Chapter 3 Road Management

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3.1 Road Administration

3.3.1 General

All roads were controlled by the Ministry of Transportation and Construction at the beginning of independence of the Country.

The former government organizations were privatized into various companies and, the Department of Roads was established to manage road administration under the Ministry of Transport and Communication since 19th July 1994.

The road network of Kazakhstan comprises of approximately 160,000 km of several categories of roads as shown below.

Republican Roads	17,670 km
Local Road	69,669 km
Service Road	71,451 km
Total	158,788 km

The Department of Roads manages the Republican Roads and also the Local Roads in close cooperation with state governments. Farmland Roads are the roads to connect the Kolkhoz or Sokhoz to markets or cities through local roads and republican roads. Urban Roads are managed by the State Governments.

Management and maintenance of both Republican Roads and the Local Roads belongs to the State Road Authorities with close cooperation of the State Governments. The funds for the construction and maintenance of roads comes from the Road Fund.

3.1.2 Department of Roads

Administrative reforms were carried out related to the various organizations in the transport and road sector. The relationship of various organizations after the administrative reforms is shown in Fig. 3.1.1.

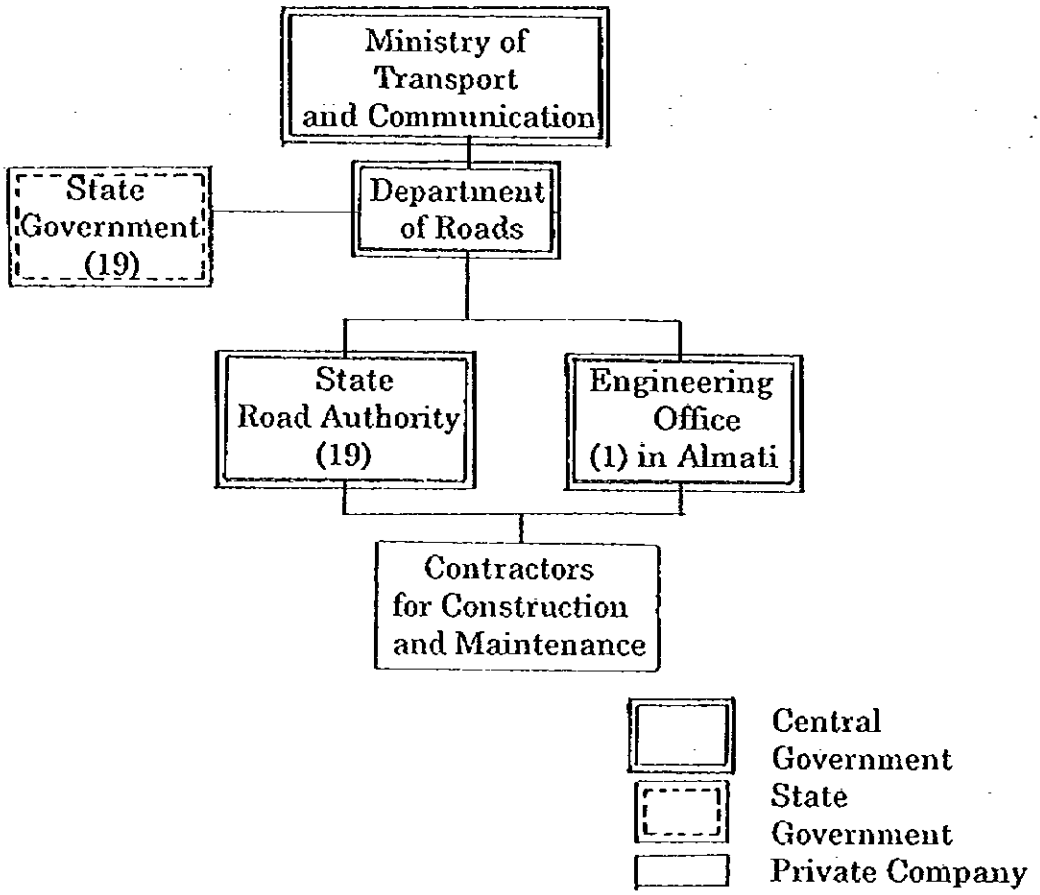


Fig. 3.1.1 : Relationship of Various Road Organizations

The organization of the Department of Roads and the Ministry of Transport and Communication is shown below in Fig. 3.1.2

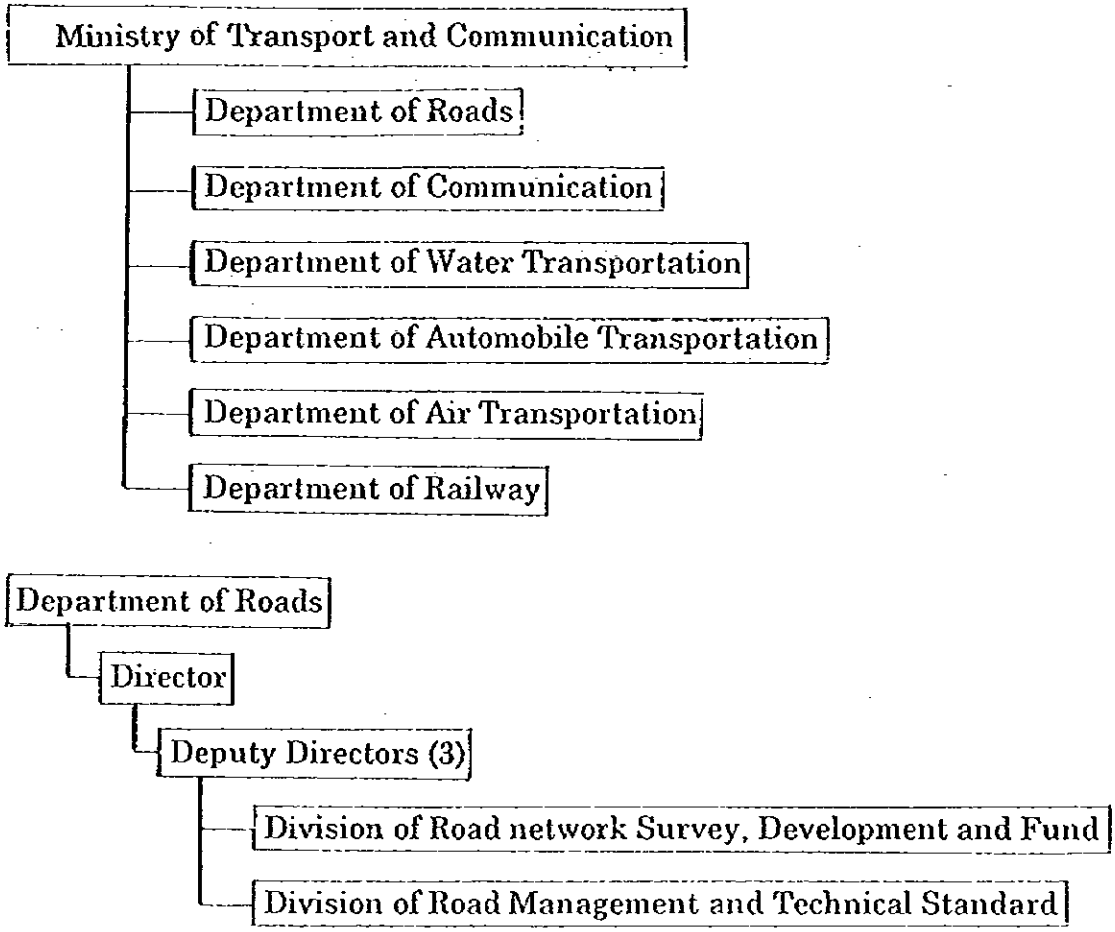


Fig. 3.1.2 : Organization of Ministry of Transport and Communication

3.2 Road Design Standards

3.2.1 General

Standards for the road design which were developed by the former Soviet authorities, are still in force in the Republic of Kazakhstan, such as the Road Construction Standard 2.05, 02-85 (State Committee of USSR, 1986) and Instructions for Flexible Pavement Design (USSR, Ministry of Transportation/Construction, 1985) etc. The design standards include a wide range of norms for roads, bridges and tunnels.

3.2.2 Road Classification and Geometric Standards

In the road design standards of the Republic of Kazakhstan, the roads are classified into five categories according to traffic volume, economic and administrative significance, traffic characteristics and topographical conditions.

Geometric standards for roads in Kazakhstan are summarized in Table 3.2.1. Based on the traffic forecast as mentioned in Chapter 6, republican roads in Western Kazakhstan will be developed as the category III roads, same as the present category.

Table 3.2.1 : Existing Road Category and Geometric Standard

Road	Traffic volumes		Economic and administrative	Design speed (km/h)			No. of	Lane width	Shoulder
Category	Pcu	Vehicle	significance of roads	Flat	Rolling	Mountainous	lanes	(m)	width (m)
Ia	> 14,000	> 7,000	Movement between states	150	120	80	4,6 or 8	3.75	3.75
Ib	> 14,000	> 7,000	〃	120	100	60	4,6 or 8	3.75	3.75
II	6,000 - 14,000	3,000 - 7,000	〃	120	100	60	2	3.75	3.75
III	2,000 - 6,000	1,000 - 3,000	Movement between states within state	100	80	50	2	3.50	2.50
IV	200 - 2,000	100 - 1,000	Movement between major regional cities and local cities	80	60	40	2	3.00	2.00
V	< 200	< 100	Movement between local cities	60.0	40	30	1	-	1.75

Source : Road Construction Standard 2.05, 02-85, State Committee of USSR, 1986

Table 3.2.2 shows the design standards of the category IA road to those used in other countries. Geometric standard of the category IA road in Kazakhstan are rather higher than in other countries.

However, there is no motorways in Kazakhstan with full access control in the international sense. Category IA roads in Kazakhstan often have direct access from the roadside and vehicles are often allowed to turn on roads. Also, these roads are often used by slow moving vehicles.

Table 3.2.2 : International Comparison of Road Geometric Standard for Category IA

Items \ Country	Kazakhastan	France	Germany	USA	Japan
Design speed (km/h)	120 ~ 150	80 ~ 140	80 ~ 140	80 ~ 112	80 ~ 120
Min. radius of horizontal curvature (m)	800 ~ 1,200	240 ~ 1,000	270 ~ 1,140	250 ~ 600	230 ~ 570
Min. radius of crest curvature (m)	15,000 ~ 30,000	3,000 ~ 18,000	7,000 ~ 50,000	7,300	3000 ~ 11,000
Min. radius of sag curvature (m)	5,000 ~ 8,000	2,200 ~ 6,000	4,500 ~ 8,000	4,300	4,000 ~ 7,000
Max. longtudinal slope (%)	3.0 ~ 4.0	4.0 ~ 6.0	4.0 ~ 5.0	3.0 ~ 5.0	2.0 ~ 4.0
Lane width (m)	3.75	3.5	3.5	3.65	3.5

Source : "Road and Road Transport Study" report, 1992 by European Bank, and
"Road structure ordinance" by Japan Road Association

3.2.3 Pavement Design Standard

(1) Design Method

The design approach used for pavement in Kazakhstan is essentially based on a theory of flexible pavement developed before World War II by a large number of Soviet researchers under the leadership of Professor Ivanov. Later, this theory was substantially modified after its assumptions of elastic pavement deformation were contradicted by large-scale road experiments, the prominent AASHO (American Association of the State Highway Officials) tests (now AASHTO).

(2) Pavement Type

In Kazakhstan, existing pavement types and their scope of application are divided into four basic categories as indicated in Table 3.2.3.

For each pavement category, a combination of layer compositions and thickness is selected, based on traffic requirement, economic and administrative significance, local conditions and availability of materials.

(3) Axle Load

Pavement structure is, at present, designed by using a standard axle load of 10 tonnes, which is similar to the AASHTO standard ; however, most of roads were designed using a standard axle load of 6 tonnes.

Currently, road damage caused by exceeding the standard axle load of 6 tonnes gives rise to increased maintenance and improvement costs and a shortening of pavement life. Therefore, the following should be conducted :

- Axle load surveys to determine the actual heavy vehicle loading practices
- Creation of new pavement design parameters and models revised according to the surveys
- Enactment of regulation to control heavy vehicle loading over the determined 10 tonne axle load.

Current worldwide regulations on the range of standard axle loads are shown in the Table 3.2.4. In Kazakhstan, it is an urgent necessity to develop a policy which includes fair practical regulations to control overloading and revises pavement design criteria.

Table 3.2.3 : Categories of Existing Pavement Types

Types of pavement	Main kinds of Surface Course	Categories of Roads
High	• Cement concrete or asphalt concrete	• I ~ IV
Semi - high	• Asphalt concrete • Crushed rock, gravel and sand treated with binder	• III and IV • At 1st stage of two stage road construction of Category II
Intermediate	• Crushed rock and gravel • Soil and local low strength rock materials treated with binder	• IV and V • At 1st stage of two stage road construction of Category III
Lowest	• Ground reinforced or improved with admixtures	• V • At 1st stage of two stage road construction of Category IV

Data Source : Road Construction Standard 2.05, 02-85, state Committee of USSR, 1986

Table 3.2.4 : Current Regulations Worldwide on Standard Axle Load

Country Name	Single Axle (Tonne)	Tandem Axle (Tonne)
Japan	10.0	18.0
USA	9.1 ~ 10.9	14.5 ~ 18.2
France	13.0	14.7 ~ 21.5
Greece	13.0	14.7 ~ 21.5
Luxembourg	13.0	14.7 ~ 21.5
Spain	13.0	14.7 ~ 21.5
Southeast Asia	8.0 ~ 10.0	12.0 ~ 16.0
India	10.2	18.0

Data Source : International Road Federation, 1989

3.3 Road Sector Funding

Expenditures on roads in Kazakhstan are funded from two types of funds; Republican Road Fund and Oblast (State) Road Fund. The Republican Road Fund is utilized to fund the Republican Road Network and the Oblast Road Funds are used to fund the State (Oblast) Road Network.

The Road Fund was established by Declaration 260 of the Cabinet of Minister on 19 March 1992. Since then, the administrative setup for collection and management of this Road Fund has undergone several changes in the past few years. The original Road Fund which was established on 19 March 1992 had the following eight fund sources.

1. Road User Tax
2. Value added tax (VAT) on petroleum and petroleum products
3. Purchase tax on vehicles
4. Road Vehicle Tax
5. Transport Company Tax
6. Income from rent to third parties of Kazzholdary property
7. Toll charges on foreign vehicles entering the Republic
8. Fund assignments from National and Oblast Government Budgets

As mentioned earlier, the administration and collection of Road Fund has undergone several changes since its establishment on 19 March 1992. The present sources for the Road Fund are not clear, however based on the interviews with relevant organizations, it is expected that the Road Fund in 1996 will consist of the following fund sources.

1. Road Users Turnover Tax (0.5%)
2. Petroleum Tax (3 Tenge/l)
3. Passage Tax for Foreign Vehicles
4. Tax for Heavy Vehicles

3.4 Condition of Roads

3.4.1 Road Network and Traffic Condition

In the four states of Western Kazakhstan, the total length of public roads was about 17,200 km in 1995 excluding farmland and urban roads, compared to about 87,600 km in whole of Kazakhstan as shown in Table 3.4.1 below.

Table 3.4.1 : Public Road Length in Kazakhstan

Road Category	Road Length (km)	
	Kazakhstan	Western Kazakhstan states
Republican Road	17,670	3,721
Local Road	69,667	13,336
Total	87,337	17,057

Data Source : Department of Roads, Ministry of Transport and Communication, 1996

The road network and the condition of roads in Western Kazakhstan is shown in Fig. 3.4.1.

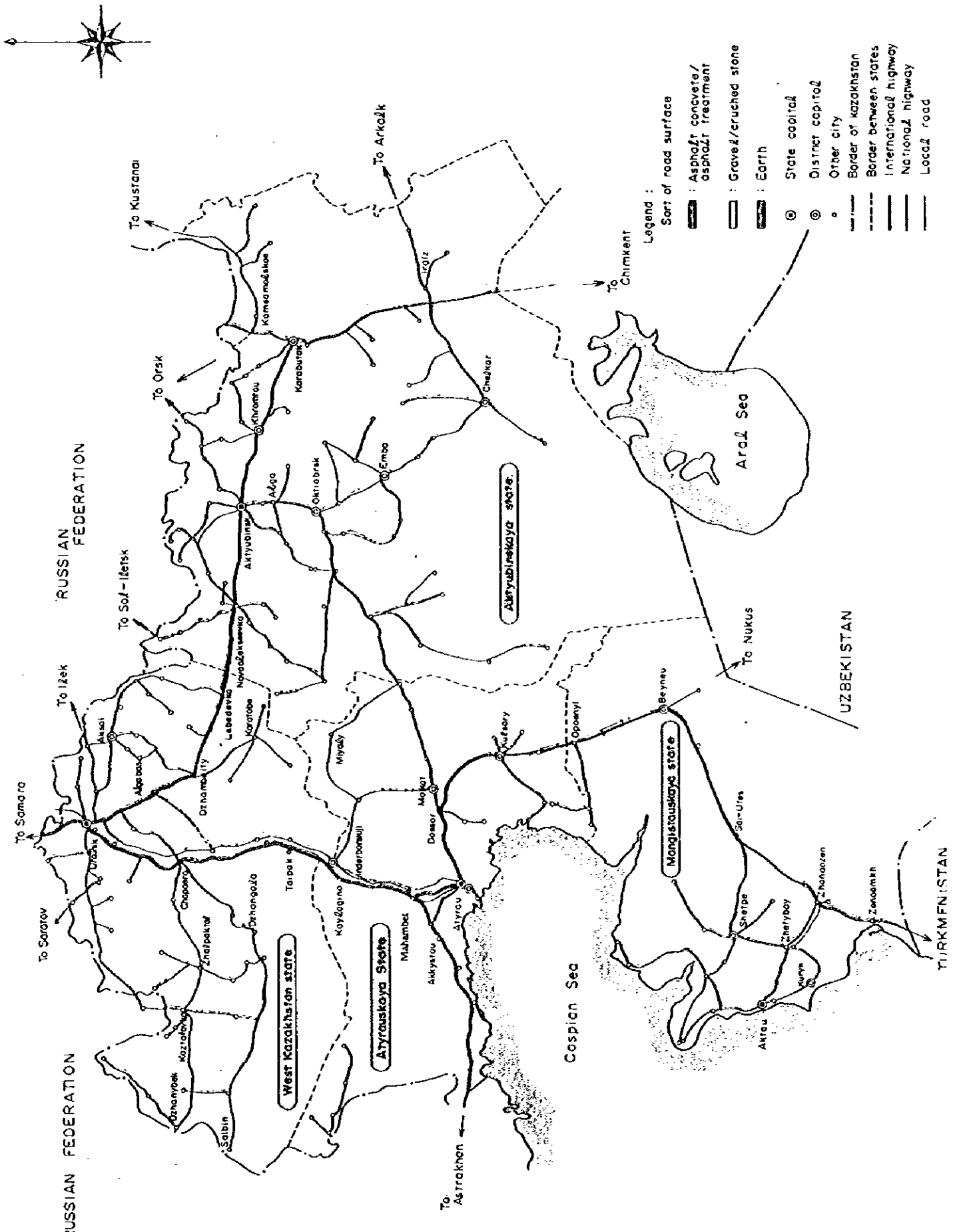


Fig. 3.4.1 : Road Network and Condition of Public Roads in Western Kazakhstan

(1) Republican Roads

Roads within the 4 states surveyed totaled some 17,200 km, amongst which 20.2% or 3,470 km were republican roads. Traffic volume on such republican roads, as shown on Figure 3.4.2, ranges between 4,900 vehicles/day on busy days to 400 vehicles/day on slack days.

Within a radius of 100 km of the capitals of the 4 states, Aktyubinsk, Uralsk, Atyrau and Aktau, traffic volume was 2,000-4,900 vehicles/day, but beyond such 100 km radius it fell to less than 1,000 vehicles/day. Nearby state boundaries, daily traffic dropped to 400-600 vehicles/day. By routes, the sector of the republican road between Uralsk and Chapeti which links Samara and Chimkent (route M1) was the busiest with 4,900 vehicles/day. The next heavily traveled sector was between Dossor and Kulsary, between Atyrau and Astrakhan which links Kulsary and Aktau (route P117) with 4,300 vehicles/day. The reason for this was thought to come from oil field related activities centering on Atyrau.

While the heavily traveled republican road linking Samara and Chimkent (route M1) is functioning well as a route for transporting agricultural produce, the republican road linking Atyrau and Astrakhan, Kulsary and Aktau (route P117) functions as a route for transporting oil field development related equipment.

(2) Local Roads

Of the 13,700 km local roads in the 4 states surveyed, most consisted of roads with a traffic volume of 500 vehicles/day or less as Figure 3.4.3 indicates. Such roads serve as access roads to kolkhoz and other collective farms such as sovkhoz and are unpaved. Amongst such roads, the traffic volume between Aktyubinsk and Martuk (route AT4) was 1,400 vehicles/day and between Aktyubinsk and Orsk (route AT1), 1,260 vehicles/day on the day of survey, both exceeding the 1,000 vehicles/day mark.

