam	σck = 240kgf/cm^2	RC Pile (Precast)	σck = 240kgf/cm^2
Concrete Pavement	σck = 240kgf/cm^2	RC Box Culvert (Precast)	σck = 210kgf/cm^2
RC Hand Rail	σck = 210kgf/cm^2	RC Pipe Culvert (Precast)	σck = 210kgf/cm^2

* Concrete Compressive Strength σck (28 days)
Cement Factory (Darkhan, EREL Cement & other one factory in Mongolia)

(Darkhan Metallurgical Plant)

Steel Grade (Deformed Bar)	Length (Dia. mm)	Chemical Composition %					Strength (N/mm^2)	
		C	Si	Mn	P	S	Yield	Tensile
SD295	Length	0.16-0.18	0.15-0.37	0.60-0.90	0.04 max	0.04 max	295 min	440-600
SD345	6000-12000mm	0.18-0.20	0.15-0.37	0.80-1.00	0.04 max	0.04 max	345-440	490 min
SD390	Diameter 10- 32mm	0.18-0.26	0.15-0.37	0.95-1.25	0.04 max	0.04 max	390-510	560 min

* Steel Reinforcing Steel SD295, SD345 , SD390 (Yield strength σpy >30 kgf/mm^2)
Prestressing Steel T-12.7mm (Yield strength σpy= 160kgf/mm^2)

b) Live Load

Various live loading systems have been applied in the previous Projects, such as Mongolian, Russian, Chinese, American and Japanese Standards.

To produce robust structures on the Project Road, it is recommended that either the Japanese and/ or American AASHTO live load system shall be adopted as per the following Specifications:

Applied Live Loading System:

*** Japanese A-Live Load**

Specifications for Highway Bridges, Japan Road Association, 1994-1996

*** AASHTO of American HS20-44 Live Load**

Standard Specifications for Highway Bridges, AASHTO of American, 1995

c) Other Loads

Impact fraction, Earthquake, Influence of creep, Shrinkage of concrete, Earth pressure, Hydraulic pressure, etc

4.2 Selection of Route Alternatives

4.2.1 Crossing Point of Kherlen River

The study road will cross the Kherlen river somewhere in the 20 km stretch, namely in the north, in the south or the middle.

For the purpose of qualitative comparison of the crossing points of the Kherlen River, the following aspects are taken into account;

(a) River Morphology

(b) Scale of Bridge Structures and Length of River Training

(c) Environmental Impact

(d) Ease of Maintenance

At the north where the river is located in the flooding and meandering area, it will require official consent if the route is planned to pass the water sources area for Baganuur District, notwithstanding the outstanding issues of the flood prone area at the crossing point.

It is necessary to provide a long span bridge is to cross over the river in this area because of the need for due consideration of the river morphology, river training, scouring and so forth. It is obvious that bridge becomes longer than other locations, even if bridges are planned to be limited to major watercourses. Furthermore, new guide banks are required and they may be considerable volume of works because the length of guide bank is generally equal or more a half of bridge length and they are installed at both sides. The facilities of bridges and guide banks will necessitate high costs of maintenance.

On the contrary, at the south the river is well guided by mountain ranges and the watercourse is situated in relatively narrow strip. Accordingly, the scale of bridge works will be rather small and the river training may be shorter. Moreover, it is anticipated that adverse environmental impacts will be able to minimized because there will be no significant change to the existing bridge conditions.

At the middle area, there is no salient feature on river morphology except the transition between the north and the south mentioned above. However, the foot of Mt. Tumur Ulgii is close to the river and this may cause difficulties because the approach road will require considerable volume of earthwork of cut and fill. This will bring adverse environmental impacts to the surroundings.

Figure 4-2-1 shows the salient features in the vicinity of each possible crossing point of the Kherlen River, and based on this the most suitable point for crossing the Kherlen River was selected as being around the existing bridge.

