Figure A.6.1
Location of Proposed Cultural Property for Preservation

Рисунок А.6.1
Объекты культурного наследия, предлагаемые для сохранения

LEGEND
ЛЕГЕНДА

- National cultural properties
  Объекты национального культурного наследия
- Regional cultural properties
  Объекты культурного наследия регионального значения
- Cultural properties for presevation
  Объекты культурного наследия, предлагаемые под охрану государства
- JICA-proposed cultural property for preservation
  Дополнительные объекты культурного наследия, предлагаемые под охрану государства группой ЯАМС

S :Station precinct
Район станции
B :Beibitshilik St. precinct
Район ул. Бейбитшилик
K :Kenesary St. precinct
Район ул. Кенесари
O :Others
Другие

N

S-1	2-х этажное строение по ул. Акжайык, 1, 40-х– 50-х гг. постройки 2 storied housing at 1, Akzaiyk st. built in 40-50s	S-2	2-х этажное строение по ул.Акжайык, 2, 40-х– 50-х гг. 2 storied housing at 2, Akzaiyk st. built in 40-50s	S-3	2-х этажное строение по ул.Акжайык, 3, 40-х– 50-х гг. постройки 2 storied housing at 3, Akzaiyk st. built in 40-50s

S-4	2-х этажный офис по ул.Акжайык, 4, 40-х– 50-х гг. 2 storied office at 4, Akzaiyk st. built in 40-50s	S-5	3-х этажный офис/жилое здание по ул. Акжайык, 5, 40-х– 50-х гг. постройки 3 storied office/housing at 5, Akzaiyk st. built in 40-50s	S-6	3-х этажное жилое здание по ул.Акжайык, 6, 40-х– 50-х гг. постройки 3 storied housing at 6, Akzaiyk st. built in 40-50s

S-7	3-х этажный офис по ул.Акжайык, 7, 40-х– 50-х гг. постройки 3 storied office at 7, Akzaiyk st. built in 40-50s	S-8	4-х этажное жилое здание/магазин по ул. Акжайык, 8, 40-х– 50-х гг. постройки 4 storied shop/housing at 8, Akzaiyk st. built in 40-50s	S-10/12/14/16/17	3-х этажное жилое здание/офис/магазин по ул.Акжайык, 21, 19, 17, 15, 13; 40-х– 50-х гг. постройки 3storied shop/office/housing along21,19,17,15,13Akzaiyk st. built in 40-50s

Figure A.6.2 (1) Proposed Cultural Property for Preservation
Рисунок А.6.2 (1) Объекты культурного наследия, предлагаемые к сохранению

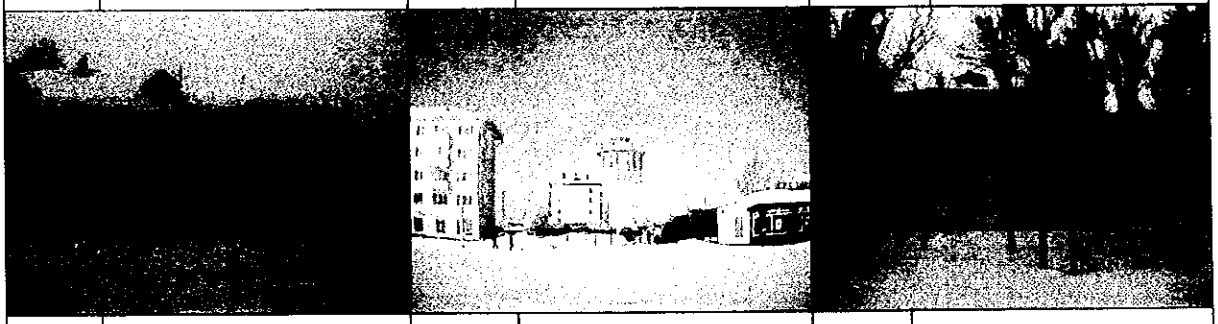
S-15	3-х этажное жилое здание по ул.Акжайык, 18, 40-х– 50-х гг. постройки 3 storied housing at 18, Akzaiyk st. built in 40-50s	S-16	3-х этажное жилое здание по ул.Акжайык, 19, 40-х– 50-х гг. постройки 3 storied housing at 19, Akzaiyk st. built in 40-50s	S-17	3-х этажное жилое здание по ул.Акжайык, 21, 40-х– 50-х гг. постройки 3 storied housing at 21, Akzaiyk st. built in 40-50s

S-18	3-х этажное жилое здание по ул.Акжайык, 23, 40-х–50-х гг. постройки 3 storied housing at 23, Akzaiyk st. built in 40-50s	S-19	3-х этажное жилое здание по ул.Акжайык, 25, 40-х–50-х гг. постройки 3 storied housing at 25, Akzaiyk st. built in 40-50s	S-20/21	2-х этажные жилые здания по ул. Либкнехта, 40-х–50-х гг. постройки 2 storied housings along Libkneht st. built in 40-50s

S-21	2-х этажное жилое здание по ул. Либкнехта, 40-х–50-х гг. постройки 2 storied housing on Libkneht st. built in 40-50s	S-22/26	2-х этажные жилые здания по ул. Линейная 2 storied housings on Lineinaya st.	S-27/31	2-х этажные жилые здания по ул. Линейная, 40-х–50-х гг. постройки 2 storied housings on Lineinaya st. built in 40-50s

Figure A.6.2 (2) Proposed Cultural Property for Preservation
Рисунок А.6.2 (2) Объекты культурного наследия, предлагаемые к сохранению

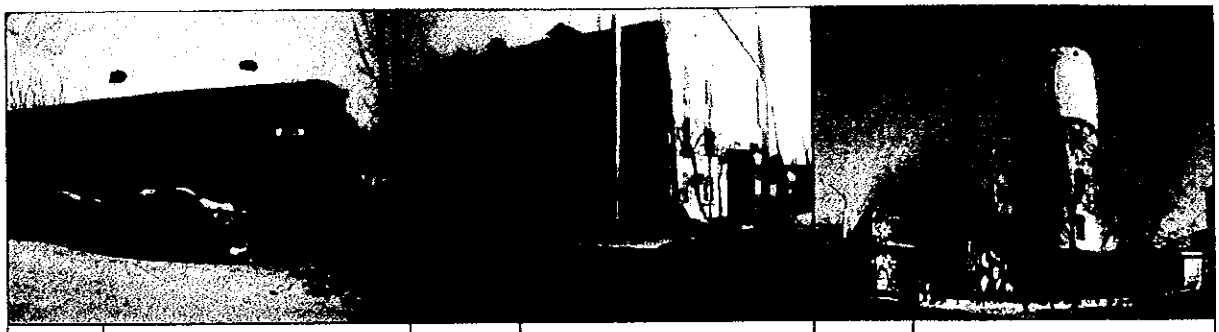
S-35	2-х этажное жилое здание по ул. Гете, 18; 40-х–50-х гг. постройки 2 storied housings at 18, Gyote st. built in 40-50s	S-36	2-х этажное жилое здание по ул. Гете, 20; 40-х–50-х гг. постройки 2 storied housings at 20, Gyote st. built in 40-50s	S-37	2-х этажное жилое здание по ул. Тимирязева, 14; 40-х–50-х гг. постройки 2 storied housings at 14, Timiryazev st. built in 40-50s



S-38	2-х этажное жилое здание по ул. Тимирязева, 16; 40-х–50-х гг. постройки 2 storied housings at 16, Timiryazev st. built in 40-50s	S-39	Водонапорная башня на станционном дворе, построенная в 30-х гг. Water tower at station yard built in 30s	S-40	Средняя школа №37 по ул. Первомайская,11; построена в 50-е гг. No.37 Secondery school at 11, Pervomaiskaya st. built in 50s

K-1	4-х этажное жилое здание/магазин по ул. Бейбитшилик,1; построено в 50-х гг. 4 storied housing/shop at 1, Beibitshilik ~~Lane~~ built in 50s	K-2	3-х этажное жилое здание/магазин по ул.Бейбитшилик ,5 построено в 50-х 4 storied housing/shop at 1, Beubitshilik ~~Lane~~ built in 50s	K-3	Деревянный дом по ул. Кенесары,151; построен в конце 19-го века Wooden house at 151, Kenesary st. built in late 19C

Figure A.6.2 (3) Proposed Cultural Property for Preservation
Рисунок А.6.2 (3) Объекты культурного наследия, предлагаемые к сохранению



К-4	Деревянный дом по ул. Кенесары, 31; построен в конце 19-го века Wooden house at 31, Kenesary st. built in late 19C	К-5	3-х этажное жилое здание/магазин по ул. Кенесары, 68; 50-х гг. 3 storied housing/shop at 68, Kenesary st. built in 50s	К-6	Водонапорная башня по ул. Кенесары, 70, построена в 30-х гг. Water tower at 70, Kenesary st. built in 30s

К-7	3-х этажное жилое здание/магазин по ул. Кенесары, 72; 50-х гг. 3 storied housing/shop at 72, Kenesary st. built in 50s	К-8	3-х этажное жилое здание/магазин по ул. Кенесары, 74; 50-х гг. 3 storied housing/shop at 74, Kenesary st. built in 50s	К-9	2-х этажное административное здание по ул. Кенесары, 76; 50-х гг. постройки 2 storied government office at 76, Kenesary st. built in 50s