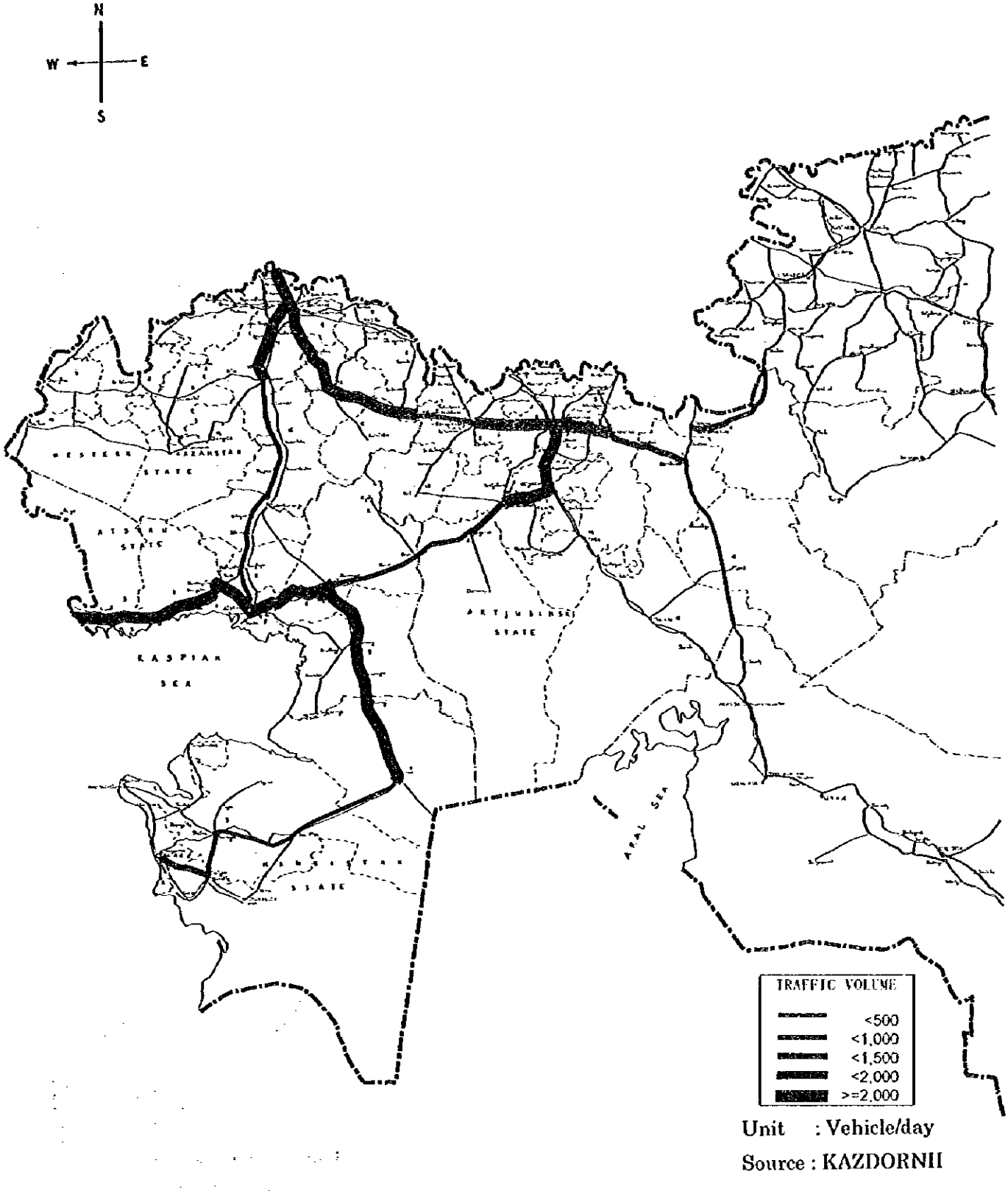
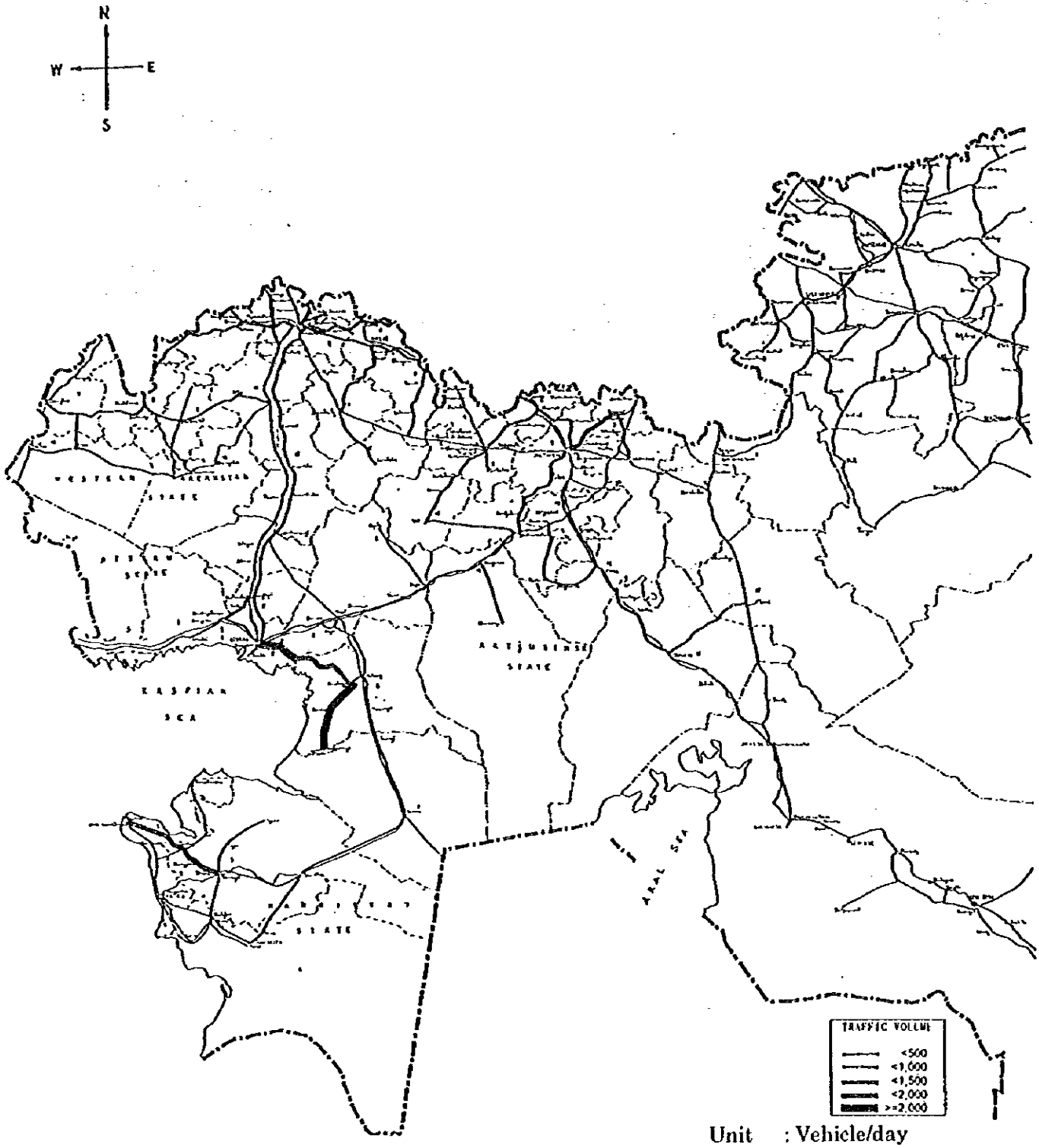


Fig. 3.4.2 : Traffic Volume on Republican Road (Oct.1993)



Unit : Vehicle/day

Source : ZHOLDARY in Study Areas.

Fig. 3.4.3: Traffic Volume on Local Road (Oct.1993)

3.4.2 Road Condition

(1) Paved and Unpaved Road

In Kazakhstan, approximately 87,300 km of inter-urban public roads consists of about 56,400 km of paved roads and about 30,900 km of unpaved roads at the present. Specifically, about 65% of the general purpose roads are paved with asphalt concrete or asphalt treatment while about 93% of the republican and the international highways and about 57% of the local roads are paved with asphalt concrete or asphalt treatment.

Table 3.4.2 indicates the pavement type and paved ratio of inter-urban general-purpose road in Kazakhstan.

Table 3.4.2 : Public Road Length by Pavement Type and Paved Ratio in Kazakhstan

Classification of Road	Total Length (km)	Asphalt	Gravel or Crushed Stone	Earth	Paved Ratio
Republican Road	17,670.0	16,433.0	1,063.0	174.0	99.1 %
Local Road	69,667.0	39,960.0	25,027.0	4,680.0	93.3 %
Total	87,337.0	56,393.0	26,090.0	4,854.0	94.5 %

Data Source : Department of Roads, Ministry of Transport and Communication, 1996

In Western Kazakhstan, which include Atyrauskaya, West Kazakhstan, Aktyubinskaya and Mangistauskaya, approximately 17,100 km of inter-urban general-purpose road consists of about 8,600 km paved road and about 8,600 km unpaved road. About 50% of the general purpose roads are paved road with asphalt concrete or asphalt treatment, while about 81% of the republican and international highways and 42% of the local roads are paved with asphalt concrete or asphalt treatment.

From the above, the percentage of paved roads in the Western Kazakhstan states (50.3%) is lower than the national average (64.6%). The percentage of paved republican roads in Mangistauskaya state and the percentage of paved local roads in Aktyubinskaya state are the lowest when compared to other states.

Table 3.4.3 indicates the pavement type and the paved ratio of inter-urban general purpose road in the western Kazakhstan states.

Table 3.4.3 : Public Road Length by Pavement Type in Western Kazakhstan

State Name	Classification of Road	Total Length (m)	Asphalt		Gravel or Crushed Stone	Earth	Paved Ratio
			Concrete	Treatment			
Atyrauskaya	Republican Road	993.0	233.0	702.0	0.0	58.0	94.2 %
	Local Road	2,104.0	151.0	858.0	426.0	669.0	48.0 %
	Total	3,097.0	384.0	1,560.0	426.0	727.0	62.7 %
West Kazakhstan	Republican Road	887.0	97.0	785.0	5.0	0.0	99.4 %
	Local Road	4,345.0	243.0	1,038.0	2,678.0	386.0	29.5 %
	Total	5,232.0	340.0	1,823.0	2,683.0	386.0	41.3 %
Aktyubinskaya	Republican Road	1,269.0	392 0	784.0	93.0	0.0	64.9 %
	Local Road	4,874.0	373.6	1,517.4	2,270.0	713.0	38.8 %
	Total	6,143.0	765.6	2,301.4	2,363.0	713.0	49.9 %
Mangistauskaya	Republican Road	572.0	191.0	73.0	245.0	63.0	46.2 %
	Local Road	2,013.0	949.0	451.0	353.0	260.0	69.5 %
	Total	2,585.0	1,140.0	524.0	598.0	323.0	64.4 %
Total	Republican Road	3,721.0	913.0	2,094.0	343.0	371.0	80.0 %
	Local Road	13,336.	1,716.0	3,864.4	5,727.0	2,029.0	41.8 %
	Total	17,057.	2,629.0	5,958.4	6,070.0	2,400.0	50.3 %

Data Source : (1) Department of Roads, Ministry of Transport and Communication, 1996
(2) JICA Study Team, 1996

(2) Pavement Condition

A visual pavement condition survey was carried out for the entire republican road network and some of the arterial local roads which are regarded as long-list projects in the Western Kazakhstan. The roads surveyed with total length 4,010 km are divided into 33 road sections as a road network for feasibility study in the next phase of the study. The survey results were compiled using an inventory form recording the physical characteristics, such as station numbers, types of surface, width of carriageways, width of shoulders, roadway formation, land use, terrain, and surface condition as indicated by the International Roughness Index (IRI), as shown in Appendix II "Road Inventory Data".

From the above survey, approximately 63% of the surveyed road length were "poor" or "Very poor" as shown in Table 3.4.5, according to the criterion for evaluation of surface roughness analyzed, as indicated in Table 3.4.4. The pavements appear to be damaged, as evidenced by extensive wheel ruts, corrugations/shovings, upheavals, edge/shoulder damages, cracks, and potholes. The above defects are especially common on the national highway and these phenomena and their causes are examined as the follows :

Wheel Ruts :
Wheel ruts are depressed sections which may develop in the wheel tracks of an asphalt pavement. They result from consolidation or lateral movement under traffic in one or more of the underlying courses, or by displacement in the asphalt surface layer itself. Wheel ruts are not generally caused by a single reason but by several phenomena. The following general comments can be made about the surveyed road sections, namely :

Since pavement defects were seen in the asphalt wearing course, it seemed that the ruts are mainly due to the poor quality of the asphalt base and surface course. Defects in the pavement layers seem to be caused by an overly asphalt mixture consisting of high as contents, poor aggregate gradations, and fractions that are not sufficiently stable to support the heavy traffic.

Corrugation/Shoving :
Corrugations are a form of plastic movement typified by ripples across the asphalt pavement surface. Shovings are a form of plastic movement resulting in localized bulging of the pavement surface. Corrugations and shovings usually occur in asphalt layers that lack stability. Lack of stability may be caused by a mixture which is too rich in asphalt, has too high a proportion of fine aggregate, has course of fine aggregate which is too round or too smooth textured, or has asphalt cement which is too soft.

Upheaval :
Upheaval is the localized upward displacement of pavement due to swelling of the subgrade or some portion of the pavement structure. Upheaval is more commonly caused by expansion of ice in the lower course of the pavement or the subgrade. It may way also be caused by the swelling effect of moisture on expensive soils.

Crack :
Cracks are divided into two types, structural cracks and non-structural crack. The former are caused rather by a lack of bearing capacity due to heavy traffic or rain/underground water seepage. Non-structural cracks are caused by the low quality of the asphalt mixture in a surface layer. Alligator cracks are formed by a number of cracks which connect and look like alligator skin. They are caused by the low quality of the asphalt mixture, aging of asphalt and an insufficient of bearing capacity in the subbase and subgrade.

Edge Damage :
Edge damage usually take place along soft shoulders which have dropped, been eroded, or rutted below the edge of the pavement. The edge of the pavement begins to break away with exposure of the base and surface course aggregate. There are loose stones and the pavement near the edge breaks up with considerable cracking with large areas of the pavement which have already broken away. Edge damage is mainly caused by seepage into the subbase or base course from the shoulder, or loose compaction of the subbase or base course.

Shoulder Damage :
The shoulders contain ruts and/or eroded areas which may retain water when it rains. The shoulders should be at the same level as the adjoining pavement. Shoulder damage is mainly caused by the low quality and the loose compaction of the subgrades.

Overall riding quality also is poor, and it causes discomfort, danger, and high operation cost. Therefore it is obvious that pavement improvement can involve substantial savings through reduced use of resources, increased lifetime of the pavement, and improved surface conditions which in turn would lead to reduced vehicle operation and accident costs.

Table 3.4.4 : Criterion for Evaluation of Road Surface Roughness

Visual International Roughness Index (IRI)	Condition		Maintenance or Improvement	Typical Surface Type	Roughness BI value (mm/km)
IRI ≦ 4	Good	The road surface is level and even without surface deformation or depressions.	Ordinary and necessary routine maintenance	· New asphalt concrete / treatment,	2500 ~ 3000
4 < IRI < 7	Fair	The road surface has a smooth and shiny appearance with no visible stones. In hot, dry weather the surface is soft and tacky.	Requires localized periodic maintenance, sealing surface treatment and re-surfacing by overlay	· Asphalt concrete / treatment after a few years of service	3000 ~ 4000
7 ≦ IRI < 9	Poor	Fretting-ravelling occurs in areas of the road surface where a loss of bitumen binder results in exposure of the stone aggregate with many loose stones which have worked free of the bitumen.	Re-surfacing and strengthening by overlay	· Asphalt concrete / treatment badly neglected, · Fairly maintained gravel and crushed stone service	4000 ~ 6000
IRI ≧ 9	Very poor	A distintegrated road surface in which the bitumen binder is almost completely gone. The pavement surface has many loose stones of various sizes and looks like a gravel road with a few small areas of bitumen remaining.	Needs reconstruction and pavement replacement	· Poorly maintained gravel, crushed stone and earth service, · All pavement types badly neglected for many years	6000 <

Data Source : (1) JICA Study Team, 1995
(2) The World Bank HDM III computer analysis system

Note : Roughness, Bump integrator (BI) value is given for reference

Table 3.4.5 : Existing Condition of Surveyed Road Network

No.	Project Name	Existing Road Condition: Surface type	Roughness condition	Carriageway width (m)	Shoulder width (m)	Distance (km)	Function classification	Remark
1	Kzyl-Orda border ~ Irgiz	G	VP	7.0	5.0	80	IH	
2	Irgiz ~ Karabutak	AC	VP	7.0	5.0	195	IH	
3	Karabutak ~ Khromtau	AC	VP	7.0	5.0	124	IH	
4	Khromtau ~ Aktast	AC	P	7.0	3.0	60	IH	
	Aktast ~ Aktyubinsk	AC	F	7.0	5.0	38	IH	
5	Aktyubinsk ~ Novoalexeevka	AC	F	7.0	5.5	114	IH	
6	Novoalexeevka ~ Lebedevka	AC	F	6.0	4.0	142	IH	
7	Lebedevka ~ Belogovka	E	VP	6.0	4.0	25	IH	
8	Belogovka ~ Dzhambeity	AC	VP	6.0	3.5	54	IH	
9	Dzhambeity ~ Algabas	AC	P	6.0	4.0	71	IH	
10	Algabas ~ Uralsk	AC	F	9.0	4.0	68	IH	
11	Uralsk ~ Samara border	AC	F	6.0	3.0	37	IH	
12	Uralsk ~ Saratov border	AC	F	6.5	4.0	83	NH	
13	Karabutak ~ Kyustanais Kaya state border	AC	VP	6.8	4.0	250	NH	
14	Aktyubinsk ~ Oktiabrsk	AC	F	7.8	5.0	85	NH	
15	Oktiabrsk ~ Dossor	AC	F	7.0	5.0	417	NH	
16	Uralsk ~ Kaylagino	AC	F	7.0	5.0	386	IH	
17	Kaylagino ~ Mahambet	AC	P	6.5	6.0	50	IH	
18	Mahambet ~ Atyurau	AC	VP	6.5	6.0	70	IH	
19	Atyrau ~ Akkystau	AC	P	7.0	6.0	60	IH	
20	Akkystau ~ Astrakhan border	AC	P	7.0	6.0	232	IH	
21	Atyrau ~ Iskininski	AC	P	7.0	6.0	50	IH	
	Iskininski ~ Dossor	AC	P	7.0	6.0	42	IH	
22	Dossor ~ Kulsary	AC	P	7.0	6.0	118	IH	
23	Kulsary ~ Opornaya	E	VP	7.0	6.0	104	IH	
24	Opornaya ~ Beynew	E	VP	6.0	5.0	122	IH	
25	Beynew ~ Sai-utes	G	VP	6.0	5.0	181	IH	
26	Sai-Utes ~ Shetpe	G	VP	7.0	5.0	120	NH	
27	Shetpe ~ Dzetidai	AC	F	7.0	5.0	85	NH	
28	Dzetidai ~ Aktau	AC	P	7.0	5.0	82	NH	
29	Dzetidai ~ Zonaomkh	AC	F	7.0	5.0	69	LR	
30	Zonaomkh ~ Zonaomkh	AC	P	7.0	5.0	60	IH	
31	Zonaomkh ~ Krasnobosk border	G	VP	7.0	5.0	100	IH	
32	Beynew ~ Nukvs border	-	-	-	-	84	IH	New road
33	Sai-Utes ~ Zhanaozen	-	-	-	-	122	IH	New road
	Total					3,980		

Data Source : JICA Study Team, 1995

Note : 1) Surface type ... G:Gravel/crushed stone, E:Earth, AC:Asphalt concrete/Asphalt treatment

2) Roughness ... F:Fair, P:Poor, VP:Very poor

3) Function Classification ... LR:Local road, IH:International highway, NH:National highway

(3) Flood Area in the Atyrauskaya State

Part of the Atyrauskaya state, in and around the capital, Atyrau, flooded in 1993 and 1994 because of an increase in the water level of both the Ural river which flows into the Caspian Sea and the Caspian Sea itself. The roads, including parts of the international highway (Uralsk ~ Atyrau, Dossor ~ Akkystan) and the local roads, were covered with water for three weeks as shown in Figure 3.4.4. At the present, the Kazakhstan government does not plan any counter-measures to present road flooding although a levee is being constructed along parts of the coast of the Caspian Sea.

The Caspian Sea is characterized by periodic fluctuations of the water level of 6 ~ 7m. From the Scientific Investigation Report analyzed by the Water Resource Committee of the Republic of Kazakhstan, the following was determined :

From the past 700 years, the water level of the Caspian Sea fluctuated from a high of 22m below sea level to a low of 28m ~ 29m below sea level. Since 1830, the level of the Caspian Sea has been rising and falling in a range of between 29m and 27m below sea level. As of 1993, the level was 27m below sea level and rising 13 ~ 14cm per year.

The report predicted that the water level of the Caspian Sea will be 26.4m below sea level in 1995, 26.1m below sea level in 2000, and 25.9m below sea level in 2010. Therefore, a critical water level of 25m below sea level for the design of coastal facilities is recommended. Furthermore, the water level of the Caspian Sea increases due to strong winds, 0.8 ~ 1.0m in Mangistauskaya state, and 2.5 ~ 2.7m in an estuary in Atyrauskaya State. Consequently, considering both flooding and wind factors, it is recommended that the design water level for facilities near the Caspian Sea be set at 22.5m below sea level.

Therefore, based on the above study, to prevent flooding of the roads in this area, the roads have to be raised from their existing levels.

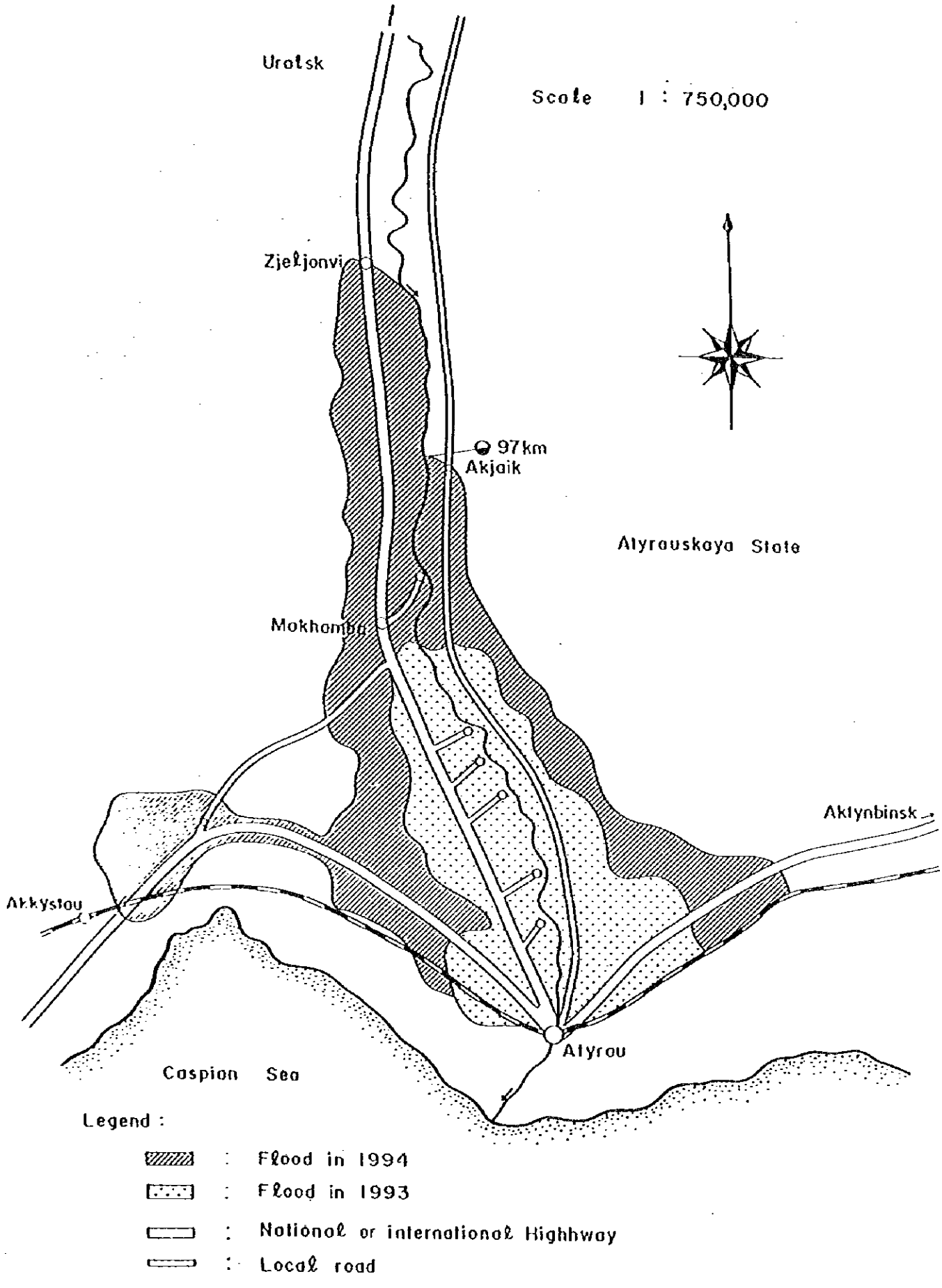


Fig. 3.4.4 : Flood Condition in Atyrauskaya State

3.4.3 Road Safety

The existing road traffic safety level in Kazakhstan is worrisome. Accident statistics show the very high fatality rates in the country compared to the developed countries as shown in Table 3.4.6. It is important to consider the factor of traffic safety in road planning such as ensuring better road surface conditions, lighting, road marking and other safety facilities.

With the present accident rates, it is obvious that traffic accidents involve economic loss to society, both in direct costs (damage to vehicles, roads and property, medical care, administrative services etc.) and in the indirect costs related to the loss of property. In order to establish as quickly as possible the framework for future safety policies and activities, it is recommended that an integrated road safety program is prepared in the Kazakhstan.

Table 3.4.6 : International Comparison of Traffic Fatality

Name of Country	Number of Fatality (1)	Population (x 10,000) (2)	Number of Vehicles Register (x10,000) (3)	Fatality Ratio (1)/(2)	Fatality Ratio (1)/(3)
*Kazakhstan	3,954	1,668	156	0.024%	0.25%
U.S.A	40,115	24,633	18,347	0.016%	0.02%
England	7,434	5,708	2,467	0.013%	0.03%
France	9,052	5,587	2,534	0.016%	0.03%
Japan	11,105	12,261	5,245	0.009%	0.02%

Data Source : 1. United Nation European Economic Committee, 1993
2. "*" : Department of Roads, Ministry of Transport and Communication, 1993

3.4.4 Bridge Condition

Due to the recent stagnation of the economic activity in Kazakstan, it is extremely limited in the implementation of the maintenance as well as the new construction of the bridge.

This limitation gets into extreme decrease of the forwarding and the production of the construction material. Therefore the production factories of the construction material in Kazakstan have being completely stopped for over three years.

As a result, the situation of the lack of the construction material and the machinery has been occurred.

The past, on the occasion of construction of the bridge, it seems that the standard drawings have being to be referred as construction drawings in Kazakstan. However, a subtle difference is seen on the type of the structure and the way of the execution. Therefore, there is a little difference of the quality, especially, in the substructures of the bridge, even though the complete year is the same. In addition to that, the parts which are left without completed of the works were to be seen.

What is most important in planning under this situation is designing the facilities which are able to minimize the construction materials to be used and the maintenance fee to sustain the facilities.

Though the extreme decrepit-ization of the bridges obstructs doing so, the present state investigations of the bridges were executed as follows to achieve the purpose of above.

(1) General

As for this study, the present state investigations of the bridges being on two sections from Karabutak to the boundary of Aktyubinskaya state and from Atyrau to Mahambet were executed. In the section from Karabuta to the boundary of Aktyubinskaya state seven bridges are included and from Atyrau to Mahambet also seven bridges are included.

