...ION AGENCY (JICA)
NATIONAL TRANSPORT RESEARCH CENTRE (NTRC)
MINISTRY OF COMMUNICATIONS, GOVERNMENT OF PAKISTAN

THE STUDY ON NATIONAL TRANSPORT PLAN IN THE ISLAMIC REPUBLIC OF PAKISTAN

Final Report / Volume II

Studies by Sub-sector

February 1995

ALMEC CORPORATION
CONSULTANTS INTERNATIONAL

The exchange rates used in the Study are:

US $1.00 = Pakistan Rupees 25.960
J.Yen 1.00 = Pakistan Rupees 0.218
Rs. 1.00 = ¥4.59
(Average during 1992-93)
Source: Economic Survey 1993-94

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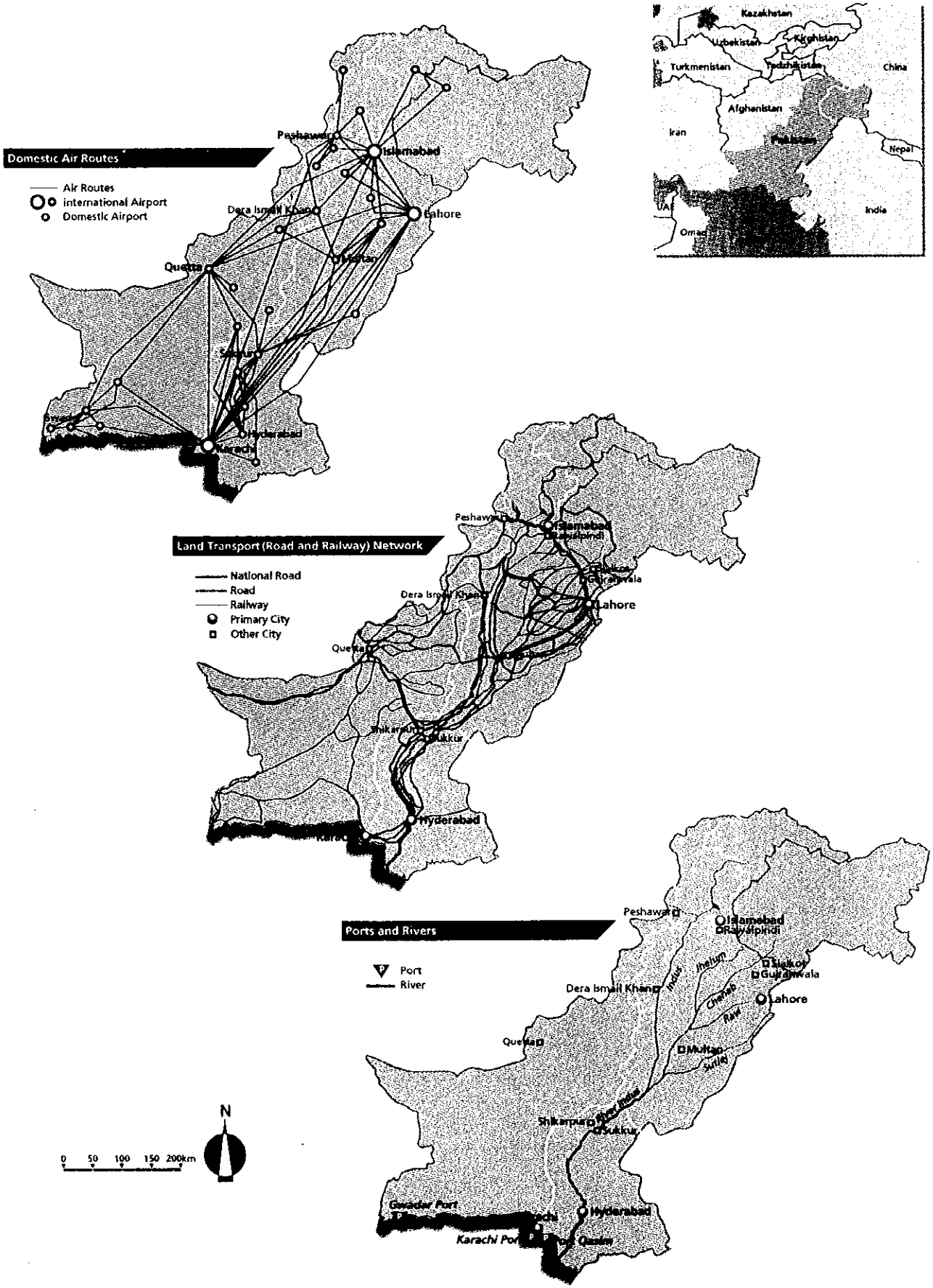
Maps of the Study Area