К-10	3-х этажное жилое здание по ул. Кенесары, 78; 50-х гг. постройки 3 storied housing/shop at 78, Kenesary st. built in 50s	К-11	3-х этажное жилое здание по ул. Кенесары, 80; 50-х гг. постройки 3 storied housing/shop at 80, Kenesary st. built in 50s	К-12	2-х этажное жилое здание/магазин по ул. Победы, 30; 50-х гг. постройки 2 storied housing/shop at 30, Pobeda st. built in 50s

Figure A.6.2 (4) Proposed Cultural Property for Preservation
Рисунок А.6.2 (4) Объекты культурного наследия, предлагаемые к сохранению

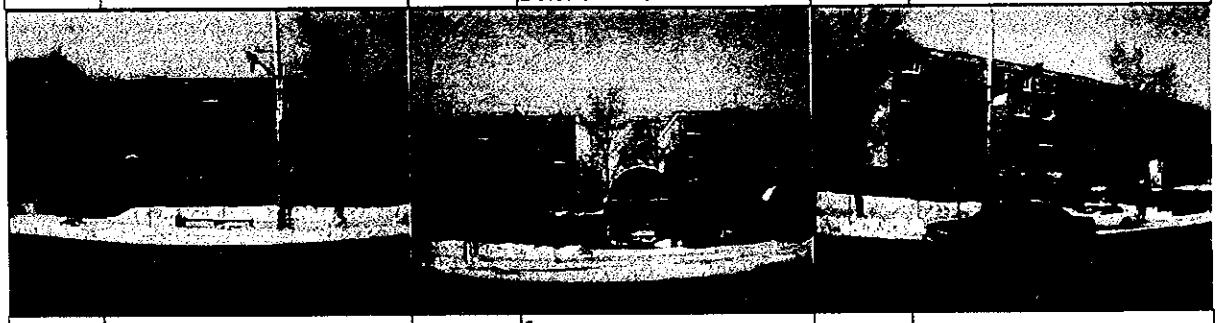
К-13	3-х этажное административное здание по ул. Кенесары, 93; 50-х гг. постройки 2 storied government office at 93, Kenesary st. built in 50s	К-14	3-х этажное жилое здание по ул. Кенесары, 95; 50-х гг. постройки 3 storied housing/shop at 95, Kenesary st. built in 50s	К-15	3-х этажное административное здание по ул. Кенесары, 97; 50-х гг. постройки 2 storied government office at 97, Kenesary st. built in 50s

К-16	2-х этажное административное здание по ул. Кенесары, 99; 50-х гг. постройки 2 storied government office at 99, Kenesary st. built in 50s	К-17	2-х этажное здание жилого типа по ул. Победы, 20, построено в 50-е гг. для железнодорожников 2 storied housing at 20, Pobeda st. built in 50s for railway staff	К-17/18	Жилые дома по ул. Победы, 20, 22, построены в 50-е гг. по дизайну московских архитекторов Housings at 20, 22, at Pobeda st. built in 50s designed by Moscow arch.

К-19	2-х этажное жилое здание по ул. Победы, 24, построено в 50-е гг. для железнодорожников 2 storied housing at 24, Pobeda st. built in 50s for railway staff	К-21	2-х этажное жилое здание по ул. Победы, 32, построено в 50-е гг. д/ железнодорожников 2 storied housing at 32, Pobeda st. built in 50s for railway staff	К-22	2-х этажное здание жилого типа по ул. Победы, 27, построено в 50-е гг. для железнодорожников 2 storied housing at 27, Pobeda st. built in 50s for railway staff

Figure A.6.2 (5) Proposed Cultural Property for Preservation
Рисунок А.6.2 (5) Объекты культурного наследия, предлагаемые к сохранению

В-1	4-х этажное здание промышленно-функционального стиля советской эпохи по ул. Бейбитшилик, 25, построено в 60-х гг. Soviet Industrial-Functional Style 4 storied bldg. at 25, Beibitshilik st. built in 60s	В-3	5-ти этажное жилое здание из бетонных панелей московской сборки по ул. Бейбитшилик, 26; построено в 62-64 гг. Moscow-made PC panelled 5 storied housing at 26, Beibitshilik st. built in 62-64	В-5	5-ти этажное жилое здание из бетонных панелей московской сборки по ул. Бейбитшилик, 30; построено в 62-64 гг. Moscow-made PC panelled 5 storied housing at 30, Beibitshilik st. built in 62-64



В-6/7	5-ти этажное жилое здание из бетонных панелей ленинградской сборки по ул. Бейбитшилик, 29, 31; построено в 62-64 гг. Leningrad-made PC panelled 5 storied housing at 29&31, Beibitshilik st. built in 62-64	В-7/8	5-ти этажное жилое здание из бетонных панелей ленинградской сборки по ул. Бейбитшилик, 31, 33; построено в 62-64 гг. Leningrad-made PC panelled 5 storied housing at 31&33, Beibitshilik st. built in 62-64	В-9	5-ти этажное жилое здание из бетонных панелей ленинградской сборки по ул. Бейбитшилик, 35; построено в 62-64 гг. Leningrad-made PC panelled 5 storied housing at 35, Beibitshilik st. built in 62-64

В-10	Министерство Энергетики по ул. Бейбитшилик, 37; построено в 60-х гг., хрущевский стиль Ministry of Energy at 37, Beibitshilik st. built in 60s, Khrushchev style	В-11	Политехнический институт по ул. Бейбитшилик, 39; построен в 60-61гг, сталинский стиль Polytech College at 39, Beibitshilik st. built in 60-61, Stalin style	В-13	5-ти этажное жилое здание из бетонных панелей ленинградской сборки по ул. Бейбитшилик, 42; построено в 62-64 гг. Leningrad-madePC panelled 5 storied housing at 42, Beibitshilik st. built in 62-64

Figure A.6.2 (6) Proposed Cultural Property for Preservation
Рисунок А.6.2 (6) Объекты культурного наследия, предлагаемые к сохранению

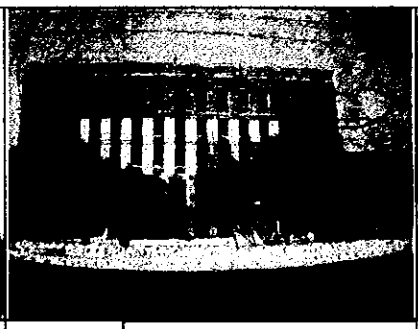
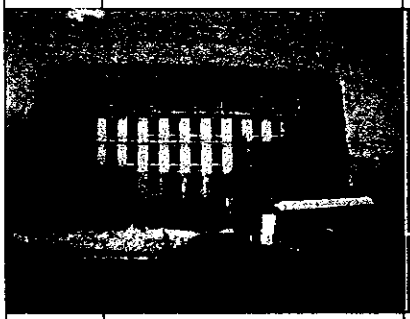
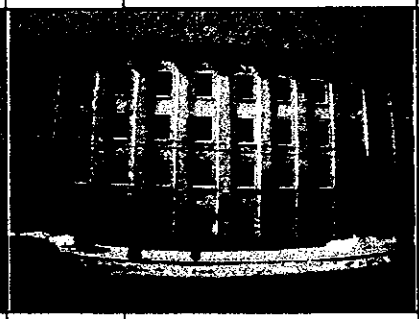
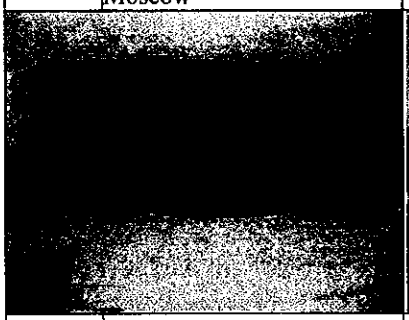
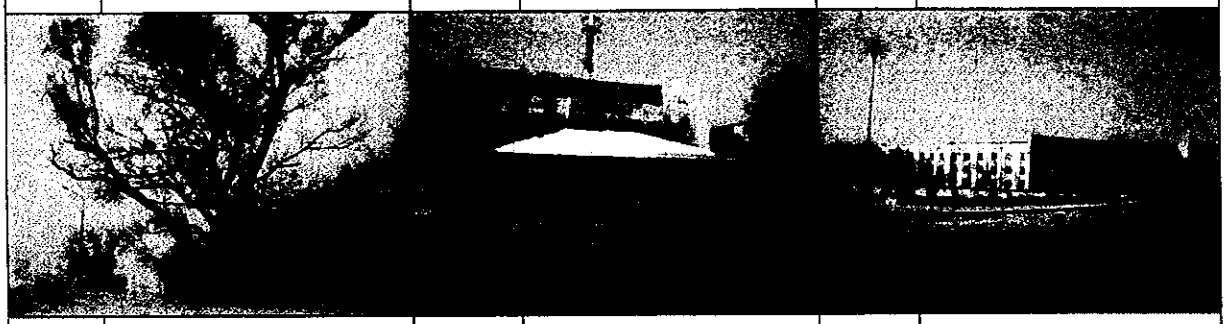
					
B-14	5-ти этажное жилое здание из бетонных панелей ленинградской сборки по ул. Бейбитшилик, 44; построено в 62-64 гг. Leningrad-made PC panelled 5 storied housing at 44, Beibitshilik st. built in 62-64	B-15	Медицинская Академия по ул. Бейбитшилик,49, построена в 63-64 гг, типичный московский дизайн Medical Academy at 49, Beibitshilik st. built in 63-64, typical design from Moscow	B-16	Медицинская Академия по ул. Бейбитшилик,51, построена в 63-64 гг, типичный московский дизайн Medical Academy at 51, Beibitshilik st. built in 63-64, typical design from Moscow
					