The details of the investigation result about each bridge have been shown in the appendix.

The structure form which is used for each bridge is as follows.

The types of the beams of the superstructure are "T" shape precast prestressed concrete beams or hollow slab precast prestressed concrete beams, the abutments are pilebent or block stacked, and the piers are pilebent or combination of blocks and cast-in-place concrete.

Concerning executing of concrete work in Kazakstan, a contrivance of how to minimize the concrete placement work in the spot is very important for the establishing of the construction execution plan of the concrete structure.

For, in this area, the temperature in the summer exceeds of 45 degrees centigrade, and oppositely, in the winter the minimum temperature becomes -20 degrees centigrade. When the temperature is over 35 degrees centigrade or lower than zero degrees centigrade, concreting should not be executed. Therefore, concreting is to be implemented on the outdoors for 3 months in a year, namely, in the spring 1.5 months and the autumn 1.5 months respectively.

By such a reason, all the beams of the superstructure were made at the concrete product factory which is in Almaty.

This factory is barely but continues operating with enough production facilities and the checking tools. The productive capacity of this factory is 20 beams at least per month. The compression strength of the concrete of the product is 400 kg/cm^2.

Though the products are inspected before forwarded from the factory, looseness are seen to the quality of the products.

The kinds of beams which are produced at present are T-shape PC concrete beams of the 24-meter and 21 meter span and hollow slab beams of the 18-meter and 12 meter span.

The order of the beams differ from these kinds are accepted as the special order.

Meanwhile, precast blocks of the piles, the pillars, and the horizontal members which have been produced at the factory are used for the substructure.

However, the factories near the site have being stopped for three years. These facilities should be restored.

Taking the above conditions into consideration, the concrete mixing work will be executed at the site. In addition to that, some kinds of the construction materials such as steel, PC wire etc., will be imported from overseas.

Besides, for a few plainly decrepit-ized bridges contain the danger of the bridge collapse, a plan for new construction of them is under execution by one of the authority concerned.

(2) Destruction Situation

According to the bridge investigation by the observation, the degrees of the destruction of the bridges are as follows.

(a) Superstructure

Through the handling and transportation from the factory to the site, beams are often damaged and are placed to the position without any repair. Moreover, due to the insufficient covering for the reinforcing bars and the PC wires, some of them stand out

on their surfaces and get rusted. The handrails of the pedestrian are considerably deteriorated and destroyed.

Plane figures of some PC wire's arrangement which are appeared in the surface are not straight but curved. It implies that they have no prestress in the PC wires. Insufficient beam connection with transverse beams brought about longitudinal clacking of the slab of the superstructure.

The carriageway surface of the slabs of the beams are worn out and are made holes here and there by which the traffic traveling abrasion on the slab.
Though the transverse beams of the old type bridges were observed, the connections of each transverse beam is insufficient, so several longitudinal cracks were observed on the slab of the superstructure.

(b) Substructure

Some newly constructed but extremely destroyed abutments are observed.

The big reasons that the abutments have been decrepit-ized extremely are considered that the bridge length is too short and some abutments are always in water which contains a lot of salinity. As a result, the water makes the concrete walls weak. Moreover, the repetition of the freezing and the melting of moisture in the abutment walls promotes the degradation of concrete. Though the reinforcing bars were arranged, some parts of the wing walls are left without casting the concrete.

(c) Foundation

For the abutments and the piers of the bridges which are installed on the hard soil have no footings and the insertion length into the soil is not enough. Therefore soil in the lower part of them is washed away with the effluent, in consequence, some parts become the condition of floating in the air.

(d) Wing Wall

For size of the wing walls are insufficient, soil slope collapse in both approach and prevents pedestrian's passing through. As reinforcing bars are not included in some retaining walls, cracks are made by the earth pressure of the behind soil.

(e) Approach Road

Owing to the settlement of the roadway near abutments, the approaching concrete plates on the roadway are destroyed.

(3) Structural Defects

The considerable structural defects of the existing bridges would be as follows.

(a) Superstructure

Though there are concrete barriers between the sidewalk and the carriageway on the bridge, the handrails on the bridge is, however, too poor.

Except old type bridges, for the main beams have no transverse beams to tying the main beams, lateral load distribution due to the live load act on the longitudinal beam would not be distributed to the other longitudinal beams.

Concerning the beams of the bridges, the slab thickness of the beams of the hollow slab is 65 mm and of the "T" shape PC concrete beams 140 mm. In this connection, comparing with Japanese standard, it is defined that the slab thickness of the hollow slab beams should be more than 140 mm and the "T" shape PC concrete beams more than 150 mm.

(b) Substructure

On account of using the pilebent type structure for the bridge abutments, soil movement from behind to forward of them is observed.

The phenomenon causes the limitless sinking of the roadway surface just behind the parapet of the abutments and the rise of the ground in the front of the abutments.

To avoid the phenomenon, the pilebent type structure should not have been constructed for the abutments of the bridge but other type or the measures of prevention of the soil slope collapse near to the abutments should have been invented.

Some piers are composed of the precast concrete blocks and cast in place concrete. So the reinforcing bars connecting between blocks or places of cast-in-place concrete are not always inserted with necessary length and not tightly fixed into the other blocks, in addition, the main reinforcing bars and transverse reinforcing bars have not connected each other.

When the deluge in 1991, a pier of the bridge number 28 was drifted slightly by the water flow pressure of the flood. Movement quantity was, according to the authority concerned, about 0.7 m right side and 0.5 m downward in parallel. As a matter of course, the superstructure of the bridge was fallen down to the river bed. Then the temporary repairs was made on the bridge as follows:

Owing to the changing of supporting positions of the superstructure on the pier both horizontally and vertically, the left span fallen down beams were made longer with cast-in-place concrete while the right span beams were shortened and set on the steel foundation. On the other hand, transverse beams which had not been connected were welded together on the adjacent lower corner plates.

3.4.5 Assessment of Maintenance Condition

(1) General

The state zholdaries under Kazakhstan Zholdary managed and maintained national highways and local roads basically according to their individual previous functions, i.e., based on the criteria of Former Soviet Union with some structural changes.

The criteria themselves are considered to contain almost necessary structures and functions for road management and maintenance. They are however not enough for applying to the present commercial market conditions such as change of cost and depreciation cost of equipment

The Department of Roads, Ministry of Transport and Communication planned to execute not only construction works but also maintenance works on contract bases.

According that policy, in February, 1996, State Road Authority was established to be in charge of ordering and superintending of road construction and maintenance works in each State. The construction and maintenance of roads will be executed on contract base. The Kazakhstan Zholdary including state zholdaries remained as contractors. Their organizations are almost same as before. Road maintenance works, including new road construction, are ordered on competitive tendering. Routine maintenance works are ordered on negotiation basis.

(2) Norms for Maintenance and Repair of Road

The methods of maintenance and repair of road are generally indicated or recommended in the norms from former soviet union such as "Technical Rules for Repair and Maintenance". These guidelines are similar to ones of western developed counties. Actual works are executed based on such guidelines. Some items were re-arranged by Kazakhstan considering the conditions of the areas.

(3) State Road Authority

State road authority in each state is a government enterprise. The enterprise manages the national highways and local roads in each state. Their main functions are as followings regarding maintenance and repair of road.

1. Planing and order of the works
2. Supervising and Inspection of work implementation
3. Management of Equipment for the work

(4) Zholdary

Kazakhstan Zholdary continues as contractor of maintenance and repair work including new construction of road and keeps same functions and organizations except ordering and superintending as before the establishment of State road authority. State zholdary in each state, 2 state zholdaries in Almaty, actually executes road maintenance work. The organization of zholdaries is explained in Appendix-VII.

(5) Equipment for Road Maintenance and Repair

Many vehicles and equipment owned by the zholdaries was transferred to State road authorities. Almost all of the equipment are, however, still controlled under the zholdaries.

The zholdaries in the 4 states of Western Kazakhstan maintain about 3400 of vehicles and construction equipment for maintenance, repair and construction of roads. This figure includes equipment which have already passed depreciation periods. In Mangistau, about 10 % of the equipment have passed depreciation periods and in Atyrau, about 25%.

The amount of equipment per road length maintained are 0.03 units / km against about 17000 km of road lengths in the 4 states as shown in Table 3.4.7.

Table 3.4.7 : Length of Road Maintained and Equipment owned by Zholdaries

		Atyrau	West Kazakhstan	Aktyubinsk	Mangistau	Total
Total Length	km	3,097	5,384	6,123	2,585	17,189
Nos. of workable Equipment	Nos.	88	155	170	93	506
Nos. of Equipment per km of road maintained	Nos./km	0.028	0.029	0.028	0.036	0.029

Source : Atyrau, Uralisk, Aktyubinsk, Mangistau Zholdary

This figure is much smaller than 0.2 units / km in case of Japan about 20 years ago. This was when the construction of roads were already executed on contract base, and some maintenance works were done in similar way.

According the previous criteria, DRP as a basic unit for maintenance and repair needed 15-16 units of equipment for proper work execution, i.e., 0.3 units / km recommended against 50 km of their road lengths maintained which is almost same in developed western counties.

For a typical road maintenance team, the necessary numbers of equipment are 0.09 units / km (numbers of equipment owned are 9 units, road lengths maintained are about 100 km), and 0.1 units / km are considered to be at least necessary including equipment for common use in offices. Existing equipment is one third of the necessity. To solve the lack of equipment would be a big subject to keep the work quality and to ensure time and cost efficiency not only for maintenance works but also for construction works. Machinery of Workshops, spare parts and equipment of laboratory are explained in Appendix.

(6) Maintenance and Repair of Road

The following shows a review of existing practices for regarding the execution of road maintenance and repair.

(a) Inspection

Execution of inspection, inspection sheets, data form of road inventory, bridge inventory and etc. are established in the direction of diagnosis and evaluation regarding traffic and usage of automobile roads issued by kazakhstan zholdary, based on the criteria of the former soviet union. The direction includes necessary items for inspection. The inspection works of zholdaries have comparatively executed in spite of lack of budget. However, maintenance and repair works have not almost be done recently, especially in 1995 for lack of budget.

(i) Daily Inspection

Daily inspection is visually executed using a exclusive vehicle which is also used for emergency repairing works such as patching with some hand tools and necessary materials.

(ii) Periodic Inspection

A visual inspection is executed twice a year, in spring and autumn by state zholdaries. The result of inspection will be reported to the Kazakhstan zholdary, however, the data of the present road condition are not maintained. One sample of the result is shown in Table 3.4.5.8. This sample was the inspection results of the section Atyrau-Uralsk national road, 993 km of total length, executed by Atyrau zholdary in Atyrau state in October, 1995. This section has damaged by flooding in 1993,1994. Of 935 km of paved road only about 324 km (36 percent) was in good condition.

Repairing of the damaged section could not be done because of insufficient maintenance budget.

(b) Maintenance and Repair

Classification of work items for road maintenance and repair mainly routine and periodic maintenance is shown in Appendix.

Recently, periodic maintenance and improvement/ rehabilitation have almost not done. Only some routine maintenance works are executed.

The present situation of routine maintenance in Republican Roads, Local Roads and the other roads such as Urban and Private roads is mentioned as followings.

(i) Republican Roads

- Asphalt Pavement

Republican Roads in the 4 states are class III and their pavement is generally cold mixed type named lighten asphalt pavement.

Even emergency works and works for keeping road safety have not been done in many roads, such as patching of pothole, sealing of crack. Sand spreading on crossings in winter season have been executed in some roads.

Repairing works were generally executed in insufficient way. Patching works of potholes were executed, in many cases, only to be spread asphalt concrete materials and compacted manually without treatment such as sweeping and cutting off the weak parts of potholes before.

- Unpaved Road

During the field survey, the maintenance works were generally not seen to be carried out.

(ii) Local Road

- Asphalt Pavement

The maintenance of these roads was less than republican roads, many potholes were left without repairing. Many sections of roads were evaluated over 12 of IRI.

- Unpaved Road

The maintenance works were also generally not carried out.

(iii) Urban and Private Roads

The maintenance conditions of city road and farm road were very bad, evaluated over 12 of IRI except main roads of capital city in states and some roads which have been constructed recently.

Many private roads are comparatively new and seen to be kept good conditions evaluated under 6 of IRI. Maintenance of the private roads transferred to zholdaries were delayed and insufficient.

Chapter 4 Formulation of Road Network in the Study Area

Chapter 4 Formulation of Road Network in the Study Area

The existing road network in Western Kazakhstan which includes the Republican Roads, Local Roads and roads newly adopted as Asian Highway is considered as the road network for traffic demand forecast for the study. The total length of this road network is about 17,670 km. The city and service roads are not included in this road network as they do not form the main part of the road network.

There are two reasons for formulating the above mentioned road network as follows.

(1) Road capacity of the present road network mentioned above exceed both the present traffic volume and forecasted traffic volume in 2010 in any roads.

(2) Road Service Level of the present road network in terms of road length per person, registered vehicles and land extent are higher than the average of whole Kazakhstan and are not lower in comparison to other countries as shown in Table 4.1.1 and Table 4.1.2

Table 4.1.1 : International Road Development and Service Levels for Trunk Roads

Country Name	Land Area (A) (x1,000km^2)	Population (P) (x10,000)	Road Length (L) (km)	Number of Motor Vehicles Registered (x10,000)	Road Development Ratio		Road Service Levels	
					Road Development Index	Road Density (km/km^2)	km/1,000 per	km/10,000 veh.
USA	9,373	24,633	6,230,000	18,347	410.0	0.66	25.29	339.57
England	244	5,708	340,000	2,467	288.1	1.39	6.05	158.18
France	552	5,587	810,000	2,534	461.2	1.47	5.96	137.82
Canada	9,970	2,730	285,532	1,701	54.7	0.03	10.46	167.9
Japan	378	12,261	1,110,000	5,245	515.6	2.94	5.22	39.96
Malaysia	330	1,801	63,000	553	81.7	0.19	9.05	211.63
Indonesia	1,919	16,405	230,000	254	41.0	0.12	3.50	113.9
Kazakhstan	2,725	1,694	87,337	156	41.3	0.03	5.19	564.1

Data Source 1) World Road Statistics 1994
2) Doro Gyousei (Road Bureau of Construction Department in Japan 1994)
3) Department of Roads, Ministry of Transport and Communication, 1996

Note: 4) Road Development Index $D = L \sqrt{A \times P}$

Table 4.1.2 : Road Development and Service Levels in Western Kazakhstan

State Name	Land Area (A) (x1,000Km²) (1)	Population(P) (x10,000) (2)	Road Length (L) (km) (3)	Number of Motor Vehicles Registered (x10,000) (4)	Road Development Ratio		Road Service Levels	
					Road Development Index	Road Desity (km/km²)	km/1,000 per	km/10,000 veh
Atyrauskaya	118.6	45.77	2,557.0	4.11	42.0	0.03	6.27	753.5
West Kazakhstan	151.3	67.43	5,384.0	5.89	53.3	0.04	7.98	914.7
Aktyubinskaya	300.6	76.02	6,143.0	4.92	40.6	0.02	8.08	1249.8
Mangistauskoya	165.6	33.85	2,543.0	2.81	34.5	0.02	7.64	919.1
Total	736.1	223.07	17,657.0	17.73	42.5	0.02	7.71	929.7

Data Source : 1) (1), (2), (4) - - - Western Kazakhstan an Regional Annual Statics, 1994
2) (3) — Department of Roads, Ministry of Transport and Communication, 1996

Note : 1) Road Development Index $D = L\sqrt{A \times P}$

For administrative purpose, the public roads are classified into 2 categories, namely Republican Roads and Local Roads, which have a total length of 3,721 km and 13,336 km respectively. The republican roads constitute major inter-state links, and local roads form a road network extending from the republican roads to local core townships. The entire road network provides extensive coverage over the Western Kazakhstan states. The Republican Road network provide links between 4 states and their capitals, and links between district capitals.

Some of the Republican Roads have international traffic movement to neighboring countries, such as the Uralsk-Kzyl Orda border road section, the Uralsk-Turkmenistan border road section and the Atyrau-Russian border road section, though international relation with the neighboring countries have discouraged movement unstable across the borders. Further, the undiversified nature of the economies of land-locked countries around Kazakhstan stimulated neither the international movement of goods as imports and exports nor the movement of people.

The degree of accessibility of state capitals and district capitals can be represented by travel time and or a detour rate estimated from the ratio of actual road distance to aerial direct distance. For the republican road detour rates range from 1.1 to 1.3 except for the linkage between Atyrau and Aktau in which the Caspian Sea makes the detour rate relatively high. Therefore the existing network of republican roads provide a relatively high level of accessibility. However, the roads are in poor condition and require improvements.

Chapter 5 Selection of Priority Projects for Feasibility Study

Chapter 5 Selection of Priority Projects for Feasibility Study

5.1 Road Network for Selection of Priority Projects

The existing road network in Western Kazakhstan which includes the Republican Roads, Local Roads and roads newly adopted as Asian Highway is considered as the road network for traffic demand forecast. The total length of this road network is about 17,670 km. Since the republican roads need to be improved first, so only the republican road network in Western Kazakhstan is considered for selection of priority projects. This road network forms the basic skeleton of the road network in Western Kazakhstan and has a total length 4010 km.

5.2 Long-List Projects

The basic skeleton of road network as mentioned above is divided into 33 road-sections based on the road surface condition and traffic volumes, as shown in Fig 5.2.1. Each of these road section is treated as a long-list project.

The existing road characteristics of these long-list projects is shown in Table 5.2.1 and also in Fig. 5.2.2 and Fig. 5.2.3.

5.3 Evaluation of Long-List Projects

5.3.1 General

The main objective of the economic evaluation is to select priority projects from the long-list projects. These selected priority projects will be studied in detail during the feasibility stage of the study. For the purpose of evaluation, the following items were estimated for each of the long-list projects (i.e. 33 road-sections).

1. Road improvement costs and vehicle operating costs
2. Traffic growth ratio
3. Improvement cost per km.

Considering the traffic forecast on the long-list projects as explained in Chapter 6, these projects will be improved to category III standard of roads.

5.3.2 Economic Benefits and Costs

(1) Economic Benefits

There are several type of benefits from the road improvement projects such as savings in vehicle operating costs (VOC), savings in maintenance costs, increased road safety and others. However, at this stage, only the VOC benefits are considered since they constitute the major share of total benefits.

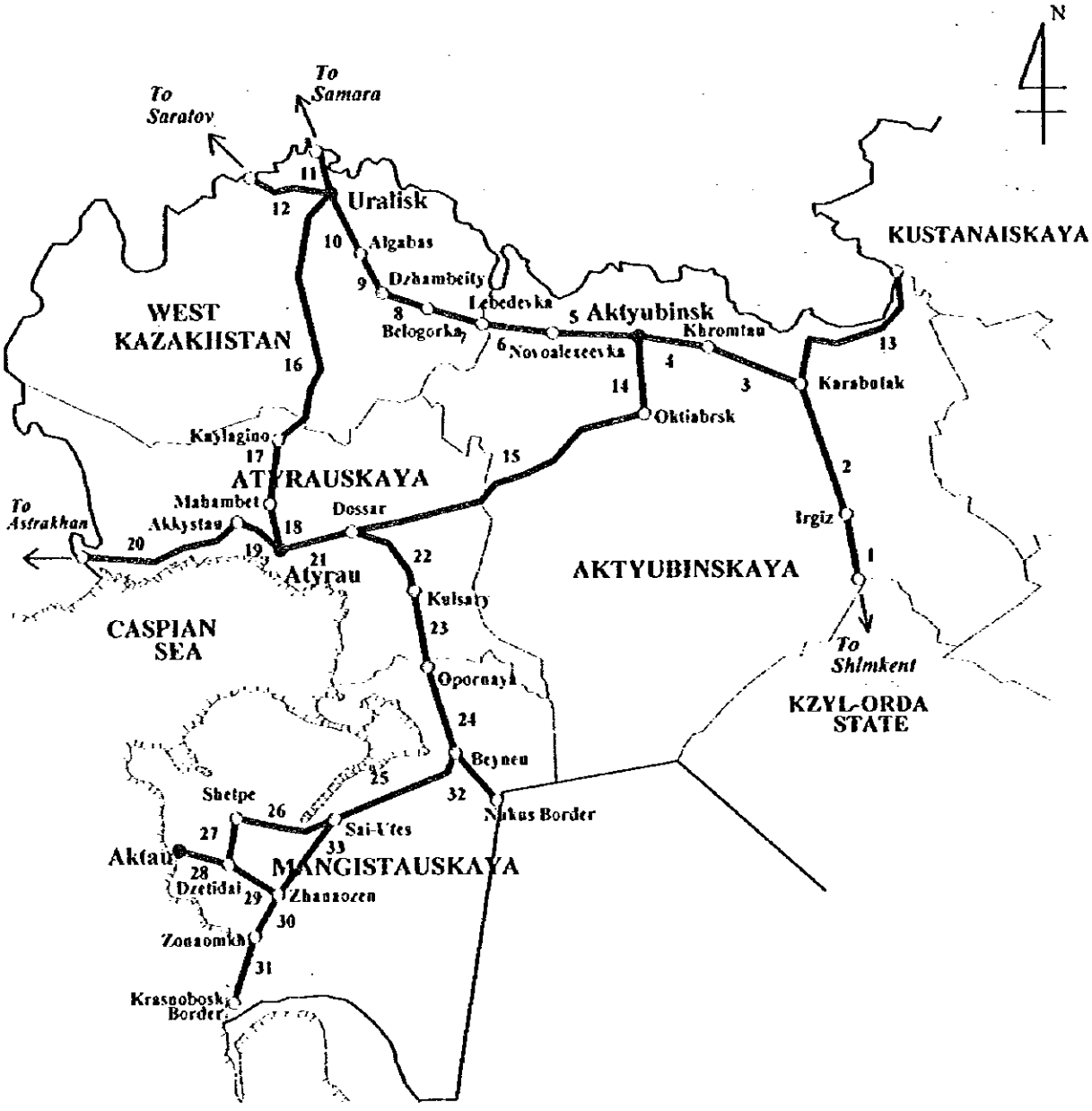


Fig. 5.2.1 : Location of Long-List Projects

Table 5.2.1 : Existing Road Characteristics of Long List Projects

No.	Road Section	Length (km)	(1) Type of Pavement	(2) Road Surface Condition	(3) Type of Highway
1	Kzyl-Orda Border - Irgiz	80	G	VP	IH
2	Irgiz - Karabutak	195	AC	VP	IH
3	Karabutak - Khromtau	124	AC	VP	IH
4	Khromtau - Aktyubinsk	98	AC	P	IH
5	Aktyubinsk - Novoalexeevka	114	AC	F	IH
6	Novoalexeevka - Lebedevka	142	AC	F	IH
7	Lebedevka - Belogorka	25	E	VP	IH
8	Belogorka - Dzhambeity	54	AC	VP	IH
9	Dzhambeity - Algabas	71	AC	P	IH
10	Algabas - Uralsk	68	AC	F	IH
11	Uralsk - Samara Border	50	AC	F	IH
12	Uralsk - Saratov Border	100	AC	F	NH
13	Karabutak - Kustanaiskaya B.	250	AC	VP	NH
14	Aktyubinsk - Oktiabrsk	85	AC	F	NH
15	Oktiabrsk - Dossor	417	AC	F	NH
16	Uralsk - Kaylagino	386	AC	F	IH
17	Kaylagino - Mahambet	50	AC	P	IH
18	Mahambet - Atyrau	70	AC	VP	IH
19	Atyrau - Akkystau	60	AC	P	IH
20	Akkystau - Astrakhan B.	232	AC	P	IH
21	Atyrau - Dossor	92	AC	P	IH
22	Dossar - Kulsary	118	AC	P	IH
23	Kulsary - Opornaya	104	E	VP	IH
24	Opornaya - Beyneu	122	E	VP	IH
25	Beyneu - Sai-Utes	181	G	VP	IH
26	Sai-Utes - Shetpe	120	G	VP	NH
27	Shetpe - Dzetidai	85	AC	F	NH
28	Dzetidai - Aktau	82	AC	P	NH
29	Dzetidai - Zhanaozen	69	AC	F	LR
30	Zhanaozen - Zonaomkh	60	AC	P	IH
31	Zonaomkh - Krasnobosk B.	100	G	VP	IH
32	Beyneu - Nukus Border	84	E	VP	IH
33	Sai-Utes - Zhanaozen	122	E	VP	IH
Total Length		**4010**			

(1) Type of Pavement; AC = Asphalt Concrete/ Asphalt Treatment; G = Gravel; E = Earth

(2) Road Surface Condition; G = Good; F = Fair; P = Poor; VP = Very Poor

(3) Type of Highway; IH = International Highway; NH = Republican Road; LR = Local Road