Abbreviations / Acronyms

AAGR	Average Annual Growth Rate
AC&C	Aeronautical Communication and Control
ACC	Area Control Center
ADP	Annual Development Programme
AFTN	Aeronautical Fixed Telecommunication Network
AIP	Aeronautical Information Publication
ALS	Standard Approach Lighting System
AMSS	Automatic Message Switching System
APL	American President Lines
ASF	Airport Security Force
ATIS	Automatic Terminal Information Service
ATS	Air Traffic System
BOT	Build, Operate and Transfer
C&F	Cost and Freight
C&W	Communications and Works Department
CAA	Civil Aviation Authority
CAS	Central Asian States
CAT	Category
CATI	Civil Aviation Training Institute
CDEP	Central Development Working Committee
CFS	Container Freight Station
CIS	Confederation of Independent States
DEL	Diesel Electric Locomotive
DME	Distance Measuring Equipment
DRF	Depreciation Reserve Fund
DVOR	Doppler VHF Omnidirectional Radio Range
DWT	Dead Weight Ton
ECC	Economic Coordination Committee of the cabinet
ECNEC	Executive Committee of National Economic Council
ECO	Economic Cooperation Organization
EIRR	Economic Internal Rate of Return
EL	Electric Locomotive
FAA	Federal Aviation Agency, USA
FATA	Federal Administrated Tribal Area
FIR	Flight Information Region
FOB	Free on Board
FYP	Five Year Plan
GDP	Gross Domestic Products
GNP	Gross National Products
HAT	Highest Astronomic Tide
HP	Horse Power
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IOC	Iron Ore and Coal
IRNS	Indus River Navigation Study
ISB	Islamabad
IWT	Inland Water Transport
JCAB	Japan Civil Aviation Bureau
JICA	Japan International Cooperation Agency
KHI	Karachi
KKH	Karakhoram Highway
KPT	Karachi Port Trust
LDP	Lahore Dry Port
MEAV	Modern Equivalent Asset Value
MHHW	Mean Higher High Water

MHLW	Mean Higher Low Water
MLHW	Mean Lower High Water
MLLW	Mean Lower Low Water
MLS	Microwave Landing System
MOC	Ministry of Communications
MOD	Ministry of Defense
MOR	Ministry of Railway
MSC	Milwa Shipping Company
MSL	Mean Sea Level
NDB	Non-Directional Radio Beacon
NHA	National Highway Authority
NLC	National Logistic Cell
NM	Nautical Mile
NSC	National Shipping Corporation
NTC	National Tanker Company
NTPS	National Transport Plan Study
NTRC	National Transport Research Center
NWFP	North-West Frontier Province
OD	Origin and Destination
OP	Oil Pier
ORE	Other Revenue Expenditure
PAF	Pakistan Air Force
PAPI	Precision Approach Path Indicator
PCWD	Provincial Communications and Works Department
PDD	Planning and Development Division
PERAC	Petroleum Refining and Petrochemical Corporation Ltd.
PIA	Pakistan International Airlines
PISC	Pan Islamic Steamship Corporation
PMC	Pakistan Mercantile Services Ltd.
PMD	Pakistan Meteorological Department
PNSC	Pakistan National Shipping Corporation
POL	Petroleum Products
PPSC	Pakistan Postal Services Corporation
PQA	Port Qasim Authority
PR	Pakistan Railway
PSN	Pakistan Shipping Corporation
PSO	Public Service Obligation
PSR	Primary Surveillance Radars
PSW	Ports and Shipping Wing, MOC
PTA	Provincial Transport Authority
RCD	Regional Cooperation for Development
RCLL	Runway Center Line Lights
REDL	Runway Edge Lights
RENL	Runway End Lights
RFTKs	Revenue Freight Ton-Kilometers
RIV	Rapid Intervention Vehicle
RPKs	Revenue Passenger-Kilometers
RSE	Ray Shipping Enterprises Ltd.
RTA	Regional Transport Authority
RTHL	Runway Threshold Lights
RVR	Runway Visual Range
SAARC	South Asian Association for Regional Cooperation
SALS	Simple Approach Lighting System
SAP	Social Action Programme
SCO	Special Communication Organization
SL	Steam Locomotive
SSR	Secondary Surveillance Radars
TACAN	Tactical Air Navigation System
TCLL	Taxiway Center Line Lights
TEDL	Taxiway Edge Lights

TEU	Twenty-foot Equivalent Unit
TRB	Transport Research Board, USA
TSL	Tristar Shipping Lines Ltd.
UK	United Kingdom
UNCTAD	United Nations Conference for Trade and Development
UNDP	United Nations Development Programme
VOR	VHF Omnidirectional Radio Range
VORTAC	VOR and TACAN
WAPDA	Water and Power Development Authority