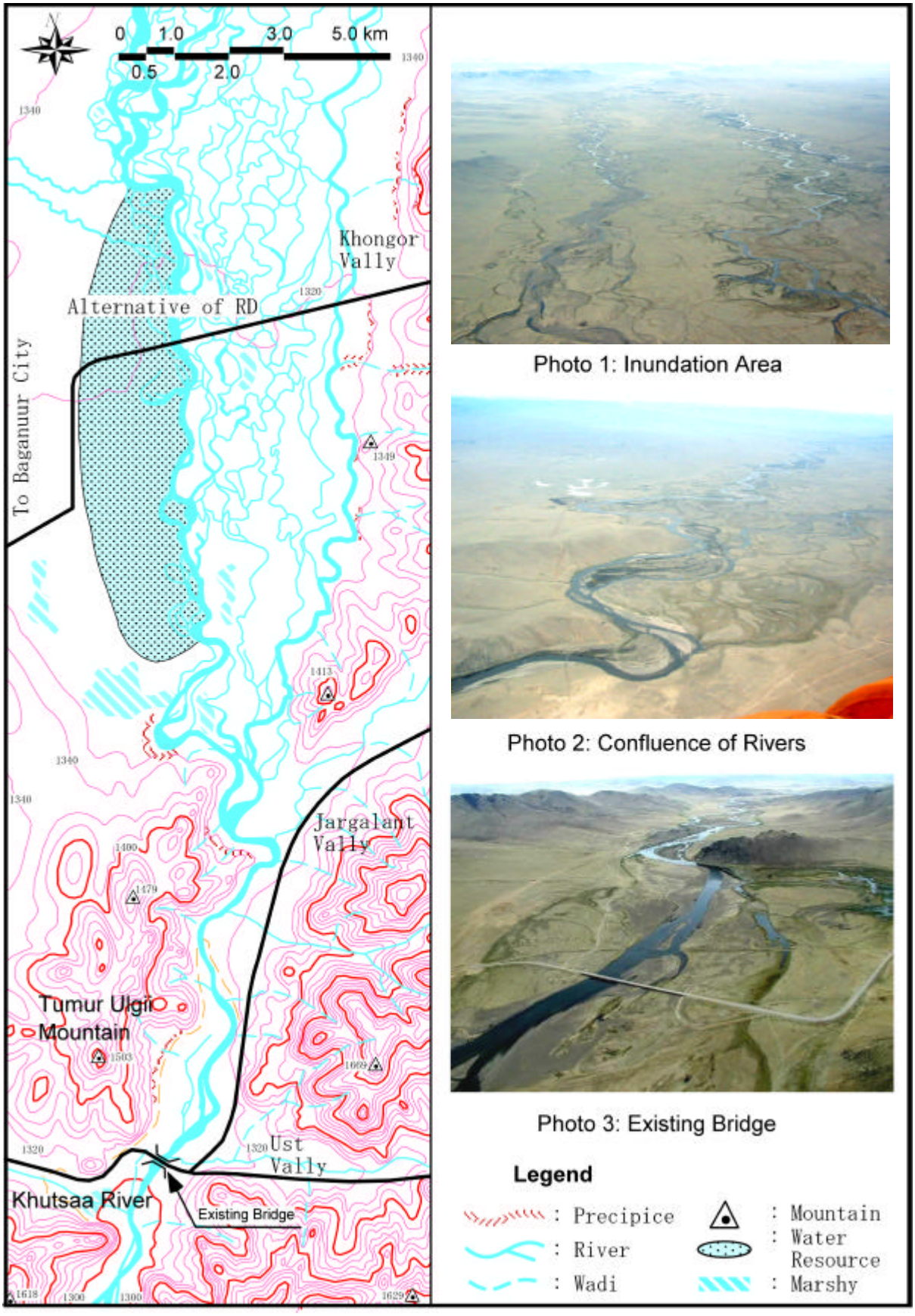


Figure 4-2-1 Condition of kherlen River