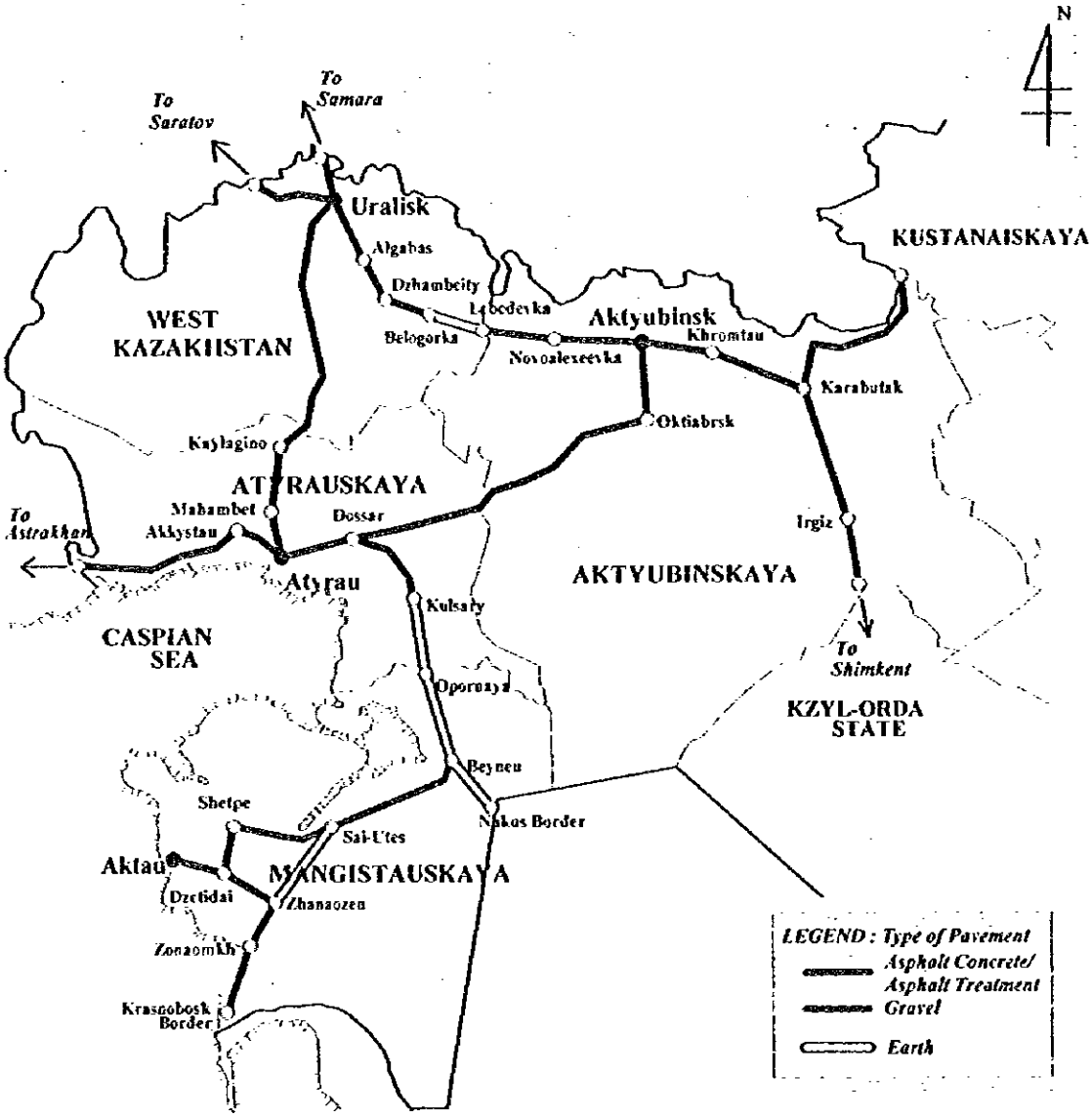


Fig. 5.2.2 : Long-List Projects by Type of Pavement

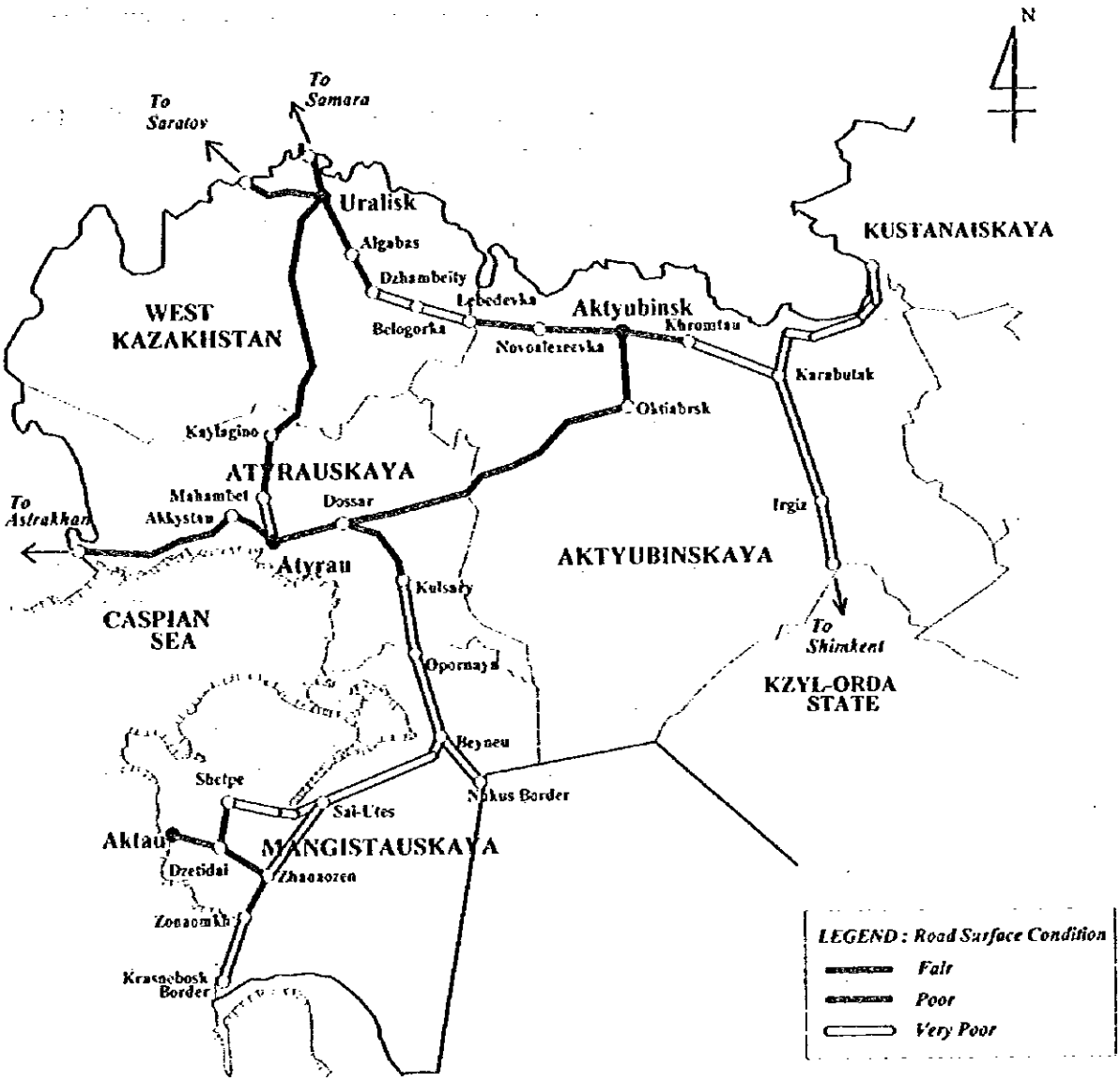


Fig. 5.2.3 : Long-List Projects by Road Surface Condition

The benefit of each long-list project is estimated as follows.

1. First, the total VOC of the road network in 2010 is calculated assuming that all the 33 long-list projects has been implemented. This can be termed as the total VOC for the "Do Maximum Case".

2. Second, the total VOC of the road network in 2010 is calculated assuming that only the project (whose benefit is being calculated) is not implemented and all the rest 32 long-list projects has been implemented. This can be termed as total VOC for the "Without Project Case".

3. The difference between the total VOC for the "Without Project Case" and the "Do Maximum Case" is the benefit of the Project.

The VOC benefits for all the road sections for year 2010 is estimated by the above mentioned method and is shown in Table 5.3.1.

(2) Economic Costs

The total costs of road improvement is estimated for each of the road sections. The cost of road improvement is estimated based on the assumption that after the road improvement, the road-section will be upgraded to category 3 standard with good road surface condition.

The cost of road improvement includes the direct costs and indirect costs. The estimation of direct costs and indirect costs per km by type of road improvement is explained in Chapter 9.

From the estimated total road improvement cost of each long-list project, the annual road improvement cost (PMT) was estimated taking the project life to be 20 years and the annual interest rate of 9% per year. PMT is the annual amount of fixed payment to be made over the entire life of the project. It is calculated as :

$$PMT = PV \times r \times [(1 + r)^n] / [(1 + r)^n - 1]$$

Where;
PV = Total Present Road Improvement Cost
r = Rate of Interest = 9% per year
n = Life of Project = 20 years

The economic cost of road improvement is taken as 95% of the financial cost. The total cost and annual economic costs for all the road sections is shown in Table 5.3.2.

Table 5.3.1 : Annual VOC Benefits of Long List Projects

No.	Road Section	Length (km)	(1) Type of Pavement	(2) Road Surface Condition	Annual VOC Benefit (US$)
1	Kzyl-Orda Border - Irgiz	80	G	VP	2,310,544
2	Irgiz - Karabutak	195	AC	VP	6,712,894
3	Karabutak - Khromtau	124	AC	VP	3,350,269
4	Khromtau - Aktyubinsk	98	AC	P	1,433,306
5	Aktyubinsk - Novoalexeevka	114	AC	F	983,831
6	Novoalexeevka - Lebedevka	142	AC	F	728,475
7	Lebedevka - Belogorka	25	E	VP	630,694
8	Belogorka - Dzhambeity	54	AC	VP	940,856
9	Dzhambeity - Algabas	71	AC	P	1,116,619
10	Algabas - Uralsk	68	AC	F	649,406
11	Uralsk - Samara Border	50	AC	F	654,506
12	Uralsk - Saratov Border	100	AC	F	90,581
13	Karabutak - Kustanaiskaya B.	250	AC	VP	21,497,190
14	Aktyubinsk - Oktiabrsk	85	AC	F	1,549,219
15	Oktiabrsk - Dossor	417	AC	F	5,048,850
16	Uralsk - Kaylagino	386	AC	F	3,191,099
17	Kaylagino - Mahambet	50	AC	P	2,778,647
18	Mahambet - Atyrau	70	AC	VP	2,058,863
19	Atyrau - Akkystau	60	AC	P	92,756
20	Akkystau - Astrakhan B.	232	AC	P	1,241,850
21	Atyrau - Dossor	92	AC	P	2,223,956
22	Dossar - Kulsary	118	AC	P	1,644,356
23	Kulsary - Opornaya	104	E	VP	1,699,894
24	Opornaya - Beyneu	122	E	VP	1,983,206
25	Beyneu - Sai-Utes	181	G	VP	812,906
26	Sai-Utes - Shetpe	120	G	VP	465,319
27	Shetpe - Dzetidai	85	AC	F	189,506
28	Dzetidai - Aktau	82	AC	P	45,131
29	Dzetidai - Zhanaozen	69	AC	F	102,656
30	Zhanaozen - Zonaomkh	60	AC	P	0
31	Zonaomkh - Krasnobosk B.	100	G	VP	0
32	Beyneu - Nukus Border	84	E	VP	1,060,294
33	Sai-Utes - Zhanaozen	122	E	VP	44,775

Table 5.3.2 : Cost of Road Improvement of Long List Projects

No.	Road Section	Length (km)	Cost per km (US$)	Total Road Improvement Cost (million US$)	Total Annual Economic cost (US$)
1	Kzyl-Orda Border - Irgiz	80	137,200	10.97	1,141,639
2	Irgiz - Karabutak	195	170,300	33.21	3,456,137
3	Karabutak - Khromtau	124	170,300	21.12	2,197,940
4	Khromtau - Aktyubinsk	98	157,900	15.47	1,609,950
5	Aktyubinsk - Novoalexeevka	114	59,200	6.75	702,467
6	Novoalexeevka - Lebedevka	142	218,300	31.00	3,226,144
7	Lebedevka - Belogorka	25	349,300	8.73	908,524
8	Belogorka - Dzhambeity	54	349,300	18.86	1,962,744
9	Dzhambeity - Algabas	71	220,300	15.64	1,627,642
10	Algabas - Uralsk	68	59,200	4.03	419,399
11	Uralsk - Samara Border	50	218,300	10.92	1,136,435
12	Uralsk - Saratov Border	100	218,300	21.83	2,271,830
13	Karabutak - Kustanaiskaya B.	250	349,300	87.33	9,088,359
14	Aktyubinsk - Oktiabrsk	85	59,200	5.03	523,468
15	Oktiabrsk - Dossor	417	59,200	24.69	2,569,467
16	Uralsk - Kaylagino	386	59,200	22.85	2,377,980
17	Kaylagino - Mahambet	50	599,700	30.00	3,122,075
18	Mahambet - Atyrau	70	111,000	7.77	808,617
19	Atyrau - Akkystau	60	599,700	35.98	3,744,408
20	Akkystau - Astrakhan B.	232	111,000	25.75	2,679,781
21	Atyrau - Dossor	92	376,600	34.66	3,607,037
22	Dossar - Kulsary	118	111,000	14.64	1,523,572
23	Kulsary - Opornaya	104	170,300	17.71	1,843,065
24	Opornaya - Beyneu	122	349,300	42.61	4,434,387
25	Beyneu - Sai-Utes	181	316,000	57.20	5,952,755
26	Sai-Utes - Shetpe	120	137,200	16.46	1,712,978
27	Shetpe - Dzetidai	85	59,200	5.03	523,468
28	Dzetidai - Aktau	82	111,000	9.10	947,029
29	Dzetidai - Zhanaozen	69	59,200	4.08	424,602
30	Zhanaozen - Zonaomkh	60	111,000	6.66	693,101
31	Zonaomkh - Krasnobosk B.	100	137,200	13.72	1,427,829
32	Beyneu - Nukus Border	84	648,600	54.48	5,669,687
33	Sai-Utes - Zhanaozen	122	648,600	79.13	8,234,992

5.3.3 Selection of Road Sections as Priority Projects

A two step method is used to select priority projects for the feasibility study. In the first step (i.e. preliminary selection), 5 road sections are selected from the 33 long list projects based on the following criteria.

(1) Criteria for Preliminary Selection

The road sections satisfying all the following three criteria are selected in the preliminary selection stage.

(a) Benefit-Cost Ratio (B/C) at present value
B/C of a road section should exceed 1 (i.e. B/C>1). Benefit by improvement of the road section should be more than total investment cost. The B/C ratio for all the road sections is shown in Table 5.3.3.

(b) Traffic Growth Ratio
Traffic growth ratio of the road section between forecasted traffic volume in 2010 and traffic volume at present in 1995 should exceed 2.0. The road sections with highly growing traffic volume will have advantage to be selected.

(c) Improvement Cost per km
Improvement cost per km of the road sections should be more than US$100,000 per/km. Road sections with low improvement cost per km mean that present road condition are rather good and budget for improvement will be easily procured.

A total of 5 road-sections with total length of 587 km is selected in the preliminary selection stage from the 33 long-list projects as shown in Table 5.3.4.

(2) Final Selection

The total length of the 5 road-sections selected in the preliminary selection stage is 587 km. This length was considered to be too large to be studied in detail during the feasibility study. So, the 5 road-sections selected in the preliminary selection stage were ranked by their benefit-cost ratio (B/C) and the top three road sections with total length of 345 km were selected as priority projects to be studied in the feasibility stage as shown in Table 5.3.4. The location of the finally selected priority projects is shown in Fig. 5.3.1.

The 3 finally selected priority projects (total length = 345 km) are as follows;
1. Road section from Kzyl-Orda Border to Irgiz (80 km)
2. Road section from Irgiz to Karabutak (195 km)
3. Road section from Atyrau to Mahambet (70 km)

For the feasibility study, the length of the selected priority projects was revised as follows.

1. Road section from Kzyl-Orda Border to Irgiz	= 80 km
2. Road section from Irgiz to Karabutak	= 195 km
3. Road section from Atyrau to Mahambet	= 70 km
Total Length of Priority Projects	= 358 km

Table 5.3.3 : Benefit - Cost Ratio (B/C) of Long List Projects

No.	Road Section	Length (km)	Annual Economic VOC Benefits (US$)	Annual Economic Cost of Road Improvement (US$)	Benefit - Cost Ratio
1	Kzyl-Orda Border - Irgiz	80	2,310,544	1,141,639	2.02
2	Irgiz - Karabutak	195	6,712,894	3,456,137	1.94
3	Karabutak - Khromtau	124	3,350,269	2,197,940	1.52
4	Khromtau - Aktyubinsk	98	1,433,306	1,609,950	0.89
5	Aktyubinsk - Novoalexeevka	114	983,831	702,467	1.40
6	Novoalexeevka - Lebedevka	142	728,475	3,226,144	0.23
7	Lebedevka - Belogorka	25	630,694	908,524	0.69
8	Belogorka - Dzhambeity	54	940,856	1,962,744	0.48
9	Dzhambeity - Algabas	71	1,116,619	1,627,642	0.69
10	Algabas - Uralsk	68	649,406	419,399	1.55
11	Uralsk - Samara Border	50	654,506	1,136,435	0.58
12	Uralsk - Saratov Border	100	90,581	2,271,830	0.04
13	Karabutak - Kustanaiskaya B.	250	21,497,190	9,088,359	2.37
14	Aktyubinsk - Oktiabrsk	85	1,549,219	523,468	2.96
15	Oktiabrsk - Dossor	417	5,048,850	2,569,467	1.96
16	Uralsk - Kaylagino	386	3,191,099	2,377,980	1.34
17	Kaylagino - Mahambet	50	2,778,647	3,122,075	0.89
18	Mahambet - Atyrau	70	2,058,863	808,617	2.55
19	Atyrau - Akkystau	60	92,756	3,744,408	0.02
20	Akkystau - Astrakhan B.	232	1,241,850	2,679,781	0.46
21	Atyrau - Dossor	92	2,223,956	3,607,037	0.62
22	Dossar - Kulsary	118	1,644,356	1,523,572	1.08
23	Kulsary - Opornaya	104	1,699,894	1,843,065	0.92
24	Opornaya - Beyneu	122	1,983,206	4,434,387	0.45
25	Beyneu - Sai-Utes	181	812,906	5,952,755	0.14
26	Sai-Utes - Shetpe	120	465,319	1,712,978	0.27
27	Shetpe - Dzetidai	85	189,506	523,468	0.36
28	Dzetidai - Aktau	82	45,131	947,029	0.05
29	Dzetidai - Zhanaozen	69	102,656	424,602	0.24
30	Zhanaozen - Zonaomkh	60	0	693,101	0.00
31	Zonaomkh - Krasnobosk B.	100	0	1,427,829	0.00
32	Beyneu - Nukus Border	84	1,060,294	5,669,687	0.19
33	Sai-Utes - Zhanaozen	122	44,775	8,234,992	0.01

Table 5.3.4 : Selection of Priority Projects

No.	Road Section	Length (km)	Cost (Mill. US$)	Preliminary Selection and Evaluation Criteria				Final Selection		
				B/C > 1	Traffic Growth Ratio > 2.0 Over 2010/1995	Imp.Cost per km >0.1M.US$	Preliminary Selected Projects	B/C	B/C Ranking	Finally Selected Projects
1	Kzyl-Orda Border - Irgiz	80	10.97	O	O	O	O	2.02	2	O
2	Irgiz - Karabutak	195	33.21	O	O	O	O	1.94	3	O
3	Karabutak - Khromtau	124	21.12	O	O	O	O	1.52	4	
4	Khromtau - Aktyubinsk	98	15.47		O	O				
5	Aktyubinsk - Novoalexeevka	114	6.75	O	O					
6	Novoalexeevka - Lebedevka	142	31.00		O	O				
7	Lebedevka - Belogorka	25	8.73		O	O				
8	Belogorka - Dzhambeity	54	18.86		O	O				
9	Dzhambeity - Algabas	71	15.64		O	O				
10	Algabas - Uralsk	68	4.03	O	O					
11	Uralsk - Samara Border	50	10.92		O	O				
12	Uralsk - Saratov Border	100	21.83			O				
13	Karabutak - Kustanaiskaya B.	250	87.33	O		O				
14	Aktyubinsk - Oktiabrsk	85	5.03	O						
15	Oktiabrsk - Dossor	417	24.69	O	O					
16	Uralsk - Kaylagino	386	22.85	O						
17	Kaylagino - Mahambet	50	30.00		O	O				
18	Mahambet - Atyrau	70	7.77	O	O	O	O	2.55	1	O
19	Atyrau - Akkystau	60	35.98			O				
20	Akkystau - Astrakhan B.	232	25.75			O				
21	Atyrau - Dossor	92	34.66		O	O				
22	Dossor - Kulsary	118	14.64	O	O	O	O	1.08	5	
23	Kulsary - Opornaya	104	17.71			O				
24	Opornaya - Beyneu	122	42.61			O				
25	Beyneu - Sai-Utes	181	57.20			O				
26	Sai-Utes - Shetpe	120	16.46			O				
27	Shetpe - Dzetidai	85	5.03							
28	Dzetidai - Aktau	82	9.10			O				
29	Dzetidai - Zhanaozen	69	4.08							
30	Zhanaozen - Zonaomkh	60	6.66			O				
31	Zonaomkh - Krasnobosk B.	100	13.72			O				
32	Beyneu - Nukus Border	84	54.48			O				
33	Sai-Utes - Zhanaozen	122	79.13			O				
	TOTAL LENGTH (in km)	4010	-				587			345
	TOTAL COST (in mill. US$)	-	793.41				87.7			51.95

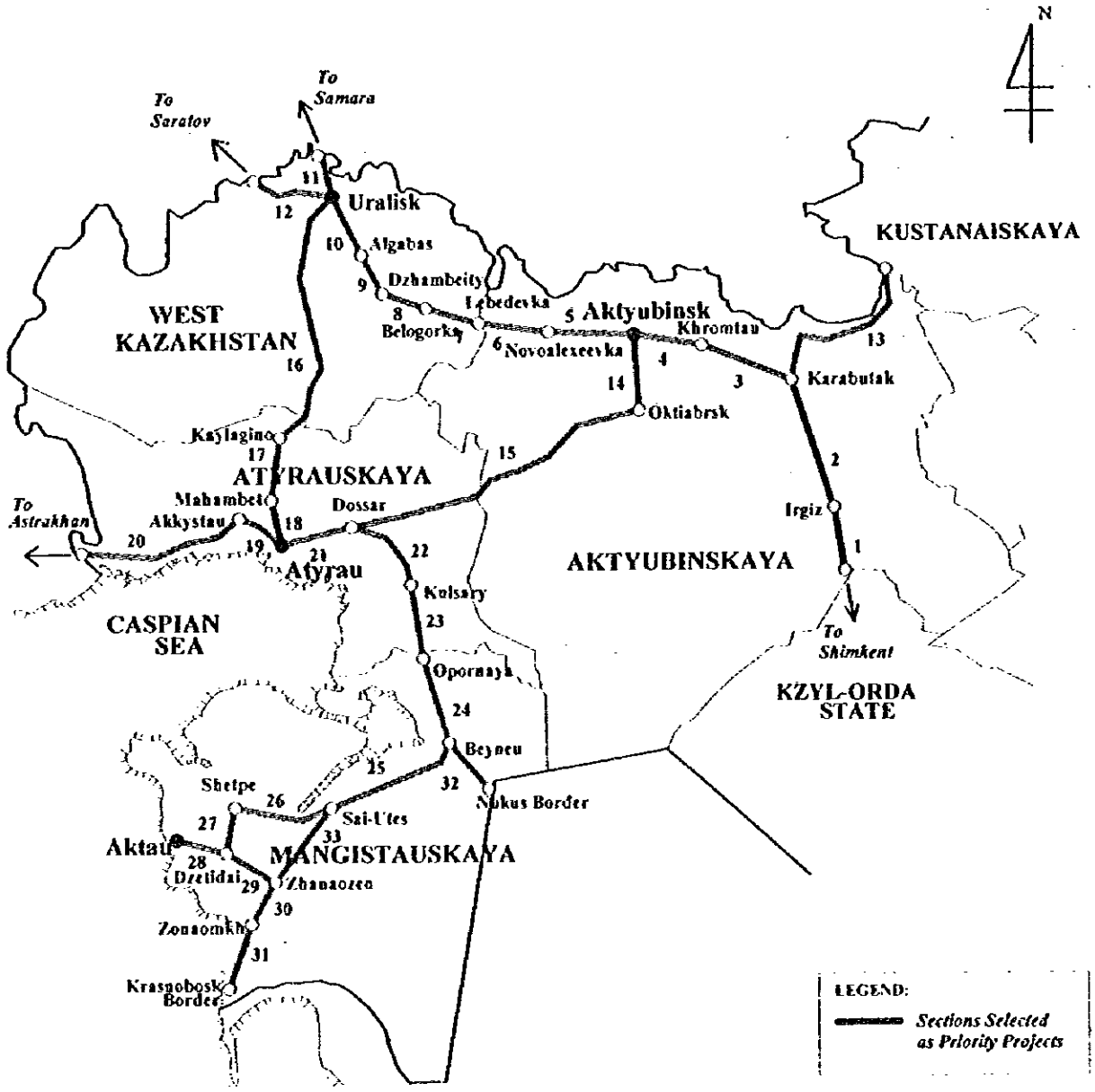


Fig. 5.3.1 : Selected Priority Projects for Feasibility Study

Chapter 6 Traffic Forecast

Chapter 6 Traffic Forecast

6.1 Traffic Forecast Method

The traffic demand forecast is made from the vehicle generation/attraction sub-model and the traffic assignment model. The procedure for the traffic demand forecast is shown in Fig. 6.1.1.