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CHAPTER 4 ROAD PLANNING

4.1 Current Status and Problems

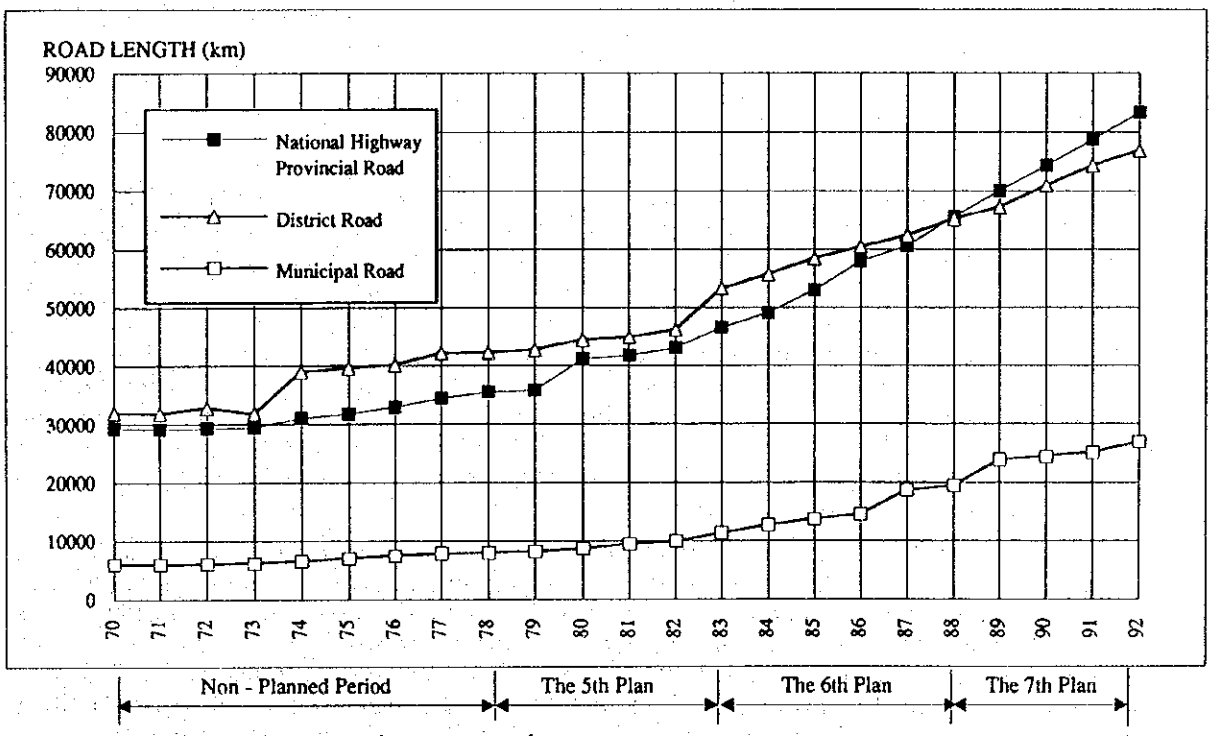
4.1.1 Roads and Road network

(1) Roads

1) Entire Country

In 1992, the total length of roads in Pakistan was 188,300km consisting of 95,700kms of paved roads (high type) and 92,600kms of gravel and earth roads (low type). This means that the total length has increased by 68% with paved road by 98% and unpaved road by 46%, respectively, between 1983 and 1992, as shown in Table 4.1.1. Annual growth trends of road development within the 6th and 7th plan periods recorded 7.1% and 6.2%, respectively, as shown in Figure 4.1.1.