B-17	Медицинская Академия по ул. Бейбитшилик,53, построена в 63-64 гг, типичный московский дизайн Medical Academy at 53, Beibitshilik st. built in 63-64, typical design from Moscow	B-18	Правительственное здание по ул. Бейбитшилик, 59, завершено в 60-61 гг., сталинский стиль Government building at 59, Beibitshilik st.completed in 60-61 in Stalin style	B-19	Сельскохозяйственный факультет Аграрного Университета по ул.Бейбитшилик, 73, построено в 50-х гг., сталинский стиль Agricultural Univ. at 73, Beibitshilik st.built in 50s in Stalin style
					
B-20	Магазин «Москва» по ул. Бейбитшилик, 64, построен в 63 г., в конструктивно-функциональном стиле "MOSKVA" shop at 64, Beibitshilik st. built in 63 in the "Constructive Functional" style	B-21	3-этажное здание, изначально построенное как больница для железнодорожников в 50-х гг., по ул. Победа, 114 3 storied bldg. originally built as a hospital for railway workers in 50s at 114, Pobeda st.	B-22	Студенческий клуб Аграрного Университета, построен в 1949 г. в сталинском стиле Student Club in Agricultural Univ. built in 1949 in Stalin style

Figure A.6.2 (7) Proposed Cultural Property for Preservation
Рисунок А.6.2 (7) Объекты культурного наследия, предлагаемые к сохранению

О-1	Мост к Центральному парку над рекой Ишим, построен в 60-х гг. Bridge to the Central Park over Ishim River built in 60s	О-2	Старая дорога конца 19 века, расположена в Центральном парке Old Road since late 19C located in the Central Park	О-3	Фрагмент оставшейся дороги в районе бывшей крепости времен 1830-х гг. The road-remains from the Old Fortress time of 1830s



О-4	Старый высокий тополь около Лодочного дома в Центральном парке, более 100 лет A tall and old poplar tree near Boat house in the Central Park, more than 100 years old	О-5	Дом, в котором останавливался Киров, политическая фигура № 2 после Сталина в 20-е годы House where Kirov from Moscow, no.2 after Stalin stayed in 20s	О-6	Бывший Управление железных дорог г. Караганда по просп. Абая, 49, построен в 30-е гг. The former Karaganda Railway Dep. at 49, Abai st. built in 30s

О-7	Каменное ограждение «Зеленой Мечети» по просп. Абая, 83, возведено в 20-е гг. Remaining wall fence of "Green Mosque" at 83, Abai st. built in 20s	О-9	3-х этажное жилое здание по пр. Абая, 86, построено в 1954г. японскими военнопленными 3 storied housing at 86, Abai st. built in 1954 by Japanese prisoners of war	О-10	Завод Целинсельмаш по ул. Пушкина, 19, построен в 50-е гг., в сталинском стиле "Tselinselmash" Plant at 19, Pushkin st. built in 50s, in Stalin style

Figure A.6.2 (8) Proposed Cultural Property for Preservation
Рисунок А.6.2 (8) Объекты культурного наследия, предлагаемые к сохранению

CHAPTER B TRANSPORTATION PLANNING

SUPPORTING REPORT B: TRANSPORTATION PLANNING

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B.1 Present Conditions of Roads and Traffic

B.1.1 Overall Transport System

(1) Regional Transport System

Astana is located in the center to northern part of Kazakhstan and is functioning as a transport hub between major cities in Kazakhstan and Russia. It is connected by roads to Karaganda and Almaty in the south, Kokshetau, the new capital of Akmola Oblast and Russia in the north, Eribastuz and Pavlodar in the northeast, and Kostanai in the northwest.

The railway station is located in the north of the city connecting to the railway system of the country. Railway corridors relevant to Astana are as follows:

- Almaty - Karaganda - Astana - North Russia
- Astana - Pavlodar - East Russia
- Astana - Kokshetau - North Russia

The International Airport of Astana, located at 18km south of the city is undergoing a major renovation and shall be reborn as the new capital airport not long to come. (Figure B.1.1)

(2) Transport System in Astana

Roads in the central area of Astana form a network in a grid pattern. The railways and the Ishim River running parallel in the northwest to southeast direction are separating the city area and road network. Currently only few bridges, namely, two land bridges over the railway track and one river bridge over the Ishim River, are provided and thereby the network has a drawback that traffic tends to concentrate on those bridges.

The urban public transport in the city is served by buses, minibuses, trolley buses and taxis. Public transport service routes are mainly set in the area between the railway station and the central district in the south. In the north of railway station only bus service is provided. The public transport routes are not well arranged to serve the whole city in terms of catchment areas. Taxis are operated by private firms, individuals owning cars and non-registered companies (Figure.B.1.2 and B.1.3, Table B.1.1).

Transportation between the airport and the city depends on bus and taxi services. Only one road enters and connects the city to the airport, which is presently adequate for the present passenger and freight transport demands.

B.1.2 Transport Demand

(1) Transport Demand Generated in Astana

The registered vehicles in 1999 were composed of 71.5% of cars, 19.7% of trucks, and 4.0% of trolley buses and buses respectively according to the statistical data.

As the registered number of cars including trucks and buses in 1999 was 29,357veh. in Astana City, the dissemination rate of vehicle was 92veh. per thousand persons. This figure is considerably low, compared with those in Central and Eastern European countries.

Number of Registered Vehicles in Astana, 1999

(unit:veh.)

Car	Truck	Bus	Trolley Bus	Special Car	Total
22,097	6,087	1,173	59	1,538	30,954

Source: Astana Socio-Economic Passport, Jan.2000, Astana Municipality

Vehicle Ownership

	Year	Population (1,000pers.)	No. of vehicle (1,000veh.)	Veh. Ownership (veh./1,000pers.)
Astana	1999	320	29	91
Moscow	1996	8,670	1,729	199
Bucharest	1995	2,340	320	137
Munich	1998	1,320	740	561
Stockholm	1994	710	221	311

Source: Major City of the World

Note: Number of vehicle includes trucks and buses and excludes special cars.

The generated trips a day by the vehicles registered in Astana were estimated as follows based on the car OD survey in May and June, 2000. The survey was conducted at all vehicle inspection facilities in Astana. The total movement of vehicles in the previous day (weekday) was interviewed.

In total, 2,401 passenger car type vehicles, accounting for some 8.5% of registered passenger type vehicles in Astana, were interviewed. Out of those vehicles 1,889 vehicles were put in use the previous day. It means that the utilization rate of passenger type vehicle is 78.3%. The average number of vehicle trips a day was 3.5 trips/day. Based on those figures

77,887 trips were estimated for Astana as those by passenger type vehicles a day (Figure B.1.4)

In the same manner the vehicle trips by trucks was estimated. In the survey 242 trucks were also interviewed. The number of trips by trucks was estimated at 9,346 trips/day (12% of total passenger car type trips) after the adjustment considering the discrepancy between the truck trips estimated applying multiplier and those observed in the traffic count and screen line survey.

From the established present OD matrix by passenger cars, a large traffic demand was identified between southeast area and central urban area along Abylaikhan St., and between the bridge over the Ishim River and Akmola Station. Also considerable traffic demand was found between central urban area and northern and central industrial area.

In 1998 the public transport carried 107.6 thousand pax./day by 633 buses and 28.0 thousand pax./day by 57 trolley buses. The number of passengers carried by the bus and trolley bus has increased in recent years. The increase of passengers is attributable to the increase in bus transport while the number of passengers carried by trolley bus is stable, which resulted in decrease in the share. Thus a high dependency on buses in urban public transport is observed.

With possible increase in the number of vehicles, the number of vehicle-trips is likely to increase steeply.

(2) Transport Demand to/from Astana

The freight transport volume by road showed an increase from 1994 at the national level, whereas the freight transport volume to and from Astana is still decreasing because of the stagnant industrial activities.

1) Railway

Astana railway predominantly receives more goods than ship goods by rail. In 1997 only 10% of freight tonnage was loaded onto freight cars at Astana. The main type of goods loaded and unloaded at the station were; petroleum and petroleum products, scrap metal, construction material and grain. Other freight types included coal, metals, flour, industrial material and food produce. Long-distance containerized transport shall probably be the railway's significant source of growth in near future. Regarding the regional passenger transport, the number of

passengers by rail also has a tendency to decrease like in the whole country.

There has been a substantial decrease in the number of passenger use at the Astana rail station. Between 1998 and 1999, the number of passenger has decreased by 13.5%. On the average 9.0 thousand passengers per day used the Astana station in 1998 according to the statistical data.

2) Roads

The traffic volume influx to and outflow from Astana were measured according to the results of Cordon Line survey and roadside car OD survey in this Study.

Following sites were selected in the Cordon Line survey. At the survey sites a traffic count for 24 hours duration was conducted from 30th to 31st of May.

- Astana-Petropavlovsk road
- Astana-Yereimentau road
- Yekaterinburg-Almaty road
- Astana-Rozhdestvenka road
- Astana-Korgaljino road
- Yekaterinburg-Almaty road

The traffic volume influx to and outflow from Astana were 7,917veh./day and 7,797veh./day respectively.