A forecast of road traffic performs estimation by 3 steps of assignment to an object road of a forecast of vehicle generation/attraction of a zone, estimation of OD table and forecast of assignment traffic on roads.

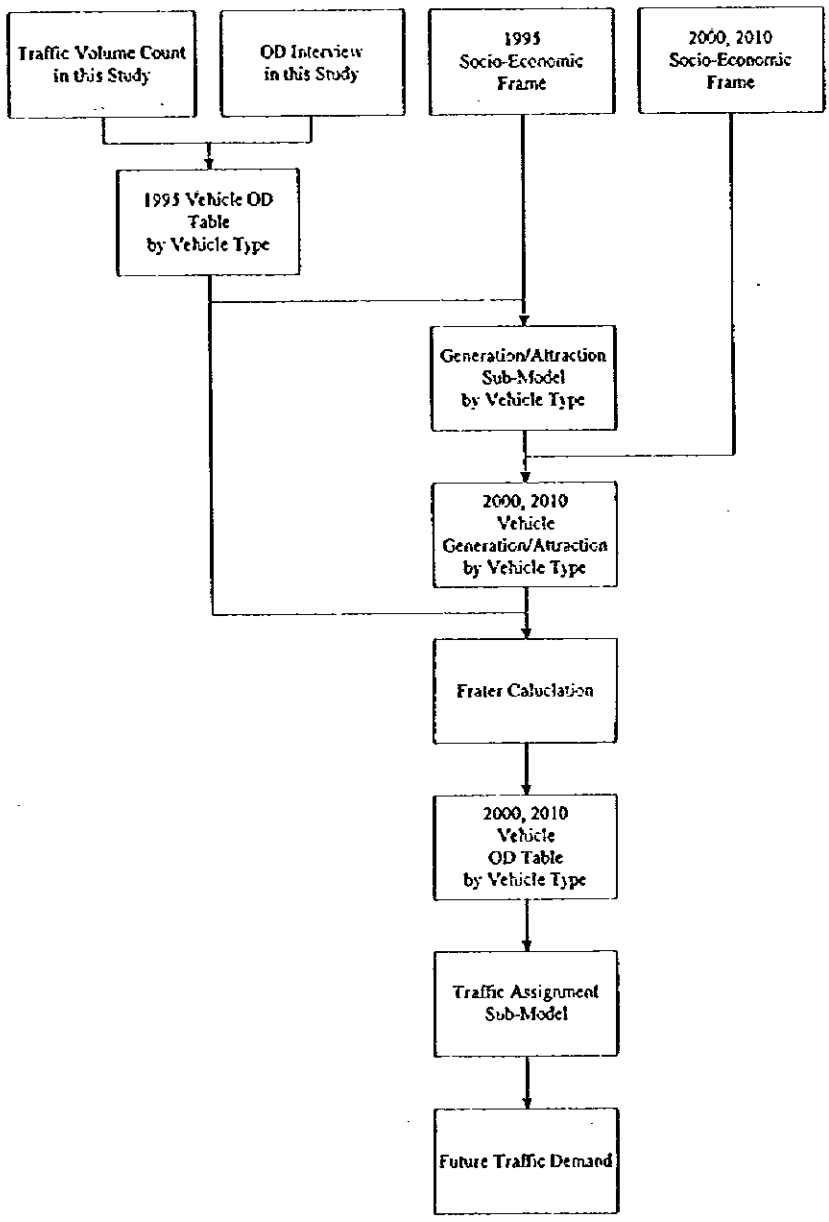


Fig. 6.1.1 : Procedure of Traffic Demand Forecast

6.2 Traffic Survey

6.2.1 Origin-Destination (OD) Survey

(1) Objective of Survey

The objective of the survey was to grasp the actual circumstances of passenger car and truck traffic from a broad perspective and to come up with a current OD table of passenger cars and trucks.

(2) Selection of Points of Survey

Roadside OD survey was, in principle, conducted at state boundaries, the border between Russia and Kazakhstan and provincial boundaries. The reason for this was to cover and include all intra zone provincial traffic. However, as the results of past surveys indicated that the traffic volume around large cities was some fourfold that of intra state traffic, points of survey were selected to include junctions of trunk roads around large cities in consideration of trunk road demand around large cities.

Twenty roadside interview OD survey points which were selected from such viewpoint are given on Figure 6.2.1.

(3) Particulars of Survey

1) Time of Survey

The subject survey was conducted at the twenty selected points between 9 (Mon.) through 12 (Thur.) October, 1995, during the twelve hours from 08:00 to 20:00.

2) Method of Survey

The survey was conducted by survey staff stopping vehicles and questioning drivers in accordance with the survey questionnaire sheet. The items of the questionnaire were as follows:

(a) Type of Vehicle

1. Motorcycle
2. Passenger car
3. Pick-up truck
4. Bus
5. Truck (2 axles)
6. Others including heavy truck

(b) Load (Trucks Only)

1. Agricultural produce
2. Industrial produce
3. Commercial produce
4. Construction material and equipment
5. Others
6. Empty

(c) Purpose of Trip

1. Commutation A (to work)
2. Commutation B (to school)
3. Returning home
4. Private

(d) Code of Origin-Destination

Study area and outside of the study area are divided into 54 areas with code numbers shown as the following Table 6.2.1.

Table 6.2.1 Code Numbers of The Study Area

Region (state)	Code No.	Number of Zone
West Kazakhstan	100 - 116	16
Atyrauskaya	200 - 208	9
Mangistauskaya	300 - 305	6
Aktyubinskaya	400 - 416	18
Other		5
Total		54

(e) Number of Passengers

1. Number of passengers
2. Seating capacity

(f) Load Capacity

1. Weight
2. Volume

(4) Traffic Volume Survey

A traffic volume survey was conducted simultaneously with the OD survey at the same points. Types of vehicles, however, were classified as motorcycles, passenger cars, pick-ups, buses, trucks (2 axles) and heavy trucks. The time of survey was over 12 hours, from 08:00 in the morning to 20:00 in the evening.

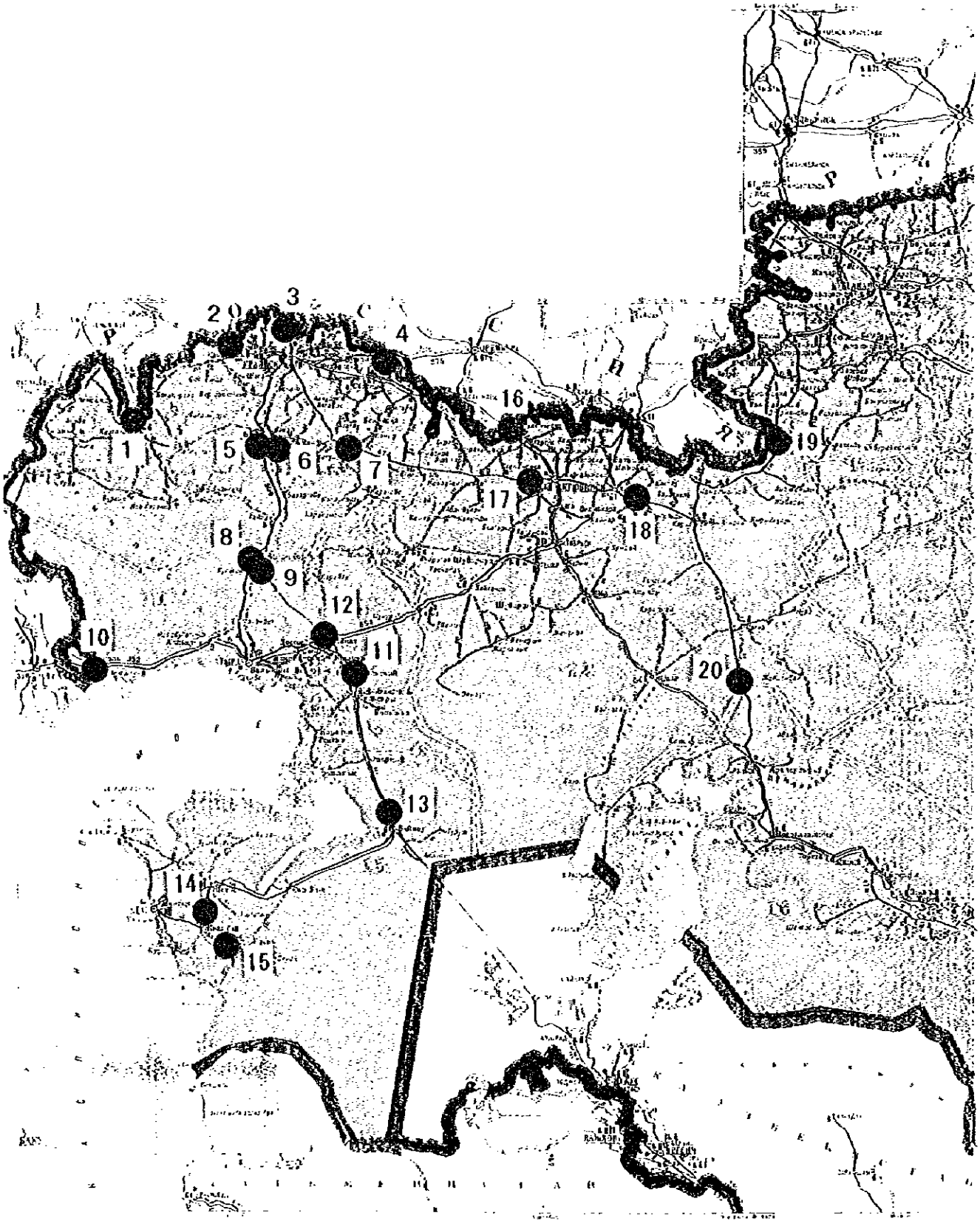


Fig. 6.2.1 : Location of Survey Stations

6.2.2 Results of Traffic Survey

(1) Traffic Volume

Traffic volume on the point of survey, as shown on Table 6.2.2. Traffic volume was 100-800 vehicles/12h, A point 18 was the busiest with 788 vehicles/12h, The next heavily volumes point was, Point 20 was 707 vehicles/12h. In these points was between Aktyubinsk and Irgiz on national highway (route M1).

Table 6.2.2 : Traffic Volume of Survey Point (Oct. 1995)

Location	Traffic volume (veh/12h)						
NO.	Motor-cycle	Passenger car	pick-up	Bus	2 axle Truck	H. Truck	Total
1	1	51	2	7	33	24	118
2	3	122	8	12	37	72	254
3	0	153	21	7	90	85	356
4	17	165	5	15	26	35	263
5	5	158	3	27	70	107	370
6	9	84	39	16	73	15	236
7	4	124	16	11	44	52	251
8	0	70	2	9	55	21	157
9	0	52	2	6	41	0	101
10	0	209	24	29	224	38	524
11	0	91	0	17	87	27	222
12	0	67	1	11	73	18	170
13	0	163	7	11	162	57	400
14	0	124	4	41	123	20	312
15	0	119	0	33	78	138	368
16	32	175	63	25	145	173	613
17	10	186	48	29	147	198	618
18	31	216	60	35	190	256	788
19	2	113	50	1	113	185	464
20	0	189	79	6	128	305	707

(2) OD Survey

The number of vehicles stopped and questioned at the twenty survey points was 4,580 as shown in Table 6.2.3 and the sampling rate of traffic volume over the 12 hour period was 62.8%.

The type of load carried was as per Figure 6.2.2 and vehicles with no load turned out to be 32% of the total. Among loaded trucks, those carrying agricultural produce were the largest in number at 28% and, especially those outside Uzbekistan and Kyrgizstan, such vehicles accounted for over 85% of the total.

Within the states surveyed, trucks in West Kazakhstan and Aktyubinskaya loaded with agricultural produce came on top at some 30%, but in Akyrauskaya and Mangistauskaya, those carrying construction materials and equipment were largest in number accounting for 18 to 20% of the total.

Unit : Vehicle/day

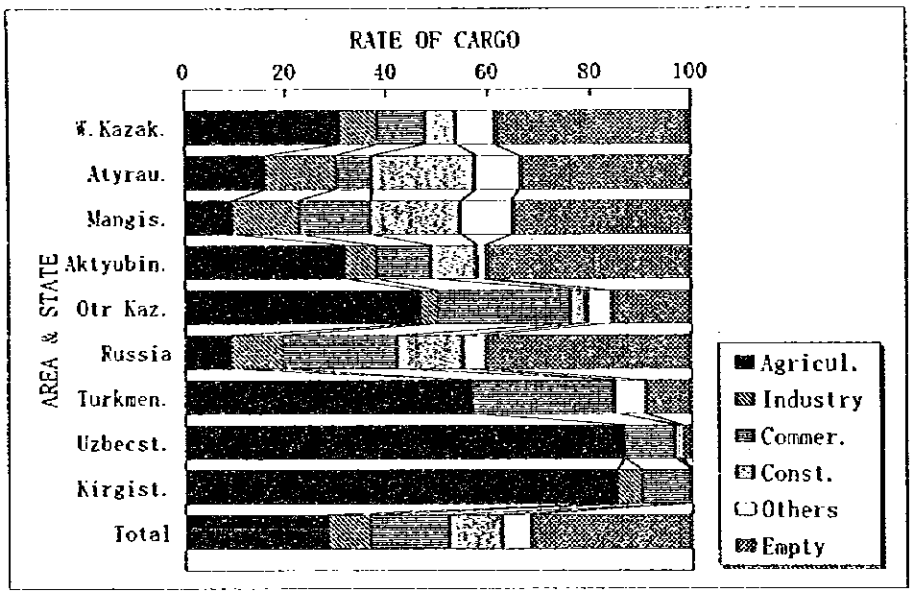


Fig. 6.2.2 : Rate of Cargo by Trucks

Table 6.2.3: Sample Numbers of OD Interview

LOC	Item	Moto	P.car	Pickup	Bus	Truck	M.Truck	Total
1	Traffic Count (Veh./12h)	1	51	2	7	33	24	118
	O/D samples (Veh./12h)	1	51	2	7	33	24	118
	Sample ratio (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2	Traffic Count (Veh./12h)	3	122	8	12	37	72	256
	O/D samples (Veh./12h)	3	114	5	12	35	70	239
	Sample ratio (%)	100.00	93.44	62.50	100.00	94.59	97.22	93.09
3	Traffic Count (Veh./12h)	0	153	21	7	90	85	356
	O/D samples (Veh./12h)	0	142	20	7	88	85	342
	Sample ratio (%)	0.00	92.81	95.24	100.00	97.78	100.00	96.07
4	Traffic Count (Veh./12h)	17	165	5	15	26	35	263
	O/D samples (Veh./12h)	17	162	5	14	26	35	259
	Sample ratio (%)	100.00	98.18	100.00	93.33	100.00	100.00	98.48
5	Traffic Count (Veh./12h)	5	158	3	23	70	101	370
	O/D samples (Veh./12h)	5	148	3	24	52	96	328
	Sample ratio (%)	100.00	93.67	100.00	88.89	74.28	89.72	88.65
6	Traffic Count (Veh./12h)	9	84	39	16	73	15	236
	O/D samples (Veh./12h)	8	48	20	11	43	10	140
	Sample ratio (%)	88.89	57.14	51.28	68.75	58.90	66.67	59.32
7	Traffic Count (Veh./12h)	4	124	16	11	44	52	251
	O/D samples (Veh./12h)	4	122	13	11	42	52	244
	Sample ratio (%)	100.00	98.39	81.25	100.00	95.45	100.00	97.21
8	Traffic Count (Veh./12h)	0	70	2	9	55	21	157
	O/D samples (Veh./12h)	0	67	2	9	55	21	154
	Sample ratio (%)	0.00	95.71	100.00	100.00	100.00	100.00	98.09
9	Traffic Count (Veh./12h)	0	52	2	6	41	0	101
	O/D samples (Veh./12h)	0	44	2	6	38	0	90
	Sample ratio (%)	0.00	84.62	100.00	100.00	92.68	0.00	89.11
10	Traffic Count (Veh./12h)	0	209	24	29	224	38	524
	O/D samples (Veh./12h)	0	201	24	29	220	38	512
	Sample ratio (%)	0.00	96.17	100.00	100.00	98.21	100.00	97.71
11	Traffic Count (Veh./12h)	0	91	0	17	87	27	222
	O/D samples (Veh./12h)	0	77	0	17	84	27	205
	Sample ratio (%)	0.00	84.62	0.00	100.00	96.55	100.00	92.34
12	Traffic Count (Veh./12h)	0	67	1	11	73	18	170
	O/D samples (Veh./12h)	0	57	1	11	72	18	159
	Sample ratio (%)	0.00	85.07	100.00	100.00	98.63	100.00	93.53
13	Traffic Count (Veh./12h)	0	163	7	11	162	57	400
	O/D samples (Veh./12h)	0	150	5	11	160	57	383
	Sample ratio (%)	0.00	92.02	71.43	100.00	98.77	100.00	95.75
14	Traffic Count (Veh./12h)	0	124	4	41	123	20	312
	O/D samples (Veh./12h)	0	112	4	41	121	20	298
	Sample ratio (%)	0.00	90.32	100.00	100.00	98.37	100.00	95.51
15	Traffic Count (Veh./12h)	0	119	0	33	78	136	366
	O/D samples (Veh./12h)	0	9	0	15	10	36	70
	Sample ratio (%)	0.00	7.56	0.00	45.45	12.82	26.09	19.02
16	Traffic Count (Veh./12h)	32	435	63	25	145	113	813
	O/D samples (Veh./12h)	25	133	41	10	87	125	436
	Sample ratio (%)	78.13	79.43	65.08	76.00	60.00	72.25	71.13
17	Traffic Count (Veh./12h)	10	186	48	29	147	198	618
	O/D samples (Veh./12h)	5	63	10	15	24	63	180
	Sample ratio (%)	50.00	33.87	20.83	51.72	16.33	31.82	29.13
18	Traffic Count (Veh./12h)	31	216	60	35	190	256	788
	O/D samples (Veh./12h)	6	33	10	8	25	58	140
	Sample ratio (%)	19.35	15.28	16.67	22.86	13.16	22.65	17.77
19	Traffic Count (Veh./12h)	2	113	50	1	113	185	464
	O/D samples (Veh./12h)	2	29	14	1	35	59	140
	Sample ratio (%)	100.00	25.66	28.00	100.00	30.97	31.89	30.17
20	Traffic Count (Veh./12h)	0	189	79	6	128	305	707
	O/D samples (Veh./12h)	0	43	13	3	29	55	143
	Sample ratio (%)	0.00	22.75	16.46	50.00	22.66	18.03	20.23
Total	Traffic Count (Veh./12h)	111	2631	434	348	1939	1826	7292
	O/D samples (Veh./12h)	76	1811	194	271	1219	949	4580
	Sample ratio (%)	66.61	68.83	44.70	77.87	65.96	51.97	62.81

Concerning purpose of travel, "Private" and "Commutation A" came on top with 44% and 46% respectively. Within the states surveyed, the trend was identical. (Figure 6.2.3).

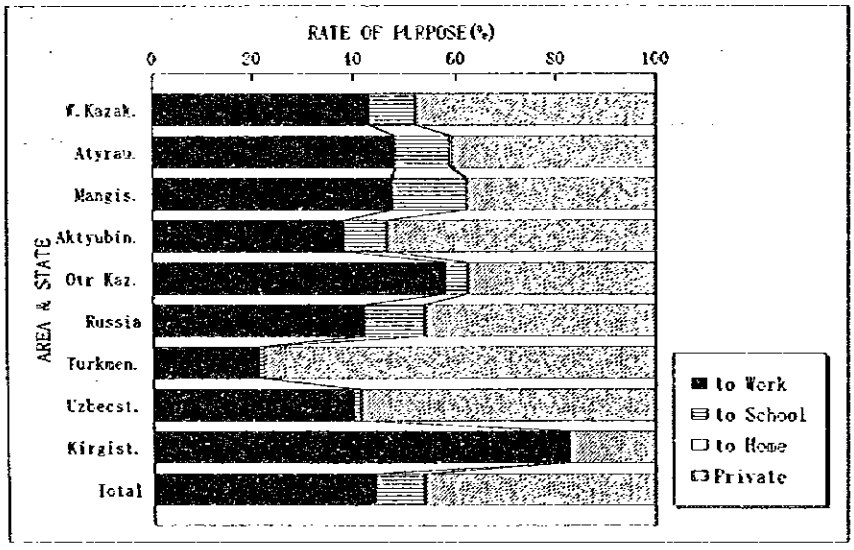


Fig. 6.2.3 : Rate of Utilization Purpose

As far as types of vehicles were concerned, trucks accounted for 49%. Passenger cars followed with 40%. In extra regional zones, 80% of vehicles on the roads were trucks.(Figure 6.2.4)

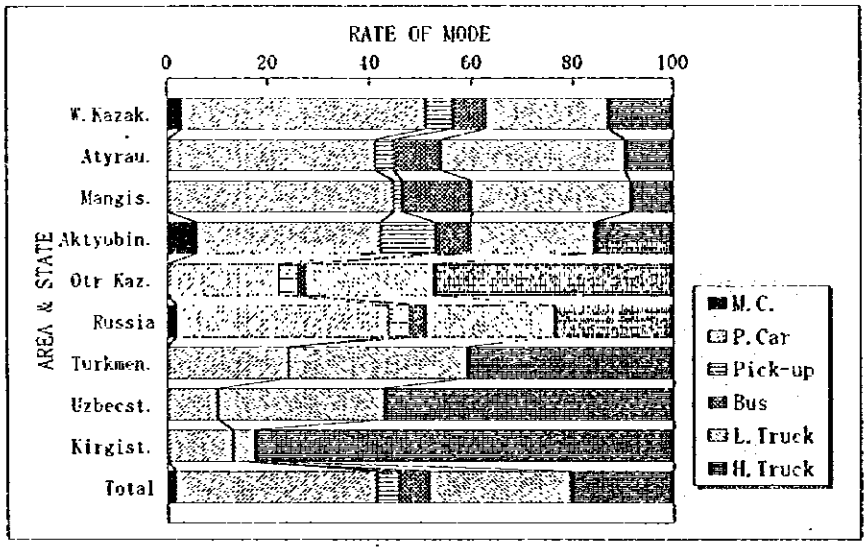


Fig. 6.2.4 : Rate of Vehicle Types

6.2.3 Preparation of OD Table

Study area was divided into 49 zones and outside of the study area into 5 zones as per Figure 6.2.5, a total of 54 zones. From OD survey, present OD was prepared (Table 6.2.4). According to this table, the OD traffic volume of all vehicles was approximately 6,867 vehicles/day. Trucks are some 3,695 vehicles/day and comprise approximately 54%. Within this number, heavy trucks are 1,297 vehicles/day and comprise some 19%.

The zone in which OD traffic volume is largest is Russia which is outside the country. It accounted for some 19.5% of OD traffic volume with 1,338 vehicles/day. Zone of Kazakhstan which was followed with 778 vehicles/day (11.3%). The aggregate of extra regional zones including Turkmenistan, Uzbekitan and Kyrgizstan accounted for 36.5% or 2,507 vehicles/day of total OD traffic volume and, transit (through) traffic constituted a large portion.