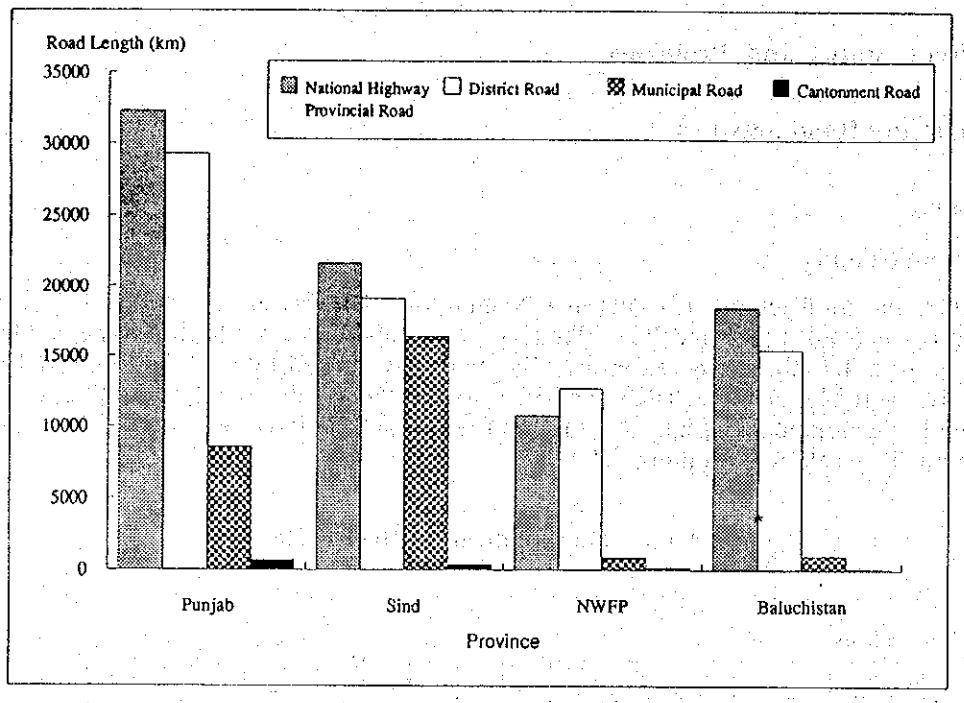
Figure 4.1.1 Development of Road 1970 - 1992



Average growth rate per annum (%)

	1970 - 78	1978 - 83	1983 - 88	1988 - 92
National Highways & Provincial Roads	2.50	5.50	7.10	6.20
District Roads	3.58	4.73	4.12	4.19
Municipal Roads	3.79	7.03	1.38	8.41
Total	3.12	5.44	6.23	5.60

Figure 4.1.2 Road Length Classified by Administration and Province



By administration, these roads are classified into 5 categories, namely national highways, provincial roads, district roads, municipal roads and cantonment roads. Table 4.1.2 and Figure 4.1.2 show the current highway / road lengths by administration / province.

2) Main Roads

The main road network of the country comprises national highways and part of provincial roads. The total length is 21,600 km approximately as shown in Figure 4.1.3. It extensively covers Pakistan, however, it is in poor conditions and greatly in need of repair, owing to the increase of traffic volume and heavy vehicles. Most of the paved roads are narrow, and only 56% of the national highways and 21% of the major provincial roads are of two lanes, as shown in Table 4.1.2 and Figure 4.1.4.

The average paved carriage way width of the national highways and major provincial roads is estimated at 6.4m and 4.4m, respectively, as shown in Figure 5.1.5. In addition, in terms of surface condition, it was found that approximately 3,800kms (58%) of the national highways and 13580kms (90%) of the major provincial roads are in need of re-surfacing / major improvement and thus are classified into the 'poor' and 'very poor' groups, while, 2733kms (45%) of the national highway and 1479kms (10%) of the major provincial roads classified into the 'fairly good' and 'fair' groups. Table 5.1.3 and Figure 5.1.6 show a summary of the pavement conditions.

Table 4.1.1 Development of Road Infrastructure

YEAR	NATIONAL HIGHWAY AND PROVINCIAL ROAD			DISTRICT ROAD			MUNICIPAL ROAD			TOTAL (KM)		
	LOW TYPE	HIGH TYPE	TOTAL	LOW TYPE	HIGH TYPE	TOTAL	LOW TYPE	HIGH TYPE	TOTAL	LOW TYPE	HIGH TYPE	TOTAL
1970	12047	17231	29278	30159	1725	31884	846	5162	6008	43052	24118	67170
1971	12207	16942	29149	29982	1838	31820	846	5197	6043	43035	23977	67012
1972	12511	16763	29274	30833	1978	32811	853	5260	6113	44197	24001	68198
1973	12511	16985	29496	29774	2019	31793	898	5392	6290	43183	24396	67579
1974	12367	18736	31103	36654	2364	39018	997	5576	6573	50018	26676	76694
1975	12291	19549	31840	37074	2576	39650	1044	6131	7175	50409	28256	78665
1976	12344	20579	32923	37546	2646	40192	1129	6414	7543	51019	29639	80658
1977	12360	22087	34447	39056	3106	42162	1132	6718	7850	52548	31911	84459
1978	12361	23190	35551	39054	3198	42252	1181	6909	8090	52596	33297	85893
1979	11491	24288	35779	39201	3598	42799	1218	7071	8289	51910	34957	86867
1980	16244	24919	41163	40777	3556	44333	1262	7415	8677	58283	35890	94173
1981	15546	26218	41764	39439	5420	44859	1408	8111	9519	56479	40380	96859
1982	15135	27904	43039	40355	5691	46046	1439	8463	9902	57020	42773	99793
1983	15596	30892	46488	46344	6879	53223	1557	9804	11361	63591	48325	111916
1984	16355	32777	49132	48174	7568	55742	1710	10982	12692	66351	52120	118471
1985	17857	35166	53023	50081	8278	58359	1851	11955	13806	69925	56318	126243
1986	19206	38728	57934	51106	9202	60308	2034	12533	14567	72489	61464	133953
1987	19312	41310	60622	52287	10042	62329	2318	16423	18741	74061	68880	142941
1988	20442	45108	65550	54152	10974	65126	2348	17122	19470	77094	74355	151449
1989	22049	47944	69993	55705	11449	67154	2446	21412	23858	80364	81981	162345
1990	22526	51667	74193	58707	12075	70782	2582	21906	24488	83984	86839	170823
1991	23239	55402	78642	61665	12541	74206	2701	22431	25131	87777	91587	179364
1992	25563	57713	83276	63963	12792	76755	2890	24001	26890	92591	95742	188332