Out of those the traffic volume by the vehicles registered outside of Astana influx to and outflow from Astana were estimated 4,761veh./day and 3,414veh./day respectively by applying multipliers deduced from the results of the Roadside car OD survey.

More than 50% of the total traffic volumes influx to and outflow from Astana are those vehicles registered outside Astana. Regarding vehicle type, passenger car and other passenger related vehicles, those registered outside Astana compose two-thirds of the share of the traffic volumes, meaning that 1,600 trucks registered outside Astana are coming to and outgoing from Astana.

The largest traffic volume was observed on the Yekaterinburg-Almaty (Astrakhan Skoye) Highway, with some 3,000veh./day in both directions. On the other radial highways more than 2,000veh./day

were observed in both directions (Figure B.1.5, and Tables B.1.2 through B.1.5)

3) Airline

Astana airport currently handles only 4% and 33% of all passenger and freight tonnage respectively, of total transported volumes handled at all airports in Kazakhstan. It is relatively a small airport, compared with Almaty airport, which account for 43% of all passengers and 18% of all freight tonnage respectively.

Experiences in the Central Asia and Eastern European countries imply that it would take some time for Kazakhstan to recover to the peak level of the past. Passenger transport demand shall recover to the past peak level at earlier stage with the progress in the functional development as a capital.

The importance of air transport is being recognized because Astana's functions as a capital are substantially shared with Almaty.

B.1.3 Infrastructure

(1) Regional Transport Infrastructures

1) Roads

The inter-city road network is composed of the national roads and regional roads. Five national roads are radiating from or passing through Astana City. Out of those, the road to the south is short and serves mostly the Astana airport. In the northern part of Astana, national road as outer ring road to connect radiating national roads and to function as a bypass way was partly constructed. The section between Astrakhanskoye Highway and Shortandinskaya Highway in the northwest was already completed and the section between Vishnevskoye Highway and Sofievskoye Highway in the northeast is underway. Some regional roads in radial direction supplement the national roads. The roads are generally of higher geometric standards than those in western countries, due to the generous former Soviet Union (FSU) standards. Due to lack of sufficient maintenance work, however, the road condition is under aggravating and hindering the road transport.

The traffic volumes on those radial roads in 1998 were estimated in the range between 1,500veh./day and 3,500veh./day.

The northern section of the Astana ring road is currently under construction and is near completion. The rehabilitation project of road between Almaty and Astana through Karaganda is now considered for implementation by the Government, and is expected to be funded by an international financing organization.

2) Railway

The railway tracks are located in the north of Astana, separating the city's territory into the northern industrial area and southern business area.

The gauge of track is 1520mm. The track is designed to apply maximum speed of 80km/hr for freight trains and 100km/hr for passenger trains, though in reality the actual operating speeds are lower.

The existing right of way being relatively large, there is sufficient space for improvements and re-design of the track layout in order to accommodate high-speed passenger and freight trains.

Satisfactory maintenance work has not been made in recent years due to the lack of sufficient funds to purchase spare parts and materials in required qualities.

Reportedly, there has been a discussion on the construction of a bypass rail line that would run parallel to the northern section of Astana ring road. However approval has not been granted yet. The section of line pertaining to the Trans-Siberian (transcontinental line) connecting Northern Europe with China and the bypass would facilitate the removal of freight traffic from the lines to the main station, releasing the entire capacity for passenger trains.

3) Airport

Currently the International Airport of Astana is dedicated mainly to domestic use and only a few international routes to and from Hanover, Frankfurt, Istanbul, and Moscow are established.

The runway of Astana airport is 2,500m in length and 45m in width, and it is sufficient to handle TU-154. The air traffic control is incorporated in the main ATC Center in Kazakhstan.

A number of improvements to the airport have been carried out which include 1,000m runway extension in 04 direction to provide overall runway length of 3,500m that can handle the Boeing 747 class aircraft.

The expansion of the existing terminal building is virtually completed and will increase passenger capacity from 200 pax./hr to 400 pax./hr.

Renovation of the international airport is underway, financed by the Yen Loan, which include the construction of the new terminal building. The recommended configuration locates an international and domestic terminal on the existing terminal side. Further expansion is planned southwards or eastwards so that no constraints are made to the expansion of the city. There is no argument on the relocation of existing airport.

(2) Transport Infrastructure in Astana

1) Roads

The total road length for vehicle traffic in Astana is 211.1km (within the former city boundary) of which 122.2km is administrated by the Astana Municipality and 88.9km is administrated by the Republic. The average width of the Municipality roads is 9m and that of Republic is 12m. The arteries in the central area have been improved to have 4 to 6 lanes and a broad right of way is defined.

Grade separation at intersections have not been adopted because of moderate road traffic and high construction cost. Median is not arranged generally and in places, central lines and markings are fading.

The heaviest public transport demand is found along the Respublica Street - Pushkin Street, the north-south axis. According to the past traffic survey, the morning peak period demand was estimated at between 10,000 and 15,000 passengers.

Traffic congestions are seldom observed and vehicles more speedily on the road.

Parking bay for vehicles are arranged in places on the arterial roads in the central area. Free parking spaces outside the road are also provided at sites of large buildings and facilities such as governmental buildings and markets.

Shortage of parking space is not observed generally except for the old market area.

In the future with the dissemination of vehicles the parking demand is supposed to intensify. In the densely inhabited collective housing

areas, due to the lack of sufficient open space, overflowing of vehicles onto for road parking may be assumed.

Bus operation in Astana City suffers from insufficient supply of bus stopping and turnaround facilities. The issue is not so much the numbers of facilities, but rather the design and layout of facilities. Bus bays, tapers and pedestrian shelters are not common. Seemingly, bus stops have been provided only on an ad hoc basis.

Intersections with traffic signals are common and few roundabouts are currently used. There are 51 traffic signals installations in Astana City, of which 37 are currently functioning. All signals are of fixed time control, however there are 32 traffic signals that are linked to the Automatic Traffic Control System (ATCS) located at the Department of Roads Inspectorate. Inappropriate maintenance has resulted in a number of inoperative signal sets.

2) Inter-modal Facilities

Only one inter-modal terminal for urban public transport exists in Astana City-bus terminal at the Astana railway station. The terminal is functioning not only for the buses serving within cities but also serving the international bus routes and regional routes to major cities in Kazakhstan. However, the passenger facility is in a poor condition without shelters and platforms.

The trolley bus depot is located in the east of the city.

The freight terminal facility for railway with a yard is established in the same area of Astana station. The freight terminal for trucks has not yet been provided.

B.1.4 Transport Condition

In this Study, traffic count surveys (7 survey sites for a 12 hour duration and 3 survey sites for a 24 hour duration), screen line surveys (one survey site for a 12 hour duration and 2 survey sites for a 24 hour duration), and travel speed survey (5 routes) were conducted to acquire the information on traffic condition on the road. The surveys were conducted on weekdays in May.

The largest traffic volumes were observed on Respublica Ave. and Abylaikhan St. with 40,000 veh./day in both directions. At intersections on those streets, long waiting time exceeding two traffic signal cycles were observed in the peak period (Figure B.1.6).

Outstanding peak period was not observed in the hourly traffic volume fluctuation. The peak traffic rate (the rate of one-hour traffic volume in 24-hour traffic volume) was to be found in the range of 7 to 9%. The nighttime traffic rate (the rate of nighttime (19:00-7:00) traffic volume to 24 hour traffic volume) was 32%. (Figure B.1.7 and Table B.1.6)

A travel speed survey was also conducted on two sequential weekdays in May. On the regional artery to/from Astana, vehicles traveled at the running speed of some 60km/h in each time zone of 8:00, 13:00, and 18:00. On those roads traffic function was well assured as a regional artery.

However on Bogembai St. (Respublica-Valikhanov), Respublica Ave. (northen part from Abai St.), Abylaikhan St. (Eastern part of Mozhaskii St.), and Valikhanov St. the average speed fell below 20km/h in the morning time zone (8:00-). It was observed that the traveling speed in daytime (13:00) was higher in the morning time.

In this time zone, however, the running speed on Respublica Ave. north of Abai Avenue, Abylaikhan St. east of Mozhaskii St., and Valikhanov St. was below 20km/h (Figures B.1.8 through B.1.10).

A mode preference survey with the survey subjects of 500 persons (200 persons with car ownership, 300 persons without car ownership) was also conducted.

The result showed that the incomes of both groups fell into the same range between Tenge 8,000 to 16,000 per month, showing that the incomes of the persons without car ownership were distributed rather in a lower range than those of persons with car ownership. However vast difference in income levels were not observed.

The rate of persons with car ownership using the car for commuting was almost 100% and the rate of using car for commuting, sending, and picking up of family members was also high.

With regard to public transport users, the modal shares comprised of bus (66%), mini-bus (17%), and trolley bus (16%). The cases of the commuting by more than one public transport means were few (2.5%).

The median of the distribution of time required for commuting in for those with car ownership was in the range between 21 to 25 minutes. For public transport users it was in the range between 26 to 30 minutes. In Astana, uses of vehicle belonging to the office or company for commuting were widely found. As for the parking, keeping the vehicle at nighttime far from the home were found to be common. About 34% of the vehicle users for commuting were reported to feel

inconvenienced for parking at work place, while 27% of the vehicle users for commuting were charged for parking. (Table B.1.7 and B.1.8)

B.1.5 Problems and Issues on the Transport System Development

The general problems to be solved in the Master Plan with regard to the transportation planning are as the follows:

- With the future increase of private vehicles, traffic congestion and shortage of parking facilities in the central area will likely be problematic.
- Regional traffic into the urban area is projected to expand rapidly.
- Poor transport infrastructure due to the insufficient maintenance work is commonly observed both in road and public transport, which makes the service level to aggravate.