In the study area, Uralsk city was foremost with 639 vehicles/day (9.3%) followed by Aktyubinsk city with 500 vehicles/day (9.3%). OD traffic volume was comparatively large in the areas to the north.

Concerning type of vehicles, OD traffic volume of extra regional heavy trucks was 751 vehicles/day and accounted for 58% of the total and when light trucks are included, extra regional OD traffic volume still comprise 41% of the total. Extra regional OD traffic volume of passenger cars was also large, accounting for 33% of the total with 918 vehicles/day. Amongst such a volume, Russia came on top with 585 vehicles/day or 21% of the total (Table 6.2.4).

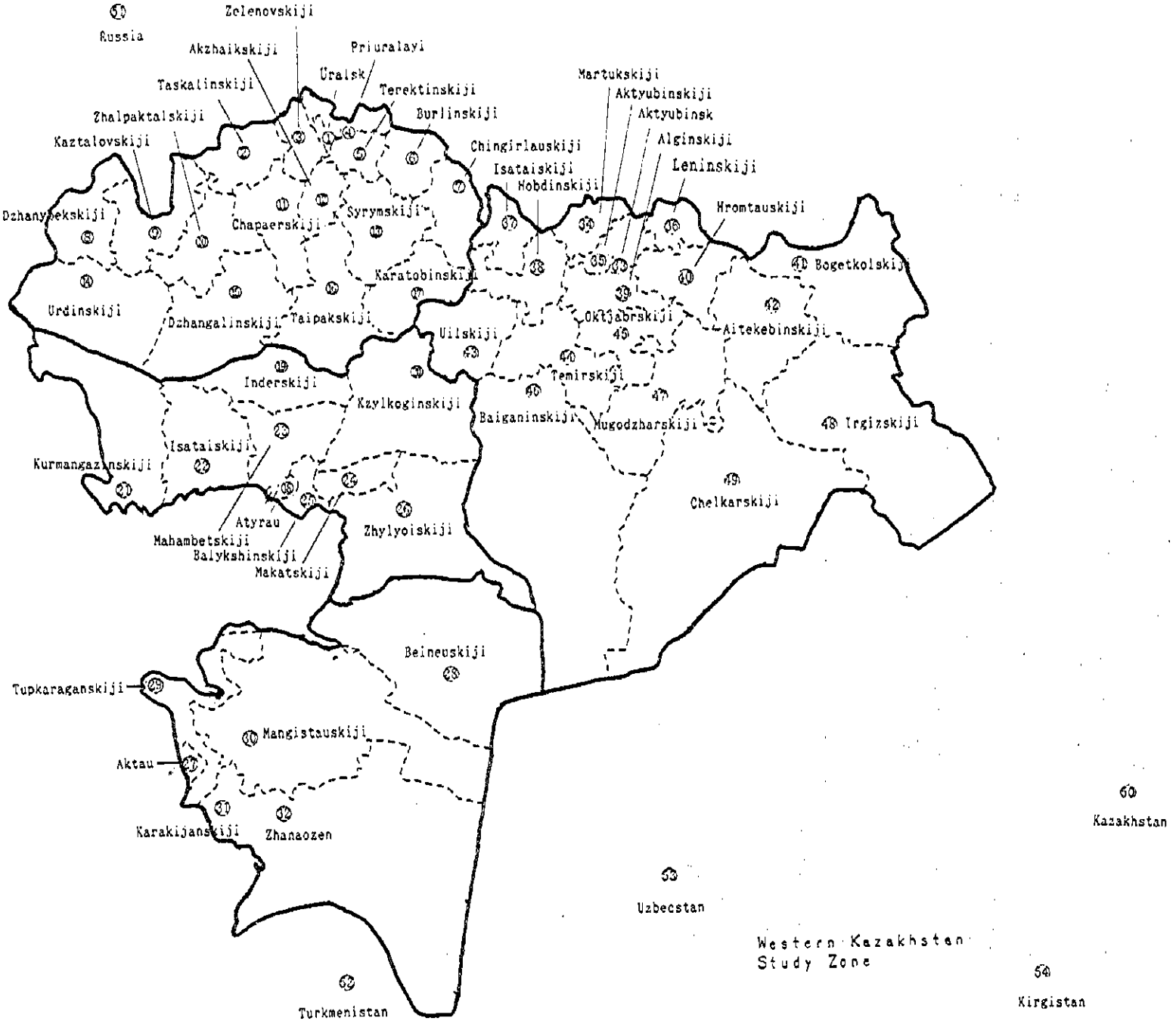


Fig. 6.2.5 : Zone Map of Survey Areas

Table. 6.2.4 : OD Table by Vehicle Type in 1995

[1995]
[Total]

Zone no	O/D Zone	Zone Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	Total
1	1000	Uralsk city	9	23		5	1		2	1	8	22	39		28	9	17	67	10	40	8			1	1	5		6	4			1	1	1	15	2							7									103	177	12	12	3	939
2	101	Taskalinskiji rajon	7	17		1	1																																													6				32
3	102	Zelenovskiji rajon		3																																																8				11
4	103	Priuralayi rajon																																																	19				19
5	104	Terektinskiji rajon																																																	1				1
6	105	Burlinskiji rajon											1							1								1						1	4																	125				133
7	106	Chingirlauskiji rajon	4																																																	2				6
8	107	Ozhanybekskiji rajon																																																					
9	108	Kaztalovskiji rajon	12	1							17	1																																								26				57
10	109	Zhalpaktalskiji rajon	18	1				3			3																																								12				37
11	110	Chapaevskiji rajon	35		6						3		5							2	1		1	1	4		2		2																							1	6				69
12	111	Akzhaikskiji rajon																41		1	15			1			1																									1				60
13	112	Syrymskiji rajon	32		1		4	1					2		80			1		1				1	3																									1	2				129
14	113	Urdinskiji rajon	4	1	1																																																		6
15	114	Ozhangakinskiji rajon	5	1																																																		7				13
16	115	Taipakskiji rajon	24										8	49	5			36		6	1		1	4	3	3	3		1						3																		18				165
17	116	Karatobinskiji rajon	10	1			1								1																																								13
18	2000	Atyrau city	29							1	3	3	5					6		1	22	24	13	1		37		40	10	6	1	1	1	5	4											3					6	62	10	13		310
19	201	Inderskiji rajon	4				2				1	2			6					20	1	1	1	1	8	1	1	2																										5				56
20	202	Kzylkoginskiji rajon	3																	13					2	12		2		3			6																				1				42
21	203	Kurmangazinskiji rajon																		21	4	1	38	45	3	3	1	2		1																						7				126
22	204	Isatajskiji rajon	1										4								1		35	1						1	2			1																		23		1		70
23	205	Makhambetskiji rajon	2					1					6					2		3	4	3	3			4		1	1	3				1	2						3										11				52
24	206	Makatskiji rajon									1									24	3	6	1		1	15		22	7	4	2	6	5	3																	6		1		107
25	207	Balykshinskiji rajon	1												1			5					1	1				2	1			3																					10				23
26	208	Zhylyoiskiji rajon	3											3						46		4		1		44	6	4	5	10		5	7	11	1																12	16		6		169
27	3000	Aktau city	8																	12			1		1			11	1	4	1	16	16	110	4																1	23	4			215
28	301	Beineuskiji rajon	4																	5					2	2		6		25		3	5	2																		2		2		56
29	302	Tupkaraganskiji rajon																									1					1	9	14																		1				26
30	303	Mangistauskiji rajon	4																	2						3		5	10	4		3	56	95																		1	6			189
31	304	Karakiyanskiji rajon											4							4				1		5		4	2	2	15	47	1	21																		1				113
32	305	Zhanaozen(Novy Uzen)	3					1												1					1			7	56	3	6	34	25	11																		6				148
33	4000	Aktyubinsk city	35													1				4			2		1				4			3	4	1	5	9			23	27			19	27	4		65			33	15	80	137	4	1		500
34	401	Martukskiji rajon																																	4					3			11				10			4		4	93				129
35	402	Aktyubinskiji rajon																																									12														12
36	403	Leninskiji rajon																																																						
37	404	Isatajskiji rajon	4																																14					3		3														24
38	405	Hobdinskiji rajon	4																																36	3								5						7				60
39	406	Alginskiji rajon																																																					16
40	407	Hromtauskiji rajon	15								3																													6				10				10		19	12				140
41	408	Bogetkolskiji rajon																																	10										4				59		9	3				86
42	409	Aktobinskiji rajon																																	25					11	8	54	8	20						8		5				139
43	410	Uilskijin rajon																																																		3				3
44	411	Terminskiji rajon																																																	7				7
45	412	Oktjabrskiji rajon		1																							1	2	2						32					9			4			12					5	3				84
46	413	Baiganinskiji rajon																											4		3		3	1																			1			12
47	414	Mugodzharskiji rajon																																																	4				4
48	415	Irgizskiji rajon																																	46															4				50
49	416	Chelkarskiji rajon																																																					
50	500	Kazakhstan	40						10						1					6						1		8	2						302	12	3			27	3	12	20	6		3	30	7	21	41	38	144	239				778
51	600	Russia	121	11	13	18	7	145		1	31	14	7		6		9	22		98	7		9	25	11	12	12	30	32	1		1	1	7	124	66	5	1		6	10	7	7		6	7	1	3	4	7	206	33	47	87	36	1338
52	700	Turkmenistan	3												1					11						2		6	34			2			9																	82				150
53	800	Uzbekistan	32																	14						1		19	3				3	1																	25	91				189
54	900	Kyrgyzstan(Kirghizia)	7																																																	10	35				52
		Total	486	59	21	24	14	153	12	2	65	38	76	57	129	10	26	166	10	336	67	40	106	83	40	151	28	174	184	65	29	123	146	300	436	116	6	1	29	70	19	80	84	164	4	9	191	11	24	99	61	936	1252	90	124	41	6867

6.2.4 Traffic Assignment

Upon preparing a route chart according to item loaded and based on OD assignment, the outcome is Figure 6.2.6-6.2.11.

The flow of traffic of all items was concentrated on the Russia to Kazakhstan route, Russia-Uralsk city, Russia-Aktyubinsk city or in this region, on the trunk line national highway linking Samara and Chimkent. The majority was traffic which transits the subject region. As for intra regional flow of traffic, links exist between the capital cities of Uralsk, Aktyubinsk, Atyrau, Aktau and their respective neighbouring regions, but links between states are comparatively small.

Concerning items loaded, Russia-Kazakhstan, Russia-Uzbekistan, Russia-Turkmenistan links were found to be the strongest in agricultural produce. For other items, the Russia-Atyrau city link was high in construction materials and equipment, the Russia-Kazakhstan link high in commercial products and Atyrau-Kazakhstan link high in industrial produce.

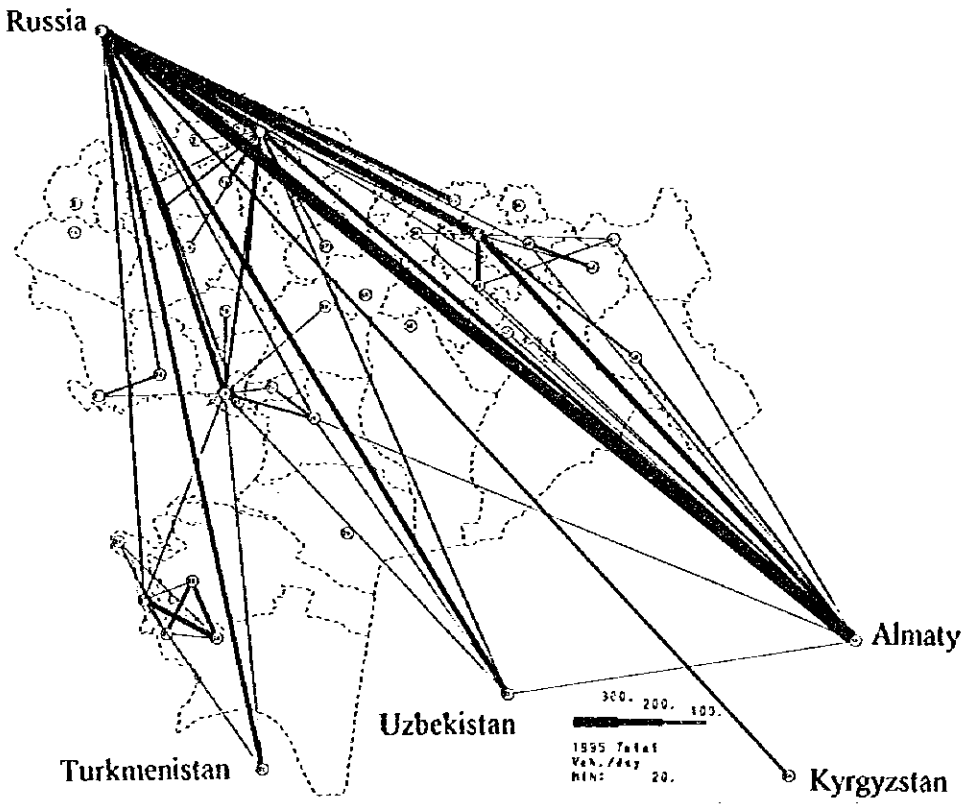


Fig. 6.2.6 : Desire Line by Vehicle OD in 1995 (Total Cargo)

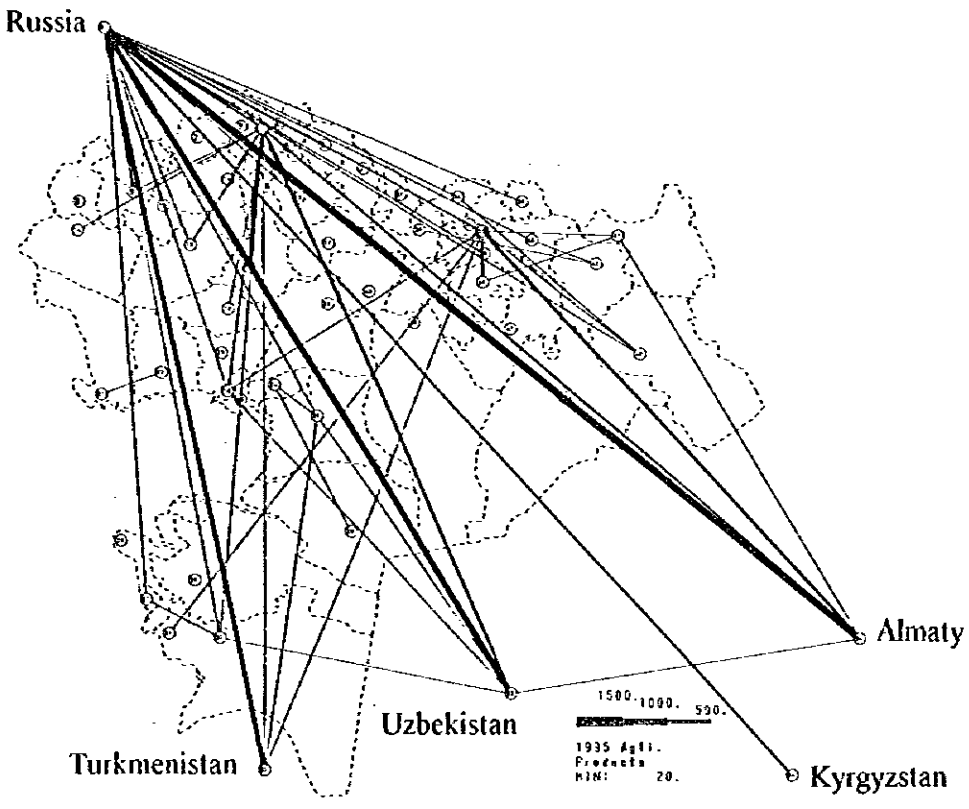


Fig. 6.2.7 : Desire Line by Vehicle OD in 1995 (Agriculture products)

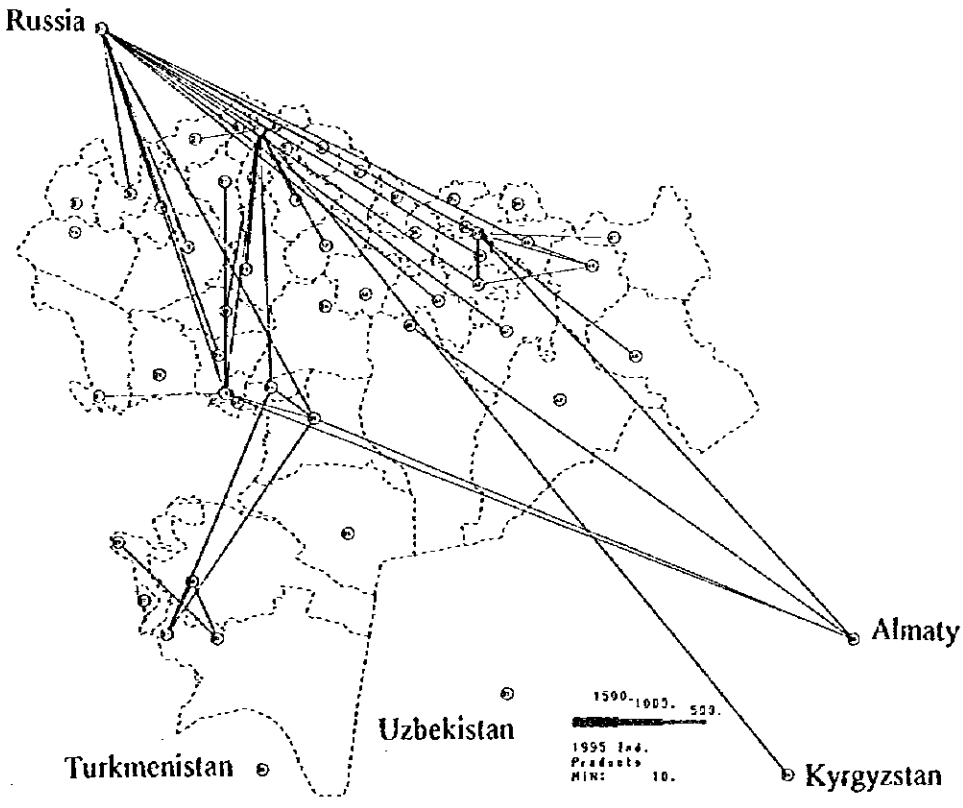


Fig. 6.2.8 : Desire Line by Vehicle OD in 1995 (Industry products)

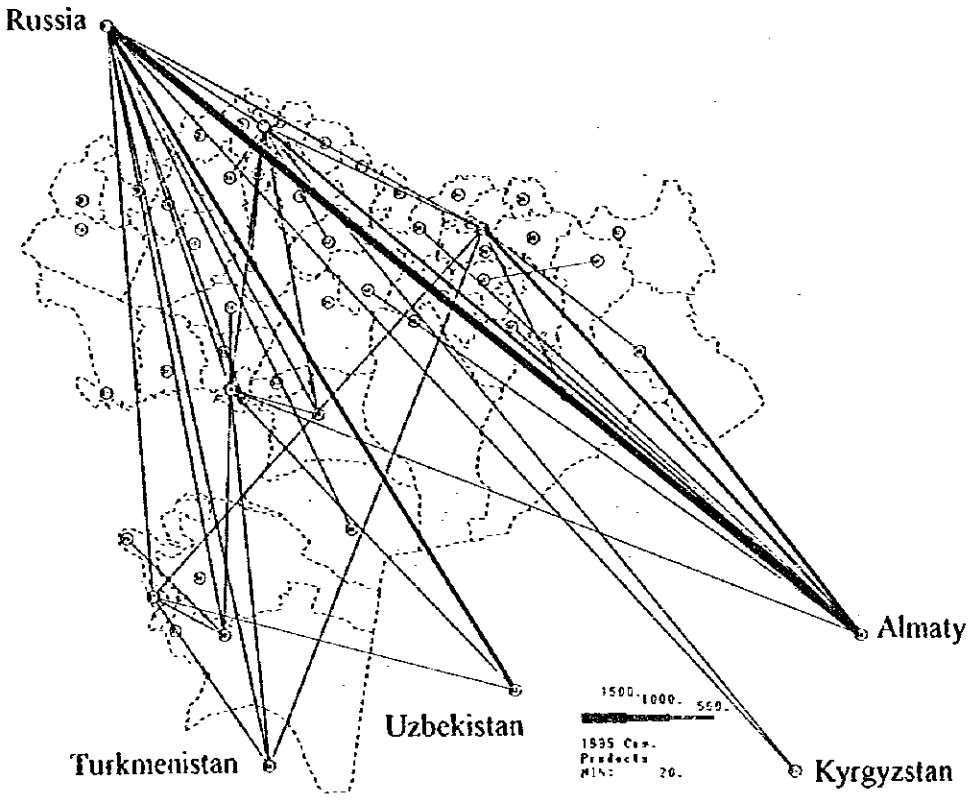


Fig. 6.2.9 : Desire Line by Vehicle OD in 1995
(Commercial products)

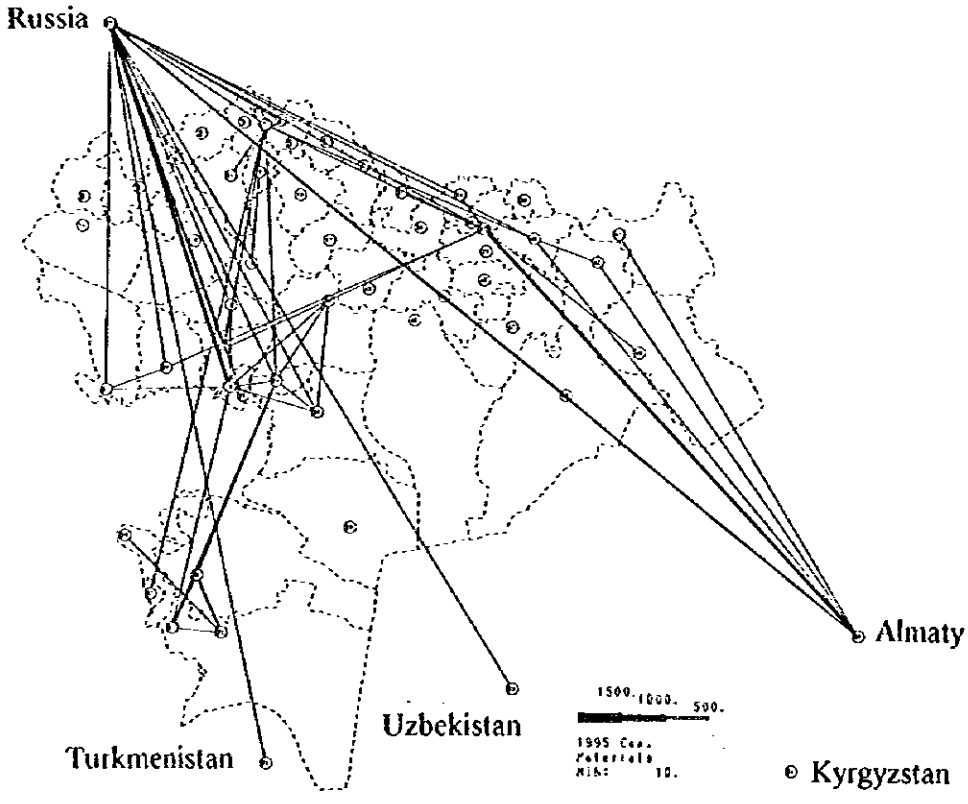


Fig. 6.2.10 : Desire Line by Vehicle OD in 1995
(Construction materials and Equipment)

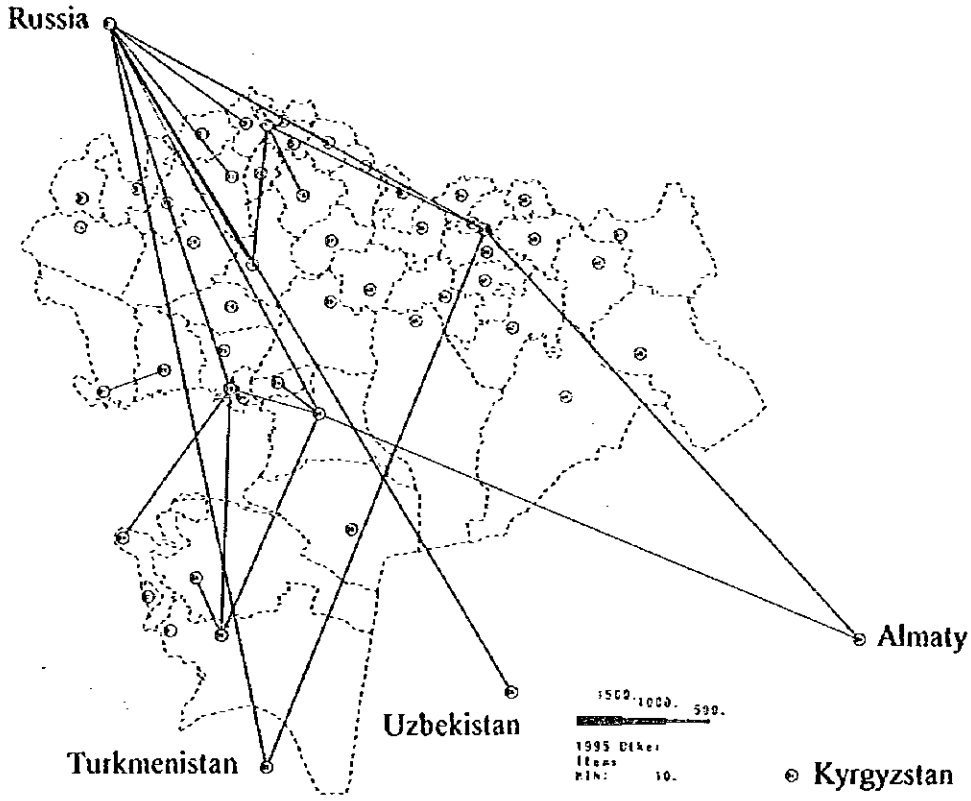


Fig. 6.2.11 : Desire Line by Vehicle OD in 1995 (Others)

The traffic volume distribution status quo outcome is shown on Figure 6.2.12. The Aktyubinsk-Oktyabrsk route was highest with some 930 vehicles/day followed by the Astrahan-Atyrau-Kulsary route with 600 to 800 vehicles/day. The Samara-Chimkent highway listed a traffic volume of 300 to 500 vehicles/day.