Source : Files in NTRC 1994

Note : Total road length in 1981-1992 period includes Cantonment Road

Table 4.1.2 Classified Existing Roads in Pakistan

(in km)

Pav. & Width Type / Admn / Fun. class	Unpaved Type			Paved Type								Grand Total
	Earth	Gravel	Total	w = < 3.6m	3.6 < w	5.4 < w	7.2 < w	10.8 < w	DV. (14.4<w)	VD. (14.4<w)	Total	
National Highway / Provincial Road	8592	16970	25563	39577	5785	10341	1367	471	91	81	57713	83276
Punjab	602	152	755	22312	1474	6495	957	180	63	57	31538	32293
Sind	7036	86	7122	10292	2479	1490	67	177	0	23	14528	21651
NWFP	413	3174	3587	3920	821	2014	320	110	29	1	7216	10803
Baluchistan	541	13558	14099	3053	1011	342	23	3	0	0	4432	18531
District Road	38883	25079	63963	11864	589	235	60	0	43	0	12792	76755
Punjab	13892	5403	19295	9897	78	19	0	0	43	0	10037	29333
Sind	16919	849	17769	861	262	216	59	0	0	0	1398	19167
NWFP	5702	5943	11645	863	225	0	0	0	0	0	1088	12733
Baluchistan	2370	12884	15254	243	24	0	1	0	0	0	268	15522
Municipal Road	1298	1592	2890	7730	4398	4894	2454	1741	1705	1080	24001	26890
Punjab	621	700	1321	3336	1842	750	815	390	70	59	7262	8583
Sind	373	482	855	3891	2187	3923	1580	1344	1626	1016	15568	16423
NWFP	127	153	280	145	245	185	27	2	4	4	611	891
Baluchistan	176	257	434	359	124	36	33	4	4	0	560	993
Cantonment Road	78	98	175	382	424	187	144	64	28	6	1237	1413
Punjab	37	86	124	260	169	60	20	14	13	3	540	664
Sind	41	1	42	34	179	35	75	28	15	3	368	410
NWFP	0	2	2	76	61	63	19	17	0	0	237	239
Baluchistan	0	8	8	12	15	28	30	5	1	0	92	100
Total	48851	43739	92591	59554	11196	15658	4025	2276	1867	1167	95742	188332

Source : Files in NTRC 1994.

Note : Symbols of "DV." and "VD." indicate divided and undivided median, respectively.