The particular issues related to the indigenous condition of Astana City are as follows:

- incorporation of planned ring road into the future urban structure
- establishment of close connection between old urban area and new urban area beyond the Ishim River
- support to the urban development corridor proposed in the Master Plan
- provision of public transport service to the Astana airport as an international airport
- establishment of coordinated transport system with staged development of city

B.2 Basic Concepts for Transportation Planning

B.2.1 Direction of Transport Network Planning

Issues on the transport planning in Astana and countermeasures by transport network formation are summarized below (refer to Figure B.2.1).

The essences are as following.

Issues	Countermeasures by transport network formation
General issues to be solved for designing the transport system	
• to establish the public transport system without large dependency on the private vehicles	- Formation of road network with sufficient cross section for the introduction of rail transit system
• to establish the parking policy and provide adequate parking facilities in the central area	- Road network pattern corresponding to the axial urban development and for the avoidance of traffic concentration (articulated urban corridor rather than multi-cores)
• to establish the urban freight transport system	- Utilization of ring roads
• to establish regional passenger and freight traffic system	- Utilization of ring roads
• to establish traffic control system and intersection improvement for the fluent traffic flow	- Establishment of road hierarchy comprising major arterial road, arterial road, supplementary road, etc. - Introduction of grade separation at intersections - Utilization of systematic traffic signal system - Establishment of traffic monitoring system and center
• to establish the ecological transport system with excellent landscape including neighboring environment	- Road construction with wide breadth for greenery - Introduction of green road and park road - Avoidance of surface structure of transport facilities
Particular issue accruing to the indigenous condition of Astana	
• to find the way to support the urban development corridors	- Introduction of ladder (grid) pattern road network
• to find the way to incorporate the planned ring road into the future urban structure	- Specialization of functional role of ring roads by introducing the new ring roads for the fluent traffic movement in the urban area
• to find the way to the access to the Astana airport as a international airport	- Introduction of new public transport system
• to find the way to connect the old urban area and new urban area	- Utilization of ring road within the urban area - Bridge construction - Arrangement of roads to connect areas on the both sides of railway
• to find the way to meet the stepwise development of the city	- Formation of structural road network for the stepwise development frame of urban area

B.2.2 Basic Concepts for Transport System

Based on the above consideration conceptual transport network was proposed (Figure B.2.2). The essences of the network are as follows.

- Avoidance of traffic concentration and reinforcement of connection between existing urban area and new development area by utilization of ring roads
- Introduction of grid road network for supporting the new urban area development
- Formation of arterial road network with sufficient width for future rail transit network formation and favorable environmental condition

B.3 Transportation Network Plan

B.3.1 Future Transport Demand

(1) Forecast Procedure

Traffic demand was forecast by an ordinary four-step estimate method as shown in Figure B.3.1.

The purpose of forecasting traffic demand is twofold; one is to achieve favorable goals of transport system and the other is to provide basic data for the transport facility planning as infrastructure. For the latter purpose the safe side traffic demand forecast is preferable.

Through the analysis of present transport condition, intensive correlation between the number of vehicle trips (VTs) by passenger cars and number of vehicles or population was identified.

The vehicle trips by trucks are regarded to have a strong relationship between indicators derived from the economic activities. The number of vehicle trips is related to the transport demand in terms of total tonnage-km, or average transport tonnage-km. Those figures are supposed to vary responding to the economic activities.

In this study, the future traffic demand by registered areas, registration in Astana and registration outside of Astana, and by vehicle types, passenger cars and trucks were separately forecast.

1) Economic indicators

Basically the values of indicators prepared in the course of this Study, as discussed in the previous Chapter, were used.

2) Total vehicle trips generated

a) Passenger car trips

Forecast was made for the trips generated within the former city boundary and those generated outside of it.

Two forecast methods were examined to apply the future demand forecast of vehicle trips by passenger cars. They are the method based on the future number of vehicles, and the one based on the future modal split taking into consideration of the social restriction on the unlimited usage of vehicles brought by the regulation or actual heavy traffic congestion.

The former method applies the assumed average vehicle trips/veh. to the forecast number of vehicles in future. In this case, however, any social restriction on the vehicle usage was neglected, the modal share of the vehicles would rise enormously high (68%), resulting in the traffic congestion and environmental problems. And the estimated modal share of public transport was less than 5%.

Therefore the latter method assuming a larger public transport share for passenger transport than present was adopted, so as to restrain the unlimited expansion of number of vehicle trips by the reinforcement of public transport modes.

The modal share of walking and bicycles in future is assumed to dwindle due to the expansion of urban area.

b) Truck trips

The utilization rate of trucks decreased in Astana due to the stoppage of operation at factories, though the rate is expected to rise once industry is activated again in Astana.

In this Study two kind of methods were adopted. First method is to apply the regression model to directly forecast the future trips with explanatory economic variables, while the second one is to apply the elasticity with respect to economic growth.

Empirically the growth of cargo transport demand was not proportional to the growth of the economy. For instance the cargo transport demand between 1982 to 1992 in Tokyo Metropolitan area was almost constant, although the so-called downsizing of average loading was observed remarkably. In Kazakhstan, though the GDP in constant prices remained at more or less the same level between 1985 to 1999, the cargo transport demand showed a tendency to decrease.

After examining the correlation with population, working population in primary and secondary industries, and working population in all industries as an independent variable for the regression model, the working population in all industries was adopted.

In the elasticity model for cargo transport demand forecast, elasticity value of 0.6 was adopted with respect to GRDP considering the experiences in other countries.

c) External trips by vehicles registered outside Astana

The future trips were forecast by elasticity model assuming that trips by vehicles registered outside Astana would expand corresponding to the economic growth of Astana.

d) Through trips

There are several factors supposed to dominate the nationwide through traffic, such as the change in international transport demand, occurrence of new transport demand (e.g. discovery of new mineral resources, etc.), changing competitiveness to railway.

However the absolute traffic volume of through traffic is considerably low and such traffic is expected to be the main traffic on the ring road (R1). The influence of the through traffic on the road planning in the urban area was considered small.

The through traffic was assumed to expand corresponding to the economic growth of Kazakhstan, elasticity model was applied to the vehicle trips registered outside Astana for the future traffic forecast.

3) Origin Destination (OD) trips

a) OD trips generated within former city boundary

Multiplier of traffic zone was determined by the forecast trips generated in each zone. OD trips were determined by applying Frator method to present OD pattern.

b) OD trips generated newly incorporated within new city boundary

OD trips were forecast by gravity model after the estimation of parameters for the model.

(2) Future Transport Demand

Reinforcement of public transport and restriction of vehicle traffic in order to alleviate the traffic congestion and to realize of better environment is a major worldwide trend in urban transport planning. In Astana this trend of urban transport planning with emphasis on less dependency on the vehicle traffic shall be pursued, which corresponds to the major trends.

As a result it was revealed that traffic demand forecast by the unit method based on the number of vehicles, is rather problematic for the urban transport plan, because of excessive utilization rate of vehicles for passenger transport.

Several forecast cases varying the modal shares of private vehicles and public transport were thus carried out in this Study.

Finally the forecast case with modal split of person trips composed of passenger car (35%) and public transport (37.5%) was adopted (case 3-1).

The modal share of walking and bicycles considerably varies according to the urban structure and the extent of the public transport services. In European cities the share varies between 20 to 50%. In Japan it varies between 40 to 50%. In Astana the future modal share of walking and bicycles was estimated to be lower than the existing one considering the expansion of urban area and severity of winter weather.

At the same time this was adopted considering that future traffic volume would have to be forecast on the safe side for the urban transport planning by raising the modal shares of public transport and private cars.

It means that while the population in Astana will become 2.4 times larger from 2000 to 2030, the number of vehicle trips will become 4.5 times larger in the same period (Table B.3.1).

Out of those trips, 350 thousand trips/day will be made by passenger cars registered in Astana, and 34 thousand trips/day will be made by trucks registered in Astana. The numbers of trips by passenger cars and trucks registered outside Astana will be 41 thousand trips/day and 5 thousand trips/day respectively.

No apparent correlation was identified in the regression analysis between the rate of intra-zonal trips (the rate of internal trips within the traffic zone to total trips generated in the traffic zone) and the traffic zone area. Therefore 10% for passenger car and 13% for trucks, to the present rates of intra-zonal trips were applied.

Estimated regression models are as follows and as shown in Table B.3.2.

Trips by passenger car

Trip-ends generated and attracted $= 0.276x_1$(Population)$+0.315x_2$(Working population)$+1261.473$ (R=0.93)

Trips by trucks

Trip-ends generated and attracted $= 0.687x_1$ (Working population in industry and construction sector) $+0.039x_2$(Working population in tertiary sector)$+$ 1105.6 (R=0.61)

Frator method based on the present OD pattern with forecast trips generated by zone as a control total was employed. This method was applied for the forecast of OD trips between traffic zones within former city boundary, OD

trips between traffic zones within former city boundary and other traffic zones, and OD trips between traffic zones outside of new city boundary.