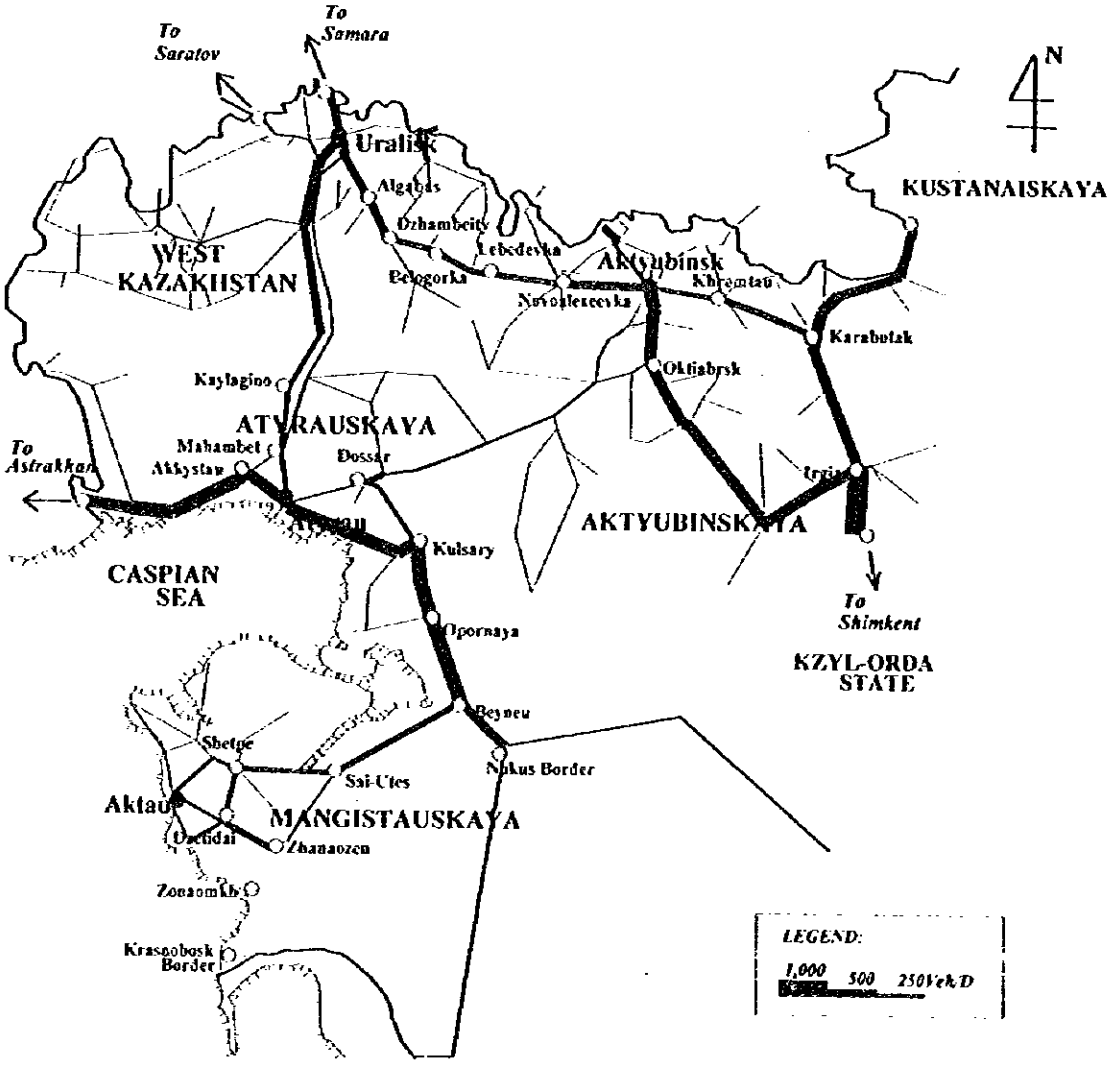


Fig. 6.2.12 : Assigned Traffic Volume of 1995

6.3 Forecast of Socio-Economic Factors

Following three socio-economic factors are available for the traffic demand estimation in the chapter 6.4.

1)Population
2)GRDP (Gross Regional Domestic Products)
3)Number of Vehicles

6.3.1 Future Population

According to the National Economic Policy for 1996-2000, the annual population increase in 2000 is estimated at about 1.0% to the previous year, which is almost the same level as in 1991, and therefore can be thought as a stable figure after the present mass-migration started by the formation of CIS. The study adopted the same figure for the population growth in the period between 2000 to 2010. The population was estimated to grow moderately and in 2010 it will be 18.54 million or 11% greater than the 1995 population and 9% greater times of 1993 population, which was the highest records.

The population by state was estimated applying rural and urban population growth in each state and the sum of each state is adjusted to the country total. The population by district is estimated by the same manner that the preliminary population by district is calculated applying rural and urban population growth in each district and finally sum of each district is adjusted to the state total

Among the population growth between 1995 and 2010 by state (Table 6.3.1), West Kazakhstan has the highest figures of 111.2% to 1995 population in 2000 and 147.3% in 2010, while Mangistauskaya state has the lowest figures of 100.8% in 2000 and 110.2% in 2010.

Table 6.3.1 : Population Estimate

State	2000/1995 (%)	2010/1995 (%)
Aktyubinskaya	104.7	119.6
West Kazakhstan	111.2	147.3
Atyrauskaya	105.3	125.1
Mangistauskaya	100.8	110.2
Western Kazakhstan Total	105.3	125.7
All Kazakhstan	101.1	111.2

Among the population growth by district, Isataiskiji rajon in Atyrauskaya state has the highest figures of 114.8% to the population in 1995 and in 2000 and 160.8% in 2010. The districts in rural area tend to have the higher figures. Among capital cities, Atyrau city has the highest figure of 138.3% in 2010, while Aktau city has the lowest of 102.8% in 2010.

6.3.2 Economy

(1) GDP

Economic Policy 1996-2000 estimates GDP between 1995 and 2000 and the annual growth rate of 5.7% to the previous year in 2000, based on the provision that economic restructuring period will continue until 1998 and after that economic development period will start. After 2000, EBRD study estimates the annual GDP growth rate of 3% to 5% for CIS countries, and IMF reports estimates 2% of per capita GDP growth rate for the Central Asian countries. Therefore, after 2000, the Study assumes 3.5% GDP growth rate, which is slightly lower than the planned GDP growth rate of the last year in the five year Economic Policy 1996-2000.

The estimated GDP, population and the per capita GDP are summarized in Table 6.3.2 GDP in 1996 is the lowest figure, however comparing the figures in 2000 to the figures in 1995, it will increase by 14.9% and the per capita GDP will increase by 14.6%. In the year 2010, they will recover to almost same level as in 1993 and comparing to the figures in 1995, GDP will increase by 62.2% and per capita GDP will increase by 46.9%.

Table 6.3.2 : GDP and Population Estimate

Year	GDP in 1995 Fixed Price		Population		Per Capita GDP	
	Bil. Tg	Annual Growth	x1,000	Annual Growth	US$	Annual Growth
1995	970	85.0	16,679.1	98.4	960	85.7
1996	962	99.2	16,430.0	98.5	970	101.0
1997	980	101.9	16,450.0	100.1	990	102.1
1998	1,010	103.1	16,550.0	100.6	1,010	102.0
1999	1,055	104.5	16,700.0	100.9	1,050	104.0
2000	1,115	105.7	16,860.0	101.0	1,100	104.8
2001	1,154	103.5	17,020.0	100.9	1,130	102.7
2002	1,194	103.5	17,180.0	100.9	1,150	101.8
2003	1,236	103.5	17,340.0	100.9	1,180	102.6
2004	1,279	103.5	17,510.0	101.0	1,210	102.5
2005	1,324	103.5	17,680.0	101.0	1,240	102.5
2006	1,371	103.5	17,850.0	101.0	1,270	102.4
2007	1,419	103.5	18,020.0	101.0	1,310	103.1
2008	1,468	103.5	18,190.0	100.9	1,340	102.3
2009	1,520	103.5	18,360.0	100.9	1,370	102.2
2010	1,573	103.5	18,540.0	101.0	1,410	102.9

(2) GRDP

Each state establishes economic development plans 1994-2000, in which GRDP by sector in terms of 1995 fixed price is estimated. However, the original plans estimates the total GRDP share of Western four states at 26.1% of GDP in 1994, and that they will increase year by year, despite a few years economic recession in GDP estimate, so that the total

share of the four states will reach to almost 40% of GDP in 2000. Therefor the Study adjusted the total GRDP growth of the four states in accordance with the GDP growth. However, in the GRDP estimates in the four states, GRDP of the industry sector has high growth rates, resulting to the high total GRDP growth rates, and the share to GDP reached to 32.2% in 2000. GRDP between 2001 and 2010 was estimated adopting GRDP growth rates in 2000 to the previous year of each state, also adjusting the sum of the four states to GDP growth.

GRDP by district was estimated with allocating GRDP of a state by the employment by sector and by district in 1995. Among GRDP growth by state (Table 6.3.3), West Kazakhstan state has the highest figure of 344.8% comparing to that in 1995, while Mangistauskaya state has the lowest of 132.2%.

Table 6.3.3 : GRDP Estimate

State	2000/1995(%)	2010/1995(%)
Aktyubinskaya	144.1	248.6
West Kazakhstan	195.4	344.8
Atyrauskaya	162.6	225.6
Mangistauskaya	114.6	132.2
Western Kazakhstan total	150.7	231.2
All Kazakhstan	114.9	162.2

6.3.3 Number of Vehicles

The graph of population and vehicle fleet by district in 1995 (Fig. 6.3.1) shows the strong linear relationship, and high concentration to the capital cities. The regression formula is;

$V = a \times P + b$ $(r = 0.98)$

where, V : Number of Vehicles
P : Population in 1,000
a : Parameter(=130.098)
b : Parameter(=-1,489.4)

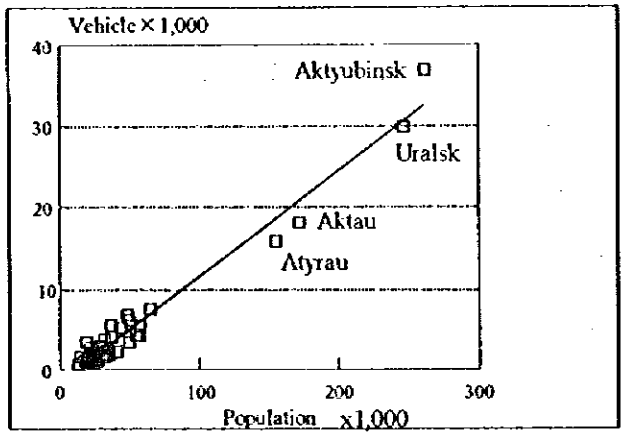


Fig. 6.3.1 : Population and Vehicle Fleet in 1995

The formula shows that vehicle ownership at present is about 130 vehicles per 1,000 persons, and the vehicles are distributed in accordance with the population in Western region. However, vehicle ownership will increase in accordance with income increase in future.

The graph of estimated GRDP and vehicle ownership by rajon in the study area is shown in Fig. 6.3.2. The correlation is not good as a whole, however the capital cities and major industrial cities of Kulsary in Atyrauskaya state and Zhanaozen in Mangistauskaya state, both are located at oil producing areas, are distributed in linear. The graph shows the tendency that vehicle ownership in rural agriculture area does not have good relationship with GRDP, while in industrial cities they have rather good relationship. It is noted that the vehicle ownership in Khromtau and Alga in Aktyubinskaya states, both are mining cities, are high despite of low GRDP. The regression formula is;

$v = a \times GRDP + b$ $(r = 0.39)$

where, v :Vehicle Ownership (Veh./1,000pop.)
$GRDP$:GRDP in 1995 Fixed Price (Mill.Tg)
a :Parameter(=0.00143)
b :Parameter(=76.1651)

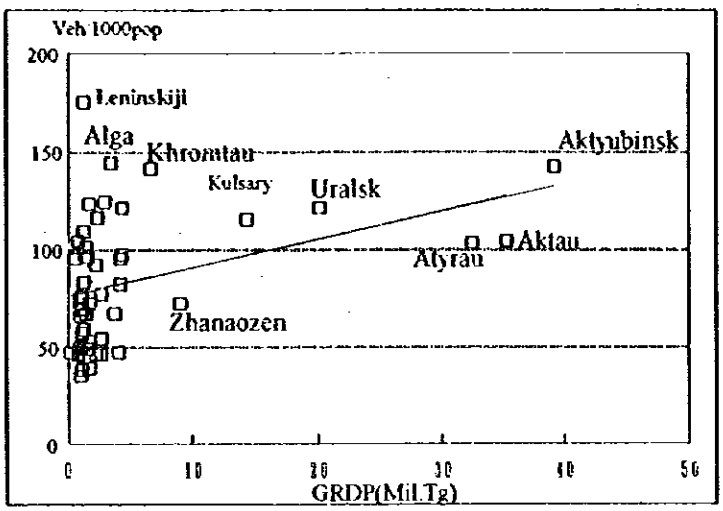


Fig. 6.3.2 : Vehicle Ownership and GRDP in 1995

Table 6.3.4 shows number of vehicles growth ratio in 2000 and 2010 estimated by this formula. In 2000, West Kazakhstan state has the highest figure of 131.9% comparing to the figure in 1995, while Mangistauskaya state has almost same figure as present. In 2010, Atyrauskaya state has the highest of 183.7%, and the average growth of four states is calculated at 160.1%.

Table 6.3.4 : Vehicle Fleet Estimate

State	2000/1995(%)	2010/1995(%)
Aktyubinskaya	112.3	153.9
West Kazakhstan	131.9	173.4
Atyrauskaya	114.9	183.7
Mangistauskaya	100.1	116.7
Western Kazakhstan total	116.6	160.1

6.4 Traffic Demand

6.4.1 Traffic Demand Model

(1) Vehicle Generation/Attraction Sub-Model

The vehicle generation/attraction sub-model is made as follows:

Prepare the vehicle OD (Origin/Destination) table for 1995 correlate with the results of the traffic survey. Then carry out a multiple regression analysis with the socioeconomic characteristics listed below and make models for vehicle generation, vehicle attraction and vehicle type.

a) Population by survey zone
b) GRDP by survey zone
c) Registered vehicle by survey zone

The four types of vehicle listed below were used for making the OD tables.

a) Passenger Car
b) Bus
c) Light Truck
d) Heavy Truck

Table 6.4.1 shows the parameters for the vehicle generation/attraction sub-model. As the multiple correlation coefficient for vehicle generation/attraction and socioeconomic parameters always show a high correlation, each model is accurates enough to be used to make forecasts.

$TE=a_0+a_1x_1+...+a_3x_3$
TE ; Vehicle Generation/Attraction (Trip)
$x_1...x_3$; Explanatory variable (population, *GRDP* ,Registered Vehicle)
$a_0...a_3$; Parameter

Table 6.4.1 : Parameters of Generation/Attraction Sub-Model

Vehicle Type	Generation and Attraction	Parameter				Multiple Correlation Coefficient
		Population (a_1)	GRDP (a_2)	Registered Vehicle (a_3)	Const (a_0)	
P. Car	Generation	0.0011522	-0.001307	-0.002506	9.974488	0.837
	Attraction	0.0006349	0.000364	-0.00185	34.10734	0.724
Bus	Generation	0.0002342	0.0000383	-0.000387	1.8344201	0.842
	Attraction	0.0001382	0.0008647	-0.000993	2.554495	0.832
L.Truck	Generation	0.0006299	0.0004051	0.0003958	5.024139	0.836
	Attraction	0.0010371	0.0005198	-0.002865	-2.82428	0.846
H.Truck	Generation	0.0007846	-0.002285	-0.0000397	-13.5314	0.927
	Attraction	0.0004111	-0.000151	-0.0004455	-5.742867	0.942

(2) Traffic Assignment Sub-Model

The process of traffic assignment is shown in Fig. 6.4.1.
A traffic assignment model estimates traffic distribution on roads by network simulation.
The traffic from one zone to another takes the minimum travel time route between zones.
In this study, travel time of each link is fixed by the length and the road surface condition of the link.

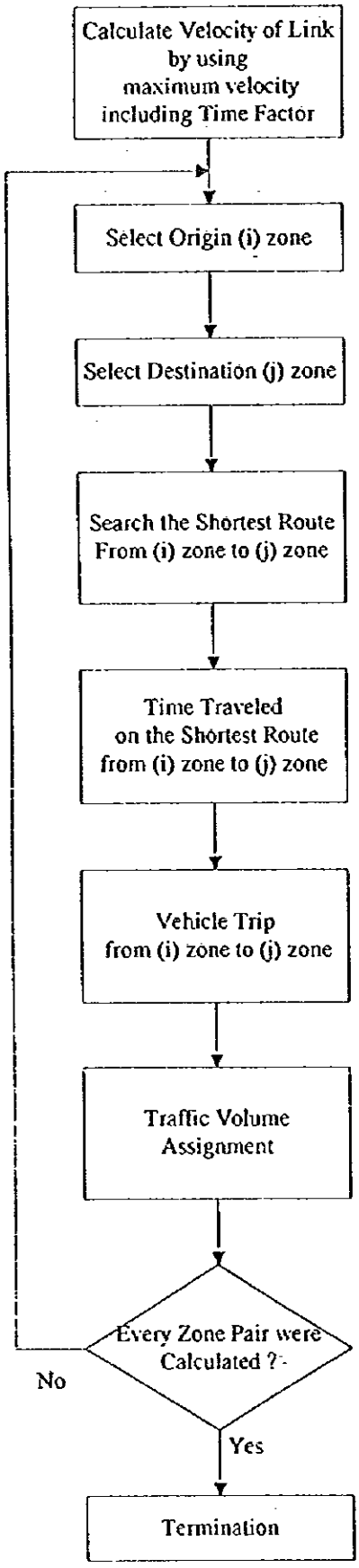


Fig. 6.4.1 : Process of Traffic Assignment

6.4.2 Trip Generation/Attraction

(1) Trip Production

Future trip productions by vehicle type are shown in Table 6.4.2.

Table 6.4.2 : Future Trip Production in the Study Area

(Unit : Vehicle/day)

Year	Generation/ Attraction				
	P. Car	Bus	L. Truck	H. Truck	Total
1995	2,750	432	2,388	1,297	6,867
2000	2,665	448	2,375	1,330	6,818
2010	2,854	574	2,782	1,296	7,506

(2) Generation/Attraction

Future trip generation/attraction and the growth rate by zone are shown in Table 6.4.3 and Fig. 6.4.2 to 6.4.4.

Table 6.4.3 : Future Trip Generation/Attraction by Zone

Unit : Vehicle

Zone	Generation					Attraction				
	1993	2000	G. Factor	2010	G. Factor	1993	2000	G. Factor	2010	G. Factor
1	639	459	0.72	341	0.53	486	458	0.94	439	0.90
2	32	53	1.66	65	2.03	59	60	1.02	76	1.29
3	11	77	7.00	122	11.09	21	67	3.19	72	3.43
4	19	31	1.63	34	1.79	24	38	1.58	44	1.83
5	1	25	25.00	33	33.00	14	29	2.07	34	2.43
6	133	49	0.37	50	0.38	153	43	0.28	52	0.34
7	6	59	9.83	59	9.83	12	58	4.83	72	6.00
8	0	75	0.00	89	0.00	2	91	45.50	97	48.50
9	57	57	1.00	67	1.18	65	54	0.83	63	0.97
10	37	35	0.95	40	1.08	38	42	1.11	50	1.32
11	69	57	0.83	63	0.91	76	49	0.64	67	0.88
12	60	76	1.27	77	1.28	57	87	1.53	95	1.67
13	129	72	0.56	82	0.64	129	77	0.60	90	0.70
14	6	60	10.00	76	12.67	10	58	5.80	79	7.90
15	13	55	4.23	58	4.46	26	70	2.69	89	3.42
16	165	43	0.26	53	0.32	186	51	0.27	64	0.34
17	13	117	9.00	119	9.15	10	119	11.90	136	13.60
18	310	434	1.40	424	1.37	336	405	1.21	421	1.25
19	56	47	0.84	59	1.05	67	52	0.78	65	0.97
20	42	48	1.14	65	1.55	40	60	1.50	70	1.75
21	126	57	0.45	81	0.64	106	56	0.53	72	0.68
22	70	112	1.60	139	1.99	83	77	0.93	90	1.08
23	52	46	0.88	54	1.04	40	61	1.53	75	1.88
24	107	46	0.43	54	0.50	151	57	0.38	65	0.43
25	23	8	0.35	10	0.43	28	21	0.75	20	0.71
26	189	44	0.23	57	0.30	174	49	0.28	67	0.39
27	215	50	0.23	66	0.31	184	51	0.28	66	0.36
28	58	49	0.84	67	1.16	65	57	0.88	75	1.15
29	26	30	1.15	40	1.54	29	47	1.62	57	1.97
30	189	74	0.39	108	0.57	123	75	0.61	91	0.74
31	113	42	0.37	56	0.50	146	46	0.32	55	0.38
32	148	48	0.32	60	0.41	300	61	0.20	70	0.23
33	500	61	0.12	87	0.17	438	74	0.17	85	0.19
34	129	52	0.40	62	0.48	116	60	0.52	70	0.60
35	12	276	23.00	292	24.33	8	371	46.38	410	51.25
36	0	67	0.00	99	0.00	1	63	63.00	91	91.00
37	24	85	3.54	126	5.25	29	81	2.79	109	3.76
38	63	134	2.13	214	3.40	70	115	1.64	156	2.23
39	16	40	2.50	62	3.88	19	46	2.42	61	3.21
40	140	59	0.42	80	0.57	83	66	0.80	87	1.05
41	88	61	0.69	88	1.00	64	62	0.97	87	1.36
42	139	119	0.86	166	1.19	164	109	0.66	139	0.85
43	3	143	47.67	128	42.67	4	140	35.00	182	45.50
44	2	343	171.50	318	159.00	9	354	39.33	370	41.11
45	64	48	0.75	78	1.22	191	63	0.33	77	0.40
46	12	27	2.25	34	2.83	11	31	2.82	39	3.55
47	4	57	14.25	86	21.50	24	75	3.13	90	3.75
48	50	42	0.84	46	0.92	99	53	0.54	56	0.57
49	0	94	0.00	106	0.00	61	110	1.80	104	1.70
50	778	795	1.02	829	1.07	636	642	1.01	630	0.99
51	1,338	1,492	1.05	1,452	1.09	1,352	1,445	1.07	1,457	1.08
52	150	144	0.96	149	0.99	83	76	0.92	76	0.92
53	189	187	0.99	189	1.00	124	117	0.94	114	0.92
54	52	47	0.90	47	0.90	41	39	0.95	38	0.93
Total	6,867	6,818	0.99	7,506	1.09	6,867	6,818	0.99	7,506	1.09