Figure 4.1.3 Road Network for National Transport Study 1994

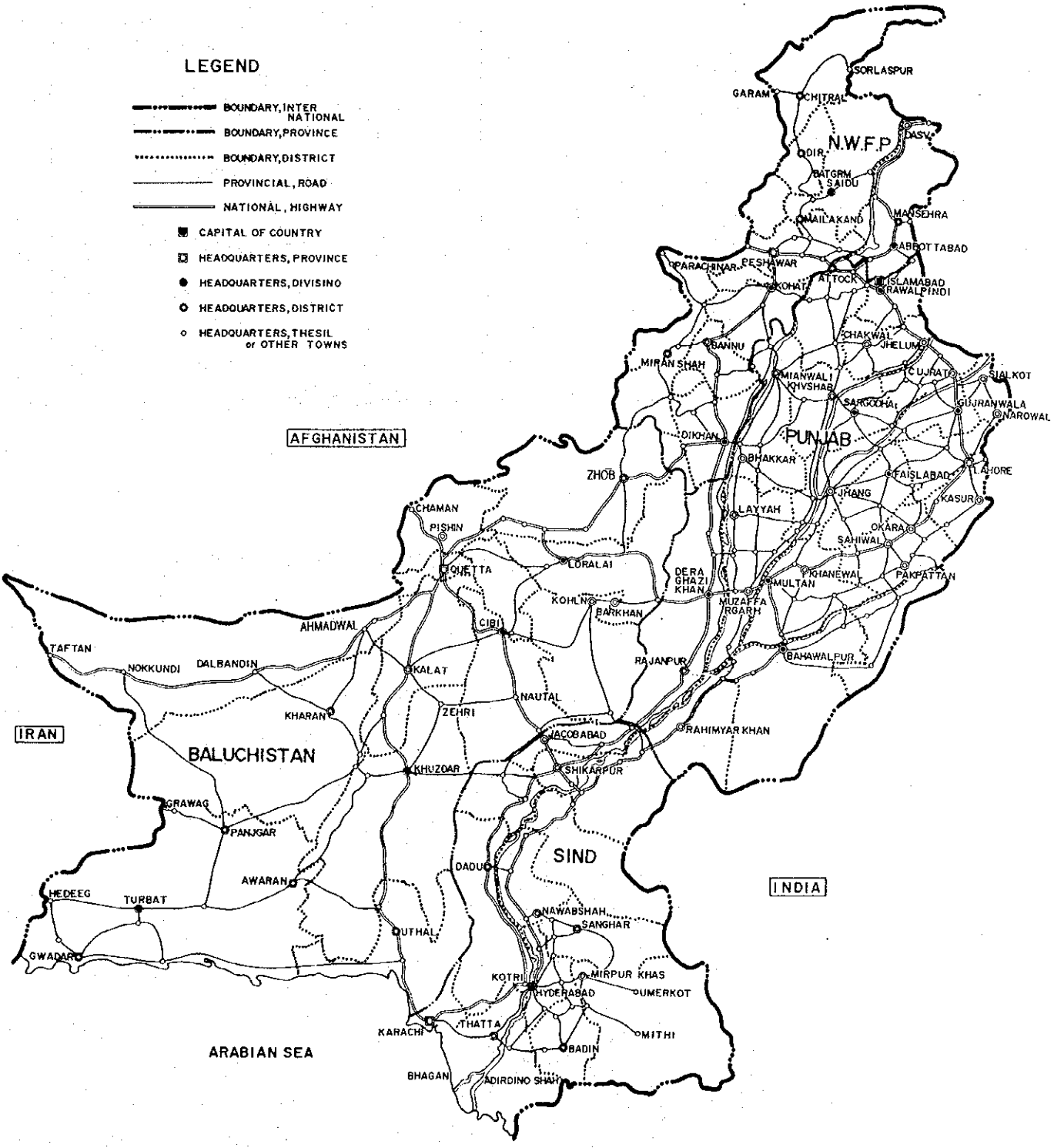
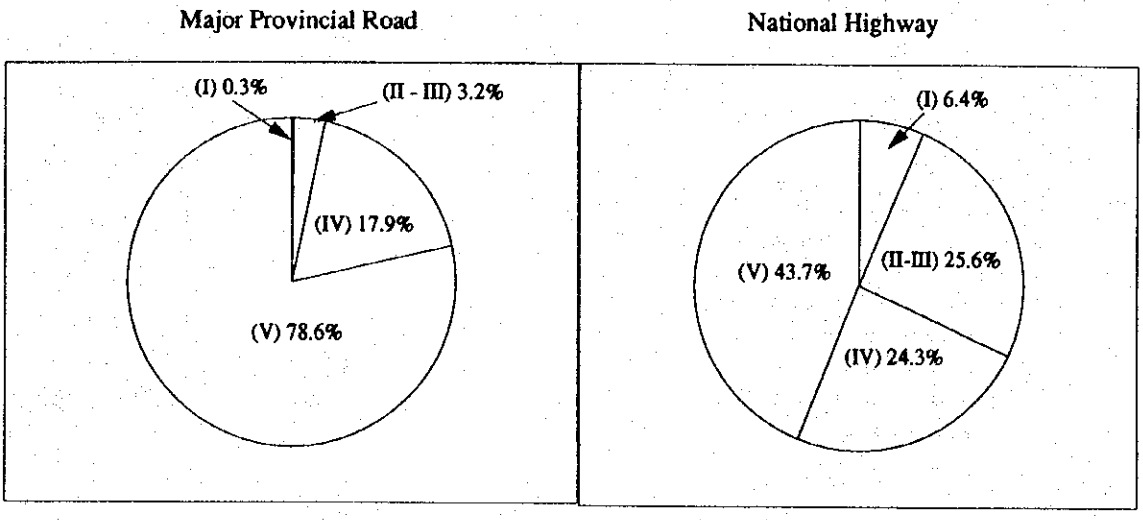