Because Frator method based on the present OD pattern could not apply, gravity model was employed for the OD trips generated in the newly incorporated area. However OD trips between traffic zones in the newly incorporated area and traffic zones outside of new city boundary were estimated based on the present OD pattern between Astana and traffic zones outside of new city boundary.

Estimated models are the following.

OD trips by passenger car

$Tij = \exp(\gamma) \cdot ((\text{Trips generated in zone}_i \cdot \text{Trips attracted in zone}_j)^{\alpha} / (\text{Distance between i and j zones})^{\beta})$

$\alpha=0.822$, $\beta=0.304$, $\gamma=-7.951$, $R=0.90$

OD trips by truck

$Tij = \exp(\gamma) \cdot ((\text{Trips generated in zone}_i \cdot \text{Trips attracted in zone}_j)^{\alpha} / ((\text{Distance between i and j zones})^{\beta})$

$\alpha=0.728$, $\beta=0.167$, $\gamma=-6.315$, $R=0.90$

· Vehicle trips related to Astana International Airport

The number of passengers at Astana International Airport in 1998 was 160 pass./day. At Almaty Airport the number of passengers had its peak in 1990, with 5,900 pass/day. After the disintegration of Soviet Union, the patronage at Almaty Airport fell down to one-third the level of the passengers in 1990. It is well considered that more than a few years would be required for Almaty Airport to recover the patronage it enjoyed at peak levels in the past.

The number of passengers at Astana International Airport is expected to steeply increase with the development of capital functions, increase in population and establishment of new international flight routes.

The number of passengers in future at Astana International Airport was assumed to reach to the one recorded at Almaty Airport in 1990, of the peak period. After that the elasticity value of 1.2 with respect to GDP growth rate of 4% was used for the forecast of passengers. As a result the number of passengers at Astana International Airport was estimated to reach 10,500 pass./day in 2030. Taking account of the passengers to see and see off, all

person trips was estimated at 1.5 times larger, thus resulting in 15,750 person-trips/day. Assuming 48% as modal share of vehicle for transport and 1.5 occupancy rate, the estimated number of traffic volume was some 5,000 vehicle-trips/day.

· Vehicle trips related to new university

University students are not included in the working population, therefore the assumption was made for the number of students and number of vehicle trips was estimated in the same manner as airport related vehicle trips. 4,000 vehicle trips/day was estimated.

Those OD vehicle trips related to the airport and university were assumed to comply with the OD pattern of the trips in the same traffic zone and added to the forecast 2030 VTOD matrices.

Conversion factors for passenger car equivalent unit were used in making VTOD matrices.

It is recognized that the desired lines of passenger car with large traffic volume would expand in 2030 corresponding to the expansion of urban area. The desired line showed large transport demand of passenger vehicle between new development residential area with high density and existing central urbanized area. Though the vehicle rips generated in new business area and residential area show the tendency of divergence, the transport demands between new business area and new residential area with high density, and between new business area and existing central urban area are prominent (Figure B.3.2).

B.3.2 Road Sector Plan

(1) Development direction

1) Priority for road use shall be given to the pedestrian, public transport, freight transport, and private car in this order. In this context, functions of road network will be segregated hierarchically and designated. Traffic restriction means such as bus priority lane and fixed route allotment for trucks, and signaling system for public transport priority will be carried out.

2) Road network formation, especially ring roads, axial roads for new urban development will be promoted with an emphasis. Bridges over the river and railway for better connection shall be constructed. The

intersections between arterial roads and LRT track shall be solid crossings.

Smooth traffic flow shall be realized by the integral and advanced traffic signaling system.

3) Parking management system will be introduced so that the inflow of vehicles to the central area will be restrained at a minimum required level. The private car use in the central urban area shall be constrained mainly for trips for business, and shopping, and trips by the residents in the area.

Minimum and maximum required parking spaces including those on road parking space shall be defined.

Control of illegal parking and a system for collection and allocation of fine shall be improsed.

4) Institutional framework for funding resources in the transport sector will be improved. For instance taxation system for oil consumption, charging system for the development in the urban area for road improvement or public transport improvement shall be considered.

(2) Road

1) Road hierarchy

Road standards in RK basically depend on SNiP 2.07.01-89.

Road network density shall be over 4km/sq.km by main streets, and streets and roads of local importance on the average of the whole city

A 10m width of strip shall be secured for the future rail transit system on the public transport corridor based on SNiP 2.05.09-90 (Tables B.3.3 through B.3.6).

At the major intersections between ring roads (R1, R2 and R3) and other main streets, grade separation shall be provided as much as possible.

The traffic volume and road capacity of tentatively proposed network for the master plan was checked by the assignment of OD matrix on the proposed network. Preliminary traffic assignment results showed favorable volume-capacity balance at each section (Table B.3.7). However enough capacity was not provided on some of the link roads where presently large traffic volume was observed, if 2-lane width was dedicated for the public rail transit.

For the establishment of future road network, present road width (no. of lanes) and existing road construction plan were also considered (Figure B.3.3) (Table B.3.8 and B.3.9). Road network plan (first alternative) in 2030 was proposed after examining the capacity requirement of the forecast traffic (Figures B.3.4 through B.3.6) (Table B.3.10 and B.3.11)

2) Road and intersection improvement

a) Road improvement

. Rehabilitation of road surface
Rehabilitation work will be promoted with emphasis on main streets.

. Marking and setting zebra crossings for pedestrian

b) Intersection improvement

Intersection improvement will be carried out at congested intersections identified in the present condition analysis (Figure B.3.7).

c) Improvements to traffic signal

- Installation of new traffic signals
  . new traffic signal intersection: some 430 sites
  . installation of vehicle reactors
  . installation of pedestrian signals
- Systemization of intersection signals (Figure B.3.8)
  . installation of controllers
  . promotion of direction control and channelization at intersections
  . systemization of sequential intersections on the trunk routes

(3) Parking

1) Temporary parking space demand

It is considered reasonable to forecast the demand separately for temporary parking and permanent parking.

Permanent parking spaces for vehicles owned by people, companies, or business entities shall be well provided concurrently with sufficient facilities for those.

Temporary parking spaces for business, shopping and private affairs shall also be provided at the time of construction according to the purpose of the facility.

In case of small shops and companies, however, enough temporary parking spaces usually cannot be secured by themselves. In the central urban area where the land is intensively utilized, temporary-parking spaces both on and off the road shall be provided not only by the private sector but also by the public sector.

In this Study, the temporary parking demand was forecast in the following manner.

According to the traffic survey conducted in this Study, 31.6% of trips by passenger car were the trips home, which require the permanent parking space. This percentage seems stable, because the share of trip purpose "to home" always falls in the range between 30 to 40% in the past person trip surveys. The trip purpose "return to work place" accounted for 11.6% in 2000.

While in 2000 23.3% of vehicles registered in Astana are owned by business entities (other than individuals), the share in the future of the vehicle owned by individuals is supposed to increase because of the projected increase in income. If the share of individual ownership rises, it will lead to a larger trip share of purpose "to home" and smaller share of the purpose "return to work place". In Astana considerable vehicles owned by business entities are privately used for the trips to work or for private affairs. The existing share of the total of the two trips purposes, "to home" and "return to work place" will not show drastic change in future. Trips of the two trip purposes will require permanent parking places.

In this Study future temporary parking demand was forecast assuming that the share of "to home" becomes 31% and the share of "return to work place" becomes 9% in 2030.

The number of vehicle trips "to home" by zone was estimated in proportion to the zonal population and the number of vehicle trips "return to work place" by zone was estimated in proportion to the working population, respectively.

Though the SNiP stipulates a parking space requirement standard for each type of facilities, some 30% of the vehicle owners expressed

difficulty in parking at working places. The share of trip purpose "to work" in 2030 was assumed at the same level as the existing 15%, and 30% of those trips are assumed to have a temporary parking demand., which corresponds to 4.5% of total vehicle trips generated. Providing that the share of " business", "shopping" and "private affairs" trips in 2030 is 45%, as a whole temporary parking demand in 2030 was estimated at 49.5% of total vehicle trips. The temporary parking demand was distributed to zones proportionately to the working population of each zone.

It is empirically known that the duration of parking time at temporary parking space is between one to two hours on weekdays. In this Study, a 2-hour duration was adopted for the estimation of necessary parking space. Peak ratio was set at 9% referring to the traffic survey results.

In Astana parking spaces on and off the road are publicly provided or approved by various organizations. Out of those the parking spaces under traffic police are regarded as temporary parking spaces (Figures B.3.9 and B.3.10) (Table B.3.12).

Necessary temporary parking space in zones 3,4,5,6,12,13, and 14 is estimated at 4,000 vehicles (pcu.) in 2030 (Figure B.3.11) (Table B.3.13).

Parking space standard basically depends on SNiP 2.07.01-89. (Table B.3.14)

2) Parking facilities

Following types of temporary parking space for general use are proposed.

a) on road parking space (public sector initiative, including those for loading and unloading purpose)

b) off road parking space (public sector initiative)

c) off road parking space (private sector initiative)

Temporary parking spaces for loading and unloading the trucks are necessary for the areas where retailers and wholesalers congregate. Multi-story parking space shall be developed in the central urban area. Parking development area shall be strategically designated for off road parking spaces to reduce on road parking in the central urban area and parking demand itself in the whole city (e.g. LRT terminal).

3) Parking restriction

As parking on the road is supposed to be problematic in future, following parking restriction shall be enforced.