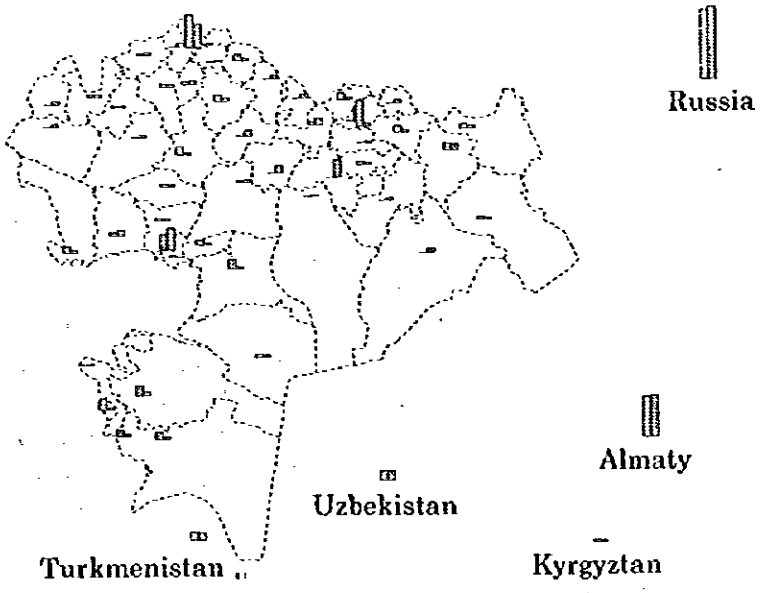


Fig. 6.4.2 : Generation/Attraction in 1995

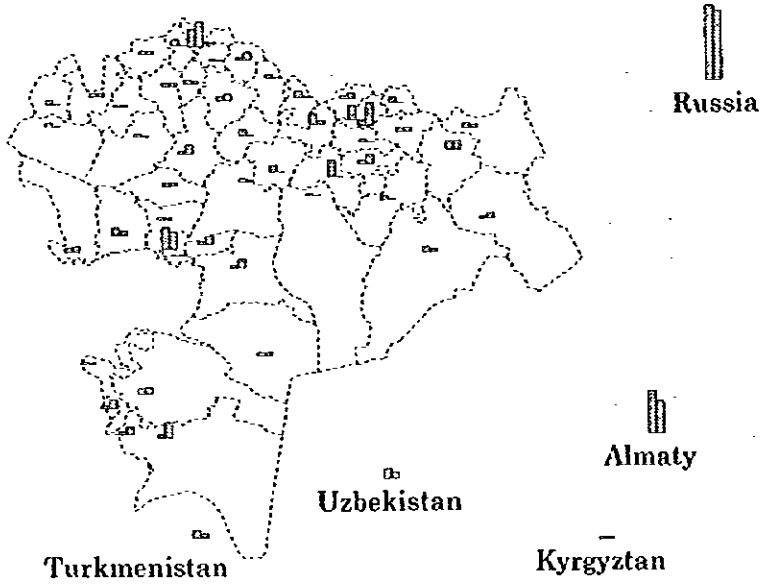


Fig. 6.4.3 : Generation/Attraction in 2000

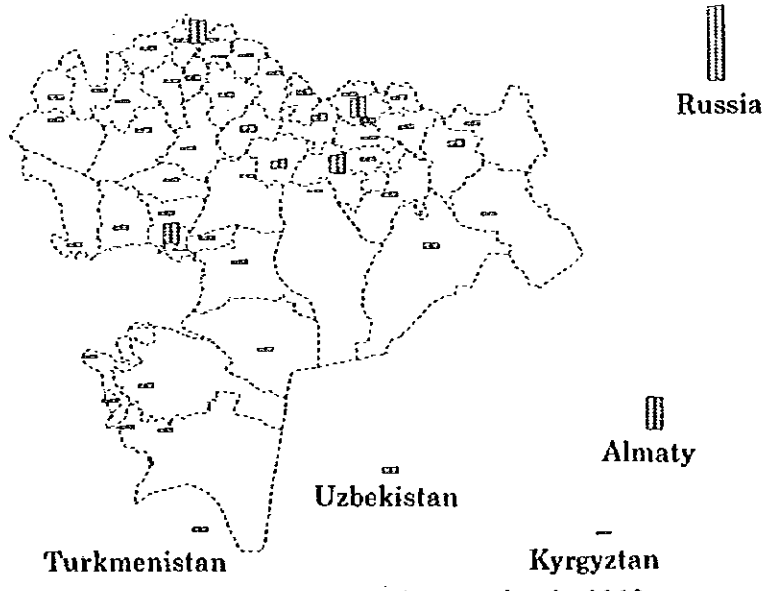


Fig. 6.4.4 : Generation/Attraction in 2010

6.4.3 OD Table

The future OD table has been prepared by using Frater model calculations based on the future trip generation/attraction in Table 6.4.3 and the current OD pattern.
Fig. 6.4.5 to 6.4.7 show the current and future desire line.
A forecast of trip distribution estimates traffic between zones from vehicle generation/attraction of each zone. In this survey area, it was thought that future traffic flowing pattern does not sometimes differ markedly and pattern of united relation of present pattern and vehicle generation/attraction of each zone and traffic volume between a zone was maintained without a change such as distance between zones and it was predicted using Frater model which estimates traffic between zones from a growth rate of vehicle generation/attraction to a future from present time in each zone.

6.4.4 Traffic Assignment

(1) Road Network

Traffic Demand Forecast are carried out on the road network with mainly national highways and local roads of total length 17,000 km shown as explained in Chapter 4.

The link lengths are taken from the road network inventory issued by the Ministry of Transport and Communication, Republic of Kazakhstan, and are measured from a map when it is not listed in the inventory.

(2) Maximum Speed

In the traffic assignment sub-model, the maximum speed is used in order to calculate the travel time on each link. Four (4) different maximum speed were set up as shown in the Table 6.4.4, in consideration of the following items.

(1) Result of traffic count survey
(2) Road inventory
(3) Result of site observation

Table 6.4.4 : Maximum Speed by IRI condition

Good (3 m/km)	Fair (5 m/km)	Poor (8 m/km)	Very Poor (10 m/km)
100 km/h	80 km/h	50 km/h	30 km/h

( ) shows IRI condition

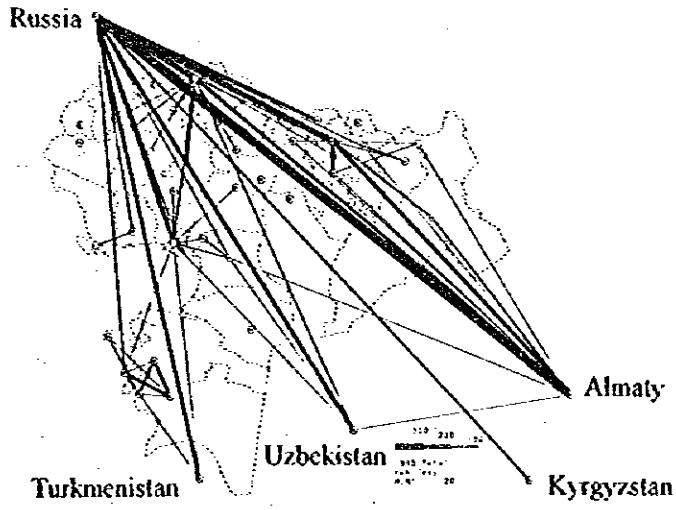


Fig. 6.4.5 : Desire Line by Vehicle OD in 1995

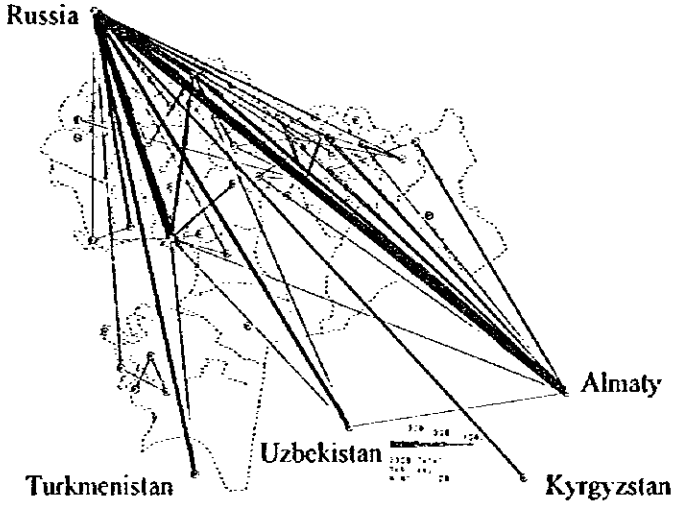


Fig. 6.4.6 : Desire Line by Vehicle OD in 2000

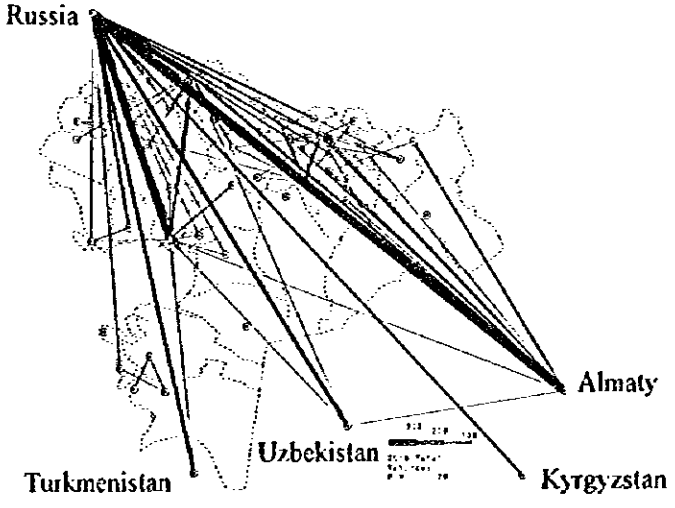


Fig. 6.4.7 : Desire Line by Vehicle OD in 2010

6.5 Traffic Distribution

The premises of the work of vehicle assignment are as follows:
(1)The object years for the vehicle assignment are year 1995, 2000 and year 2010.
(2)Alternative road networks have two patterns:

No.	Case	Long-list 33 Projects	Local Road	in Figure
1	Do Nothing	present condition	present condition	Fig. 6.5.1
2	Do Maximum	improved as Category 3	present condition	Fig. 6.5.2

(3)The road projects of the national road from Kzyl-Orda Border-Irgiz to Karabutak will be the road well maintained as the Good condition (category 3) and other national roads and all local roads will be kept same as present conditions should be competed by 2000.

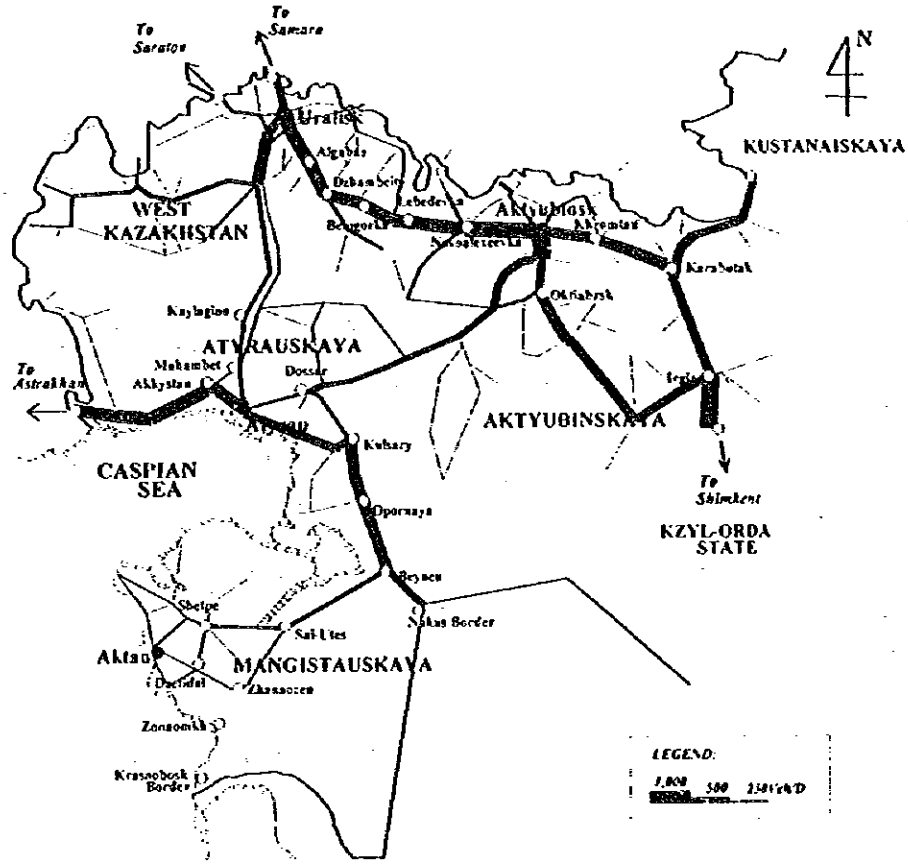


Fig. 6.5.1 : Assigned Traffic Volume for Do Nothing Case in 2010

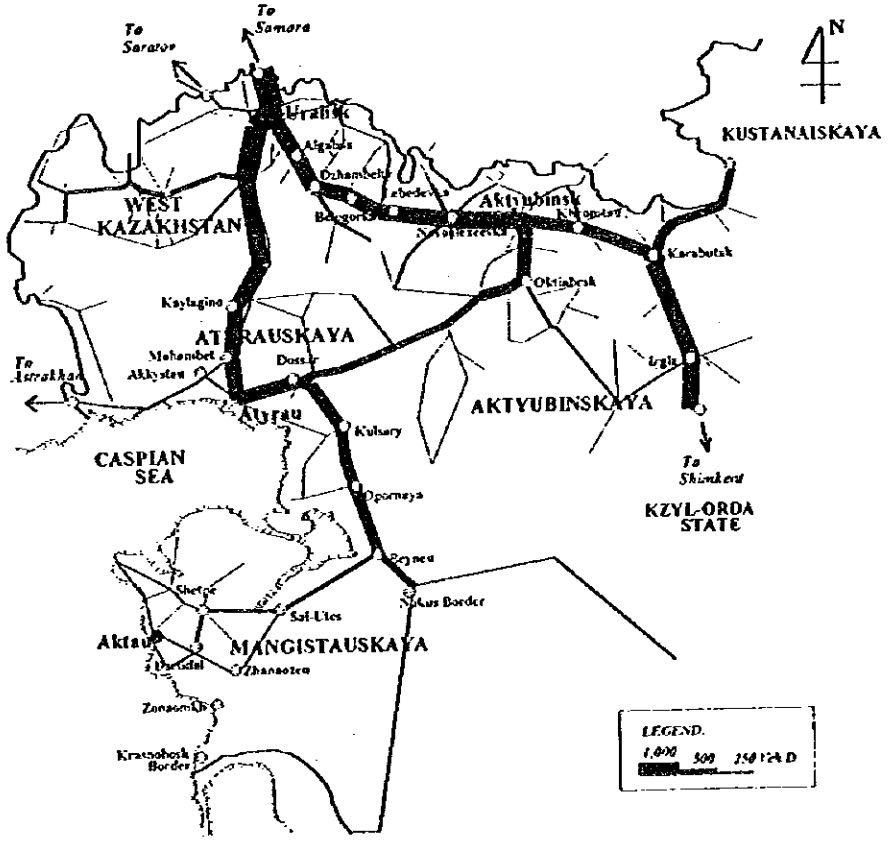


Fig. 6.5.2 : Assigned Traffic Volume for Do Maximum Case in 2010

6.6 Modal Split

Roads subject to this survey are the sections of the Atyrau- Uralsk national highway between Atyrau and Mahambet and the Samara-Chimkent national highway between Karabutak and Kzyl Orda Border.

Amongst these two sections of national highways, the stretch between Atyrau and Mahamet does not have a railroad running parallel to it and although a parallel local road exists between Atyrau and Uralsk, it is sandwiched between streams of the Ural river discouraging access to the national highway. In consequence, it is believed that for this section at least, conversion of traffic to the national highway through improvement of roads does not exist.

Concerning the Samara-Chimkent national highway, a railroad runs almost parallel to it between Uralsk, Aktyubinsk, Aralsk and Chimkent.

As Table 6.6.1 reveals, rail transportation by the West-Kazakhstan railway comprises some 1,300 thousand tons freight and some 3,800 million persons/km.
Concerning items of freight transported by rail, construction materials make up 35%, consumer goods 30% and agricultural products 17%, the three main categories as shown on Figure 6.6.1. On the other hand, according to an O/D survey conducted by JICA in October 1995 which concentrated on road traffic, excepting unloaded vehicles, agricultural products made up 55% and construction material which has a large share by rail was only 15%.

As can be seen, rail transportation is suitable for voluminous and long distance hauling of heavy items in which speed is not of essence and the existing system is constructed likewise. On the other hand, road transportation, as the large share which agricultural products command shows, is a system suitable for hauling small lots where swift delivery is vital to ensure freshness of produce.

Therefore, as regards freight transportation, unless rail freight rate goes up considerably from its present level, large scale conversion from rail to road transportation and vice versa is not conceivable although some portion of the agricultural products transportation could be diverted from road to rail.

Table 6.6.1 : Volume Transported by West-Kazakhstan Railway

	Loads shipment, thous. tones				Passenger flow, million people / km			
			1-st quarter				1-st quarter	
	1994	1995	1995	1996	1994	1995	1995	1996
West-Kazakstan railway	13396	12936	3056	2607	5794	3806	999	872
Including: 1.Aktjubinsk department of railway	5206	5600	1265	1042	1944	1280	325	274
2.Kzyl-Orda department of railway	967	512	104	129	2127	1407	367	322

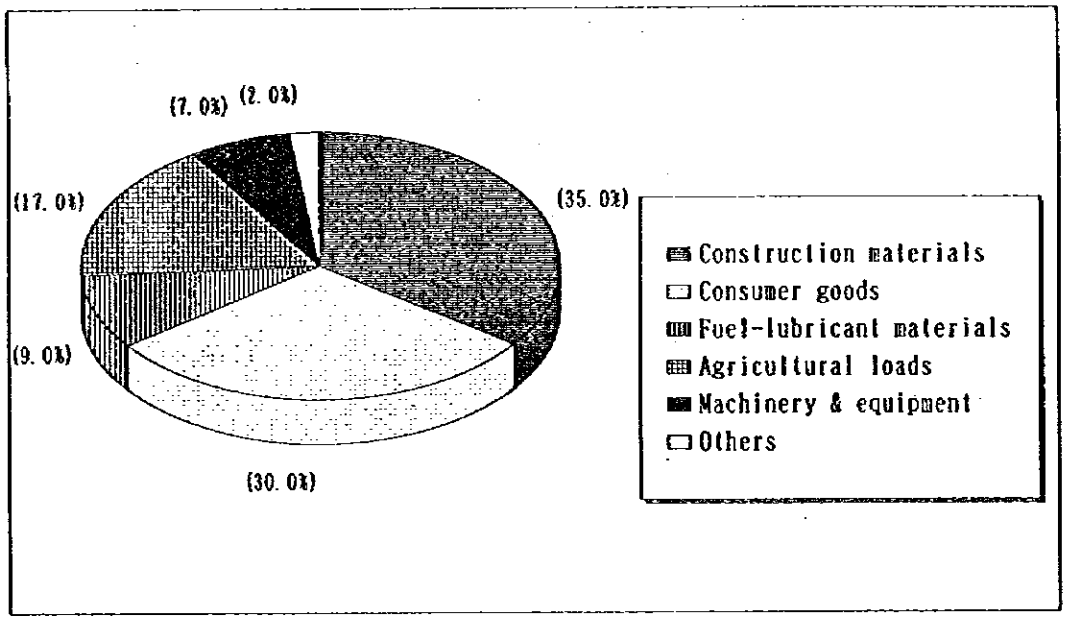


Fig. 6.6.1 : Commodities Transported by West-Kazakhstan Railway

Concerning passenger transportation, railroad's share is 46% for the country as a whole as compared to the share of buses which stands at a comparable 39%. Nevertheless, most bus passengers travel for short distances within city limits and long distance travel or transportation between cities is undertaken by railroads.

The long distance public bus shuttling between Aktyubinsk, Karabutak and Irgiz makes only four trips a week. Therefore, as far as passenger transportation is concerned, the system is quite clear, long distance travel by rail and short distance travel by bus.

The distance from Aktyubinsk to Kzyl Orda, with Karabtak, Irgiz and Aralsk in between, is approximately 1,050km and even if roads were to be improved in future, it would still require over 25 hours to travel between the two cities. On the other hand, eleven stations exist between Aktyubinsk and Kzyl Orda and the distance by rail being some 980km makes rail travel that much advantageous. Again, unless fare by rail does not exceed that by bus, passengers switching over to bus travel is unlikely. However, as it is expected that operation of short distance buses plying between towns and villages will increase hereafter, it is believed that such would be included in future demand growth.

6.7 Intra Zonal Traffic

Intra zonal traffic differs according to the characteristics of the zone and it is believed that it is influenced considerably by socioeconomic indices per unit area especially by population or through relations with the zone's hinterland.
The priority projects subject to feasibility study are three totalling 358km which can be classified into two categories from the area's characteristics, as follows:

(1) Samara-Chimkent national highway:
Karabutak-Kzyl Orda Border 275km

(2) Atyrau-Uralisk national highway:
Atyrau-Mahambet 83km

Section (1) is included in the three zones of Aitekebinskiji, Irgizskiji and Chelkarskiji. The population/area of these zones are as shown on Table 6.7.1 and as their population is 1.0 person per an area of one square km, intra zonal traffic is believed to be almost nil. A traffic survey conducted at two locations in October revealed a similar count of 700 vehicles per day and as 60% of such traffic consisted of trucks, it is believed that intra zonal traffic for the sections need not require consideration.

Section (2) is included in the two zones of Atyrau City and Mahambetskiji and in its hinterland exists the city of Atyrau with a population of 150,000. Consequently, as Table 6.7.1 shows, the population per one square km comes to 295.0 persons and intra zonal traffic can also be assumed to be high. A traffic survey conducted in 1996 revealed that the traffic at Atyrau city limits was 3,132 vehicles per day. Again, at Mahambet zone city limits, traffic was 706 vehicles per day and it can be summarized that the difference is intra zonal traffic. However, intra zonal traffic differs by the type of vehicles. Most trucks and heavy buses can be considered to be traffic between zones. Therefore, passenger cars, pick-ups and light busses have been assumed to be intra zonal traffic and the intra zonal traffic ratio against volume of link traffic has been calculated. The outcome is as shown on Table 6.7.2.

Table 6.7.1 : Rate of Population/Area by Zone

Zone No.	District	Population in 1995	Area (Km^2)	Population/Area
42	Aitekebinskiji	19,500	16,450	1.19
48	Irgizskiji	18,200	41,510	0.44
49	Chelkarskiji	56,400	60,850	0.93
18	Atyrau City	154,000	522	295.02
23	Mahambetskiji	26,100	9,176	2.84

Table 6.7.2 : Intra Zonal Traffic of Atyrau-Mahambet Road

	Traffic Volume (ver/day)				
	P. Car	Pick-up	L. Bus	H. Bus	Truck
① Atyrau City Boundary	1,784	186	159		
② Mahambet Zonal Boundary	365	46	19		
①−②	1,419	140	140		
Rate of Intra Zonal Traffic (%)	388.8	304.3	736.8	0	0

6.8 Traffic for Evaluation of The Priority Projects

Allocation of traffic was performed in the event improvements were made to the sections of the road subject to the feasibility study.

An estimated way multiplied it by the intra zonal ratio which was calculated on traffic of a distribution result every each link by Chapter 6.7 and calculated link traffic including the intra zonal traffic.

As for link 1 and 2, the intra zonal traffic turned a distribution result into link traffic from a thing without the most part. As for link 18, it was multiplied by the intra zonal ratio and link traffic was calculated.

Each traffic of the year in 4 in 1995, 2000, 2010, 2013, 2018 years is shown in table 6.8.1. In addition, traffic in 1995 years is traffic of present condition road network.

Fig. 6.8.1 : Assigned Traffic Volumes for the Priority Projects

(Unit:Vehicle/Day)

Link No.	Year	P. Car	Bus	L. Truck	H. Truck	Total
1	1995	211	13	206	277	707
	2000	232	14	227	305	778
	2010	366	23	365	482	1236
	2013	421	26	420	553	1420
	2018	531	32	529	698	1790
2	1995	190	14	179	256	639
	2000	213	16	201	286	716
	2010	364	27	357	464	1212
	2013	427	31	419	543	1420
	2018	556	41	545	706	1848
18	1995	310	152	191	61	714
	2000	721	352	442	141	1656
	2010	1116	544	687	220	2567
	2013	1273	620	784	251	2928
	2018	1585	772	976	312	3645