Figure 4.1.4 Percentage by Road Classification



Note : Carrigeway width (I>=14.4m, II-III>7.2m, IV>5.4m, V<5.4)

Figure 4.1.5 Average Carriageway Width of National Highway / Provincial Roads

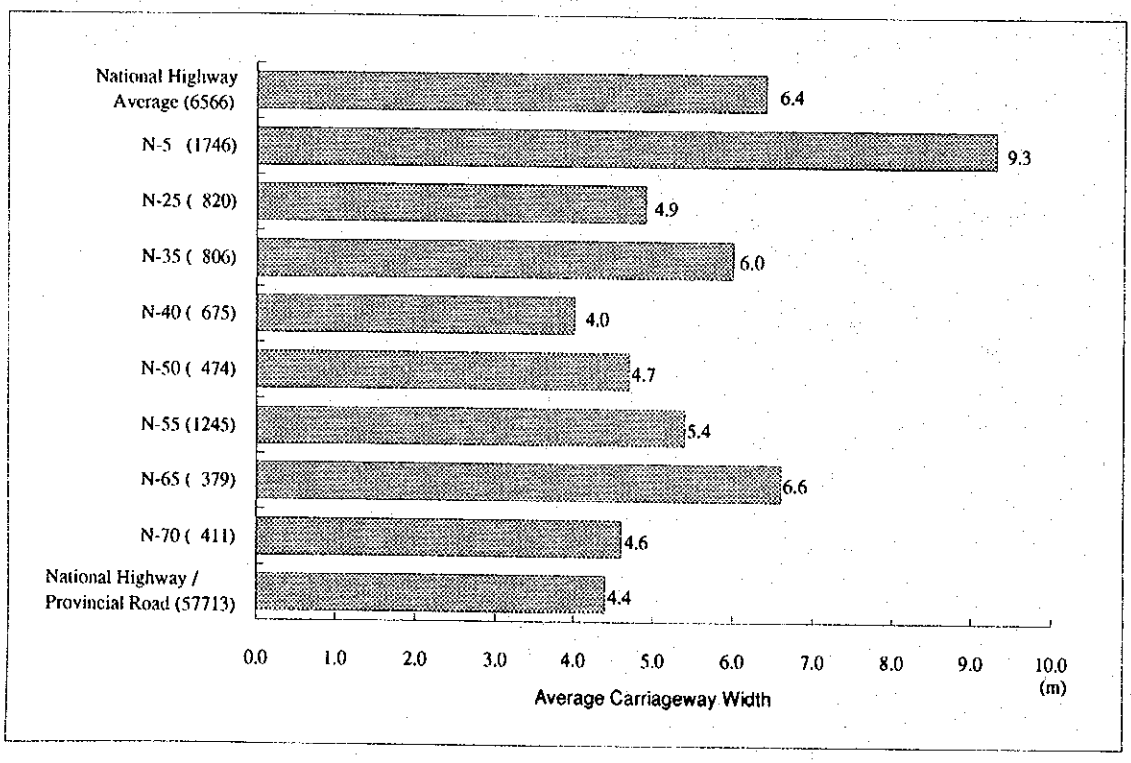


Table 4.1.3 Pavement Conditions

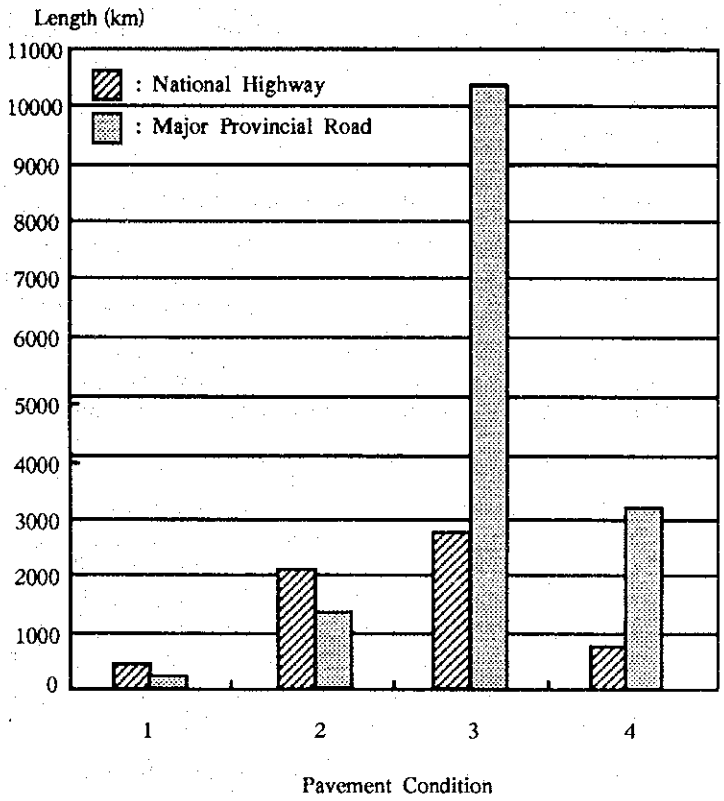
(km)