- Each section of the roads in the central urban area shall be designated as a permitted or prohibited section for parking. The permitted section for parking shall be well arranged as on-road-parking-space.
- In the prohibited sections parking will be restricted, presumably depending on vehicle type or/and by time zone.
- All parking at on road parking space shall be charged duly and the revenues shall be pooled to be spent for the provision of parking and other transport facilities.
- Control of illegal parking shall be strictly performed and sizable amount of fine for illegal parking shall be imposed. To this end zoning of model area for parking restriction shall be considered.

B.3.3 Public Transport Plan

(1) Development Direction

1) Urban transport system with an emphasis on a component friendly to citizens and environment will be pursued in near future. For this purpose policy considerations including land use, transport management, transport facilities, funding resources, legal framework, etc. shall have to be integrally improved.

2) The roles of public transport shall be hierarchically defined, typically ranging from high-speed mass transit, main feeder transport, circular transport, etc. Major public transport corridors will be also identified. Structure of roads for public transport corridor shall be provided at a high grade standard. The performance level of each public transport mode shall be defined in the light of recent technological development.

Inter-modal traffic connection between public transport and vehicles or bicycles shall be promoted in the form of seamless services among different service suppliers, such as the park and ride facilities, etc. Kiss and ride system and park and ride system will be considered only in the peripheral areas because of the limited spatial scale of the city (8-9km radius).

3) The future role of trolley bus, once regarded as an environmentally friendly public transport mode, is uncertain now. If electricity buses are

put to use widely in future, they may replace trolley buses. Meanwhile the existing trolley system shall be maintained. (Table B.3.15)

The severity of winter weather in Astana being taken into account, the private vehicle is superior to the public transport in terms of comfort. Therefore the modal share of walking shall be respected as a means of close habitation to the working place or close arrangement of service facilities to the housing area.

4) Institutional framework for funding resources in the transport sector will be improved. Also, management will have to be improved for the effective operation of public transport system.

(2) Rail Transit System

1) Type of rail transit system

Selection of the type of rail transit system should be scrutinized from the aspects of transport demand, construction costs, environmental influence, etc. (Table B.3.16).

In Astana, considering the scale of the city and the density of transport demand, middle capacity rail transit system is preferable. From the past experiences metro is not managerially profitable unless the city population is exceeds one million.

Regarding a tram system the following defects are generally recognized.

- obstruction of traffic flow and outbreak of traffic congestion due to the mixed use of the roads by vehicles
- decrease in running speed and reduced punctuality
- aggravation of traffic congestion due to the intensification of dependency on private vehicles
- managerial problem due to the shift of patronage from tram to other transport modes

In European countries, light railway transit (LRT) system as a middle capacity public transport system between mass transit and bus is broadly utilized. Much improvement has been achieved in this LRT system in terms of capacity, running speed, punctuality, and comfort by the introduction of segregated track and high performance trains based on the improvement in technology of the train system. Introduction of

LRT system is presumed in the areas without large population and high passenger transport demand.

The comparison of characteristics of tram and LRT are shown below.

In this Study, construction of LRT lines is recommended for the sections where large public transport demand is expected.

	Tram	LRT
Trucks	Basically the track is located on the street. The space for track is used by general traffic competitively. However on rare occasions priority on the tram operation, or exclusive lane for track is provided.	Track is also located on the surface of the street similarly as tram, however segregated lane is essential. For the effective operation sometimes underground or elevated track sections are adopted.
Operation	Although the passengers' convenience to take is satisfactory, punctuality and commercial speed are greatly influenced by the traffic condition along the truck. Generally commercial speed is some 15km/h.	Punctual and high commercial speed operation can be performed due to the exclusive lane and high-performance rolling stocks. Commercial speed of over 25km/h can be expected. More frequent operation than tram can be performed.
Rolling stocks and composition of train	The train has 4 to 6 axles with train length of 14 to 21m. The capacity is between 100 and 180 passengers. Passenger seats are provided for 20 to 40% of the capacity. A train is usually composed of one or two cars. In rare case the train is composed of three cars. Maximum speed of the train is 40 - 60 km/h.	Various composition types of train are operated. ex. articulated train with 6 -8 axles, train composed of 4 cars with 4 -6 axles, train composed of two cars with 8 axles. The length of an articulated type train is some 20 -30m. The capacity is 110 -250 passengers. Passenger seats are provided for 20 -50% of the capacity. Maximum speed of the train is 70 to 80 km/h. Some type of train has a maximum speed of 100 -125 km/h.

It is recommendable to realize a LRT system in Astana as a rail transit system.

2) Basic route pattern

According to the traffic demand forecast results, large transport demand will be expected in the following sections:

i) Abylaikhan St. - existing central urban area in east-west direction

ii) new housing development area - existing urban area in southeast-northwest direction

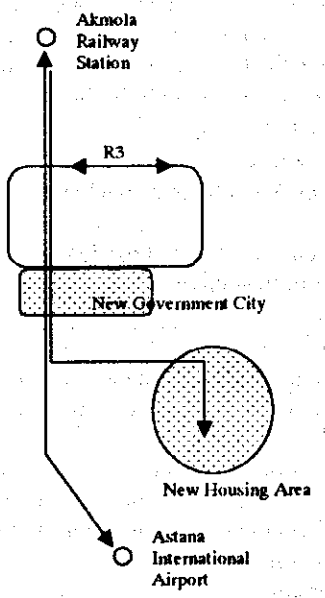
iii) existing central urban area and Astana International Airport through new business district in north-south direction

iv) new housing area - new business district

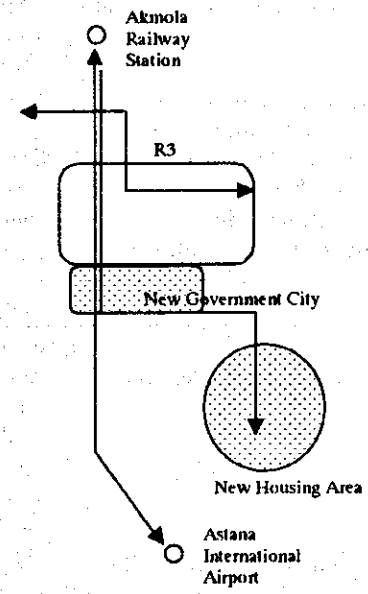
The sections ii), iii), and iv) have strategically important implications for the new urban area development. A basic route pattern was devised to accommodate the above transport demands with effective expansion of coverage area of transport service. Also structural problems with respect to the space for the rail transit system, especially in case of route convergence, and influence on the general traffic were taken into account in this process.

Following three routes patterns were considered and evaluated to fulfill the above requirement.

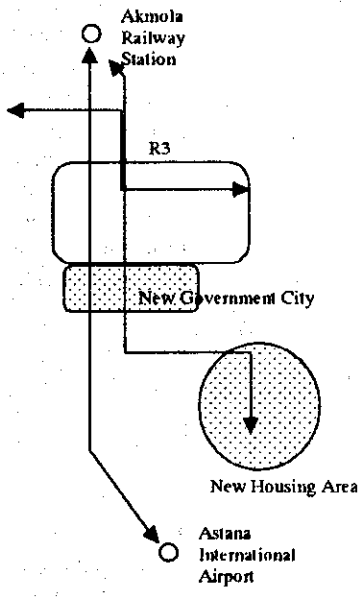
(A) Mobility oriented route pattern



(B) Government city mobility Improvement pattern



(C) Urban axis intensification pattern



Pattern Type	Route and characteristics	Advantage and disadvantage
(A) Mobility oriented route pattern	a) routes - Astana International Airport - Akmola Station route - R3 loop route - New housing area route b) characteristics This pattern was proposed to improve the mobility of the person trip movement through the multiple linkage between the old city and newly development city between Ishim river together with north-south public transport corridor development.	a) advantages - Intensification of the connection between both banks of Ishim river by public transport - Improvement of the mobility in the Government city - Convenient and smooth transferring between LRT routes - Convenient for the location plan for inter-modal facilities b) disadvantages - Lowering the road traffic capacity of R3 ring road (In case of the elevated tracks, this disadvantage is avoided.)
(B) Government city mobility improvement pattern	a) routes - Astana International Airport - Akmola Station route - East-west route - New housing area route(for Government city service) b) characteristics This pattern was proposed to improve the mobility of the person trip movement in the Government city by the new LRT route servicing a new housing development area together with north-south public transport corridor development.	a) advantages - Avoidance of the influence on the road traffic in east-west direction on R3 ring road - Expansion of servicing area along urban axis and intensification of urban axis by the partial formation of double routes - Improvement of mobility in the Government city b) disadvantages - Inconvenient transferring between LRT routes - influence on the land use in the Government city by the divergence of route
(C) Urban axis oriented pattern	a) routes - Astana International Airport - Akmola Station route - East-west route - North-south route(for new housing area service) b) characteristics This pattern was proposed to improve the mobility of the person trip movement along the urban axis and to intensify the formation of urban axis by double LRT routes.	a) advantages - Avoidance of the influence on the road traffic in east-west direction on R3 ring road - Expansion of servicing area along urban axis and intensification of urban axis by the formation of double routes both in old and new urban areas b) Disadvantages - Inconvenient transferring between LRT routes - Inconvenient mobility in the Government city by LRT

In conclusion (A) route pattern was adopted and recommended.

A 0.5-1.0 km station interval and 500m-zone strip from the truck as tentative catchment area were assumed for the route delineation (Figure B.3.12). (Table B.3.17)

Table B.3.18 shows the characteristic of LRT among several cities as a reference.

The issue of lowering the road traffic capacity of R3 ring road shall be avoided by the adoption of grade separation between LRT route and road traffic in some section. Although the new primary road along R3 ring road (Abylaykhan St.) was not proposed in the Master Plan, the construction of this road will alleviate the road traffic on R3 road and help to spare more room for LRT on R3 ring road. The construction of the new primary road parallel to R3 ring road shall be further pursued.

(3) Bus and Trolley buses

1) Trolley bus

Trolley bus has the disadvantage of relatively large amount of energy consumption per transport capacity compared with tram and the disadvantage of larger investment cost for infrastructure than buses while no discerning difference in transport capacity is found. However trolley bus has advantages on environmental aspect for urban transport in terms of noise and air pollution. In Astana the density level of NOx and CO were 1.2 -4.0 times and 1.8 times higher than those of national standard respectively in 1998. The density level of SOx is near to exceeding maximum permissible level. Therefore, trolley bus routes for the access to the business area and transportation within the business area utilizing existing infrastructure stocks shall be maintained in this regard. Moreover some new trolley bus routes by utilizing existing past assets of power stations and cautionary facilities are worth while to construct. Another problem of current trolley bus operation is the aged vehicles. More than 80 % of the existing trolley buses operates beyond their expected service lives in 2000. Those old trolley buses shall be replaced, if resources including the subsidy are secured.

There is a possibility that buses and trolley buses will be replaced by electrically driven buses. Installing new trolley routes on a large scale should be suspended under these uncertain circumstances. In case of conversion of trolley buses to LRT or other environmental sound electricity driven buses, smooth shift of staffs from trolley bus operation to other shall be implemented.

2) Bus

Out of area-wide public transport demand from a majority to many in the city, buses are expected to take care of their requirements by:

i) Public transport demand, which can not be satisfied by the individual transport mode (taxis) in terms of capacity as an area servicing public transport mode;

ii) Feeder public transport demand which cannot be adequately satisfied by rail transit system; as a linear public transport service, the bus is expected to take care over:

iii) Public transport demand in the peripheral area, which is not satisfied by individual transport mode due to the capacity, but is not enough for rail transit;

iv) Transport demand between major transferring points.
- improvement of accessibility to the LRT stations as feeder transport
- service supply to the area where no mass transit service is provided
- service supply as regional transport mean
- service supply between major inter-modal facilities

(4) Inter-modal Facilities

Astana seems to have a rather spread out urbanized area. Thus public transport system will be separated into the major public transport system and feeder public transports systems, because mass public transit could not serve all areas. In such a situation inter-modal facility shall be provided for the convenience of public transport passengers and some rearrangement of public transport routes would be necessary.

The multi-modal transferring facilities are assumed to apply following transport functions:

- Connection between feeder public transport and trunk rail transit
- Connection among long distance bus, urban transport bus and trunk rail transit
- Rectification of public transport routes for users

Though the location at city center has a large advantage for transferring many different transport modes and to all directions, the excessive concentration of surface public transport modes would cause the traffic congestion and decreased passengers' benefits. Therefore, multi-modal transferring facilities should be cautiously located at trunk rail transit system near the center of the city based on the transport demand.

The following two types of multi-modal facilities are considered:

a) multi-modal facility

Multi-modal facility is assumed to serve the transferring among bus, long distance bus, taxi, and LRT or railway.

b) feeder servicing inter-modal facility

Feeder servicing inter-modal facility is assumed to serve the transferring between LRT between residential area and business/ commercial area and feeder service public transport.

In Astana already Akmola station plaza is functioning as a multi-modal facility. However the capacity is rather limited.

In this Study a new multi-modal facility is proposed near the intersection between R2 ring road and new business urban axis (Figure B.3.12).

Feeder servicing inter-modal facilities is proposed at stations near LRT terminus. Those will be minor facilities as the assumed transferring is between feeder bus and LRT.

B.3.4 Regional Transport Plan

Confined consideration was made in this section on the regional transport plan for the regional development including Astana.

Intensification of transport network between Astana and other regions in Kazakhstan and other countries is essential for the capital development. It is necessary to transfer the roles of the existing functions now at the Almaty Airport is playing to the Astana International Airport.

Railway and road, especially the railway is an important transport means so far. The importance of railway will last in future if the reliability of transport into the winter and transport cost is taken account of.

Presently linkages are provided by national road between Astana and Kokchetav in the north, Karaganda and Almaty in the south, and Pavlodar in the east, although the conditions are not well maintained. However, there seems to be some problem in both railway and road transport network between Astana and western Kazakhstan in terms of direct linkage. Especially the linkage by railway and road between Astana and coastal area of the Caspian Sea in a long term consideration shall be respected provided that the future possibility of regional development of the region is geared with the development of crude oil and natural gas is considered.

Regarding the railway network, Astana is located on the Northern Corridor of Trans Asian Railway (Lianyugang-Urumuchi-Ekaterinburg-Moscow-Warsaw-

Rotterdom) which give the shortest railway between Asia and Europe advocated by ESCAP.

Cargo railways and yards are densely located in the northern part of the Akmola Station, and some of such facilities are laid idle due to the recent stagnation of industrial activities in this area. It is desirable that the railway function for cargo transport will be detached from Akmola Station, releasing the entire capacity for passenger trains, avoiding the freight traffic penetration into the city center and rectifying freight traffic. Reorganization of cargo transport by rail should be made through the construction of a bypass line of railway as a part of Northern Corridor of Trans Asian Railway, simultaneously with the rearrangement of industrial area in Astana.

Three new transport corridor development (for Semipalatinsk, Kyzylorda, Atyrau-Aktau) would be necessary to realize the AAKA regional development proposed in this Study in addition to the existing four transport corridors (for Kostanai, Petropavlovsk, Pavlodar, Karaganda-Almaty).

Main regional transport projects necessary are as follows.
- Construction of bypass railway for cargo transport
- Improvement of Astana International airport
- Transport corridor development (for Semipalatinsk, Kyzylorda and Atyrau-Aktau)

In addition due to the lack of sufficient fund for maintenance works, deterioration of facilities is commonly observed in both rail and road infrastructure. Restoration should be carried out in line with the above regional transport development directions.

B.3.5 Staging and Consideration of Network

Transportation network improvements are the proposed projects here in accordance with the staged development of urban areas as summarized in the following (Figure B.3.13).

(1) Up to 2010

At this stage fundamental transport infrastructure for the new city development will be provided together with that for the redevelopment of existing central area. Major projects are as follows.

· Construction of north-south transport axis for the new urban axis development

- Construction of inner ring road (R3) to improve the fluidity of the traffic movement in the new and existing central areas and the connection between both banks of the Ishim River
- Completion of the outer ring road (R1) currently underway
- Construction of roads servicing the New City Center, a new housing area in the southeast, and the industrial development area in the north
- Improvement of roads to cope with traffic condition in the existing central area and to rearrange existing urban area
- Construction of LRT (Astana International Airport - Akmola Station)
- Construction of multi-modal terminal at Akmola Station plaza and City Park of Culture and Recreation and construction of a city air terminal

(2) Up to 2020

At this stage the fundamental road network improvements for the whole city will be implemented.

- Construction of middle ring road (R2) to improve the fluidity of the traffic movement in the whole city area
- Completion of the northern half of outer ring road (R1)
- Construction of roads servicing the new housing area on the left bank of the Ishim River, and the industrial development area in the north
- Construction of roads to form new business and commercial district
- Improvement of roads in the existing low developed area for rearrangement of land use
- Construction of LRT (new housing area)
- Construction of multi-modal terminal at International Exhibition area

(3) Up to 2030

At this stage total transport network for the whole city will be formed.

- Completion of the southern half of outer ring road (R1)
- Construction of connection road between R1 and R2
- Construction of roads servicing the new housing area on the left bank of Ishim River
- Construction of roads to form new business and commercial district

- Improvement of roads in the existing low developed area for rearrangement of land use
- Construction of LRT (R3 loop route) including elevated track
- Construction of multi-modal terminal at Abylai-khan Street

With respect to the road capacity and traffic volume balance in 2030, traffic assignment by a transportation simulation computer software named JICA STRADA[1] was carried out (Figure B.3.14). The major findings are the following.

- At each section of the radial direction just outside of inner ring road (R3) was within the affordable volume capacity ratio. The capacity of north-south transport corridor was well provided in 2030.
- The section in the east of the inner ring road comprising Abylai-khan Street will be rather tight for the future traffic demand because the road network road traffic will concentrate on the Abylai-khan Street.
- The road capacity across the railway was sufficient enough for the traffic demand in 2030.
- Based on those findings, the followings shall be taken into account for the implementation.
- For the southeast-northwest movement along the Abylai-khan Street, construction of inner ring road (R3) and p-2 road shall be possibility realized at an early stage to alleviate the traffic load on the Abylai-khan Street. Also, the possibility of the additional road construction parallel to the Abylai-khan Street shall be pursued.
- Some of the proposed roads are rather above required level of the traffic volume. The proposed important main streets of the city which form the north-south axis in the southward of the new development area up to 2030 fall into such roads. With the budgetary constraint number of lanes may be reduced, however right of way shall be reserved for the future widening for the traffic demand generated by the development after 2030.

[1] JICA STRADA is computer software developed for the traffic assignment by JICA.