Class of Road	National Highway Pavement Condition 1	2	3	4	Sub Total	Major Provincial Road Pavement Condition 1	2	3	4	Sub Total	Total
I	223	35	232	0	490	0	0	106	0	106	596
II	14	0	189	0	203	0	0	97	0	97	300
III	43	132	1,263	73	1,521	0	74	678	55	807	2,328
IV	90	909	499	150	1,648	50	647	3,245	959	4,901	6,549
V	308	979	862	555	2,704	0	708	6,347	2,093	9,148	11,852
Total	678	2,055	3,055	778	6,566	50	1,429	10,473	3,107	15,059	21,625

Figure 4.1.6 Pavement Condition

SURFACE CONDITION

1	FAIR GOOD	Good road, small cracks
2	FAIR	Periodic maintenance
3	POOR	Re-Surfacing and Strengthening
4	VERY POOR	Rehabilitation / Major improvement



(2) National highways

The national highways constitute major inter-provincial links forming a part of international routes and link up all federal and provincial headquarters. Provincial roads are the roads extending from the national highways to local core townships.

The national highway network is composed of eight routes, 6,600kms in total, including route N-70 which was reclassified as a national highway in June, 1988. The backbone of the present highway network is the Karachi - Peshawar highway, N-5, which is 1,750kms and runs through the North - South corridor of the country (Karachi - Hyderabad - Multan - Lahore - Islamabad - Peshawar). Route N-5 is said to cater to 55% of inter - urban traffic and handles a larger percentage of the freight on the national highway network. At present, 458kms of route N-5 has been dualized and dualization works is in progress in other 1,077kms, while work on the remaining 217kms is being planned to be completed in the latter stage. In addition, improvement projects (raising, widening and pavement strengthening) for the route N-55 (Indus Highway) are in progress and its phase 1&2 will be completed by 1997, while the phase 3 will be completed in the 9th FYP. Of the highway N-40 from Quetta to Taftan the section Norkhandi - Dalbadin is under work and the section Dalbadin - Noshki - Mastung will commence works soon. Improvement of other national highways is also under way as part of the 4-Year Development Program (1991-1995) including the 335km Motor way between Lahore and Islamabad which is planned to be completed by 1995. Figure 4.1.7 and Appendix Table 4.1.1. show the progress of the national highway and strategic road projects as of 1993.

Table4.1.10 through 4.1.13 show the allocated budget for the 8th FYP, where the total cost on roads is planned at Rs.74.7 billion.

(3) Examination of the Accessibility of Road Network :

The degree of accessibility between two points can be utilized in analyzing the efficiency and sufficiency of a certain network configuration. Accessibility can be represented by travel time and/or a detour rate estimated from the ratio of actual road distance to aerial direct distance.

A detour rate between 1 and 1.5 in Table 4.1.5 implies a route that provides high accessibility between the two points in terms of distance only. On the other hand, a detour rate of more than 1.5 implies a route with low accessibility, which indicates problems that need to be solved.

1) Accessibility Between Major Towns :

Table 4.1.5 denotes the detour rates between National Capital and Provincial Headquarters and between Provincial Headquarters and Divisional Headquarters. Most of them range from 1.0 to 1.5 except for some linkages of the provinces. The existing network therefore provide a relatively high level of accessibility between major towns in terms of distance only. In order to provide equal accessibility, alternatives such as providing new direct access links should be considered to the linkages between Faisalabad/Sargodha and Rawalpindi in Punjab province. In Balochistan and NWFP provinces, their accessibility are strongly constrained by the topographic features characterized by a mountainous area.

2) Accessibility to the Motorway Interchange :

The total length of the Motorway is approximately 335km and it is scheduled to be completed and opened to traffic by 1995 hopefully. Since the motorway is expected to play a significant role as a major infrastructure to boost national economy, it is important to ensure that there is adequate accessibility to the Motorway interchanges. The access time to the interchange is desirably half an hour based on the data obtained from developed countries as shown in Table 4.1.5. The accessbility of Faislabad/ Sargodha to Rawalpindi/Islamabad will be improved by the completion of this Motorway and support the regional economic growth.

Figure 4.1.7 Progress of The NHA Projects (1992-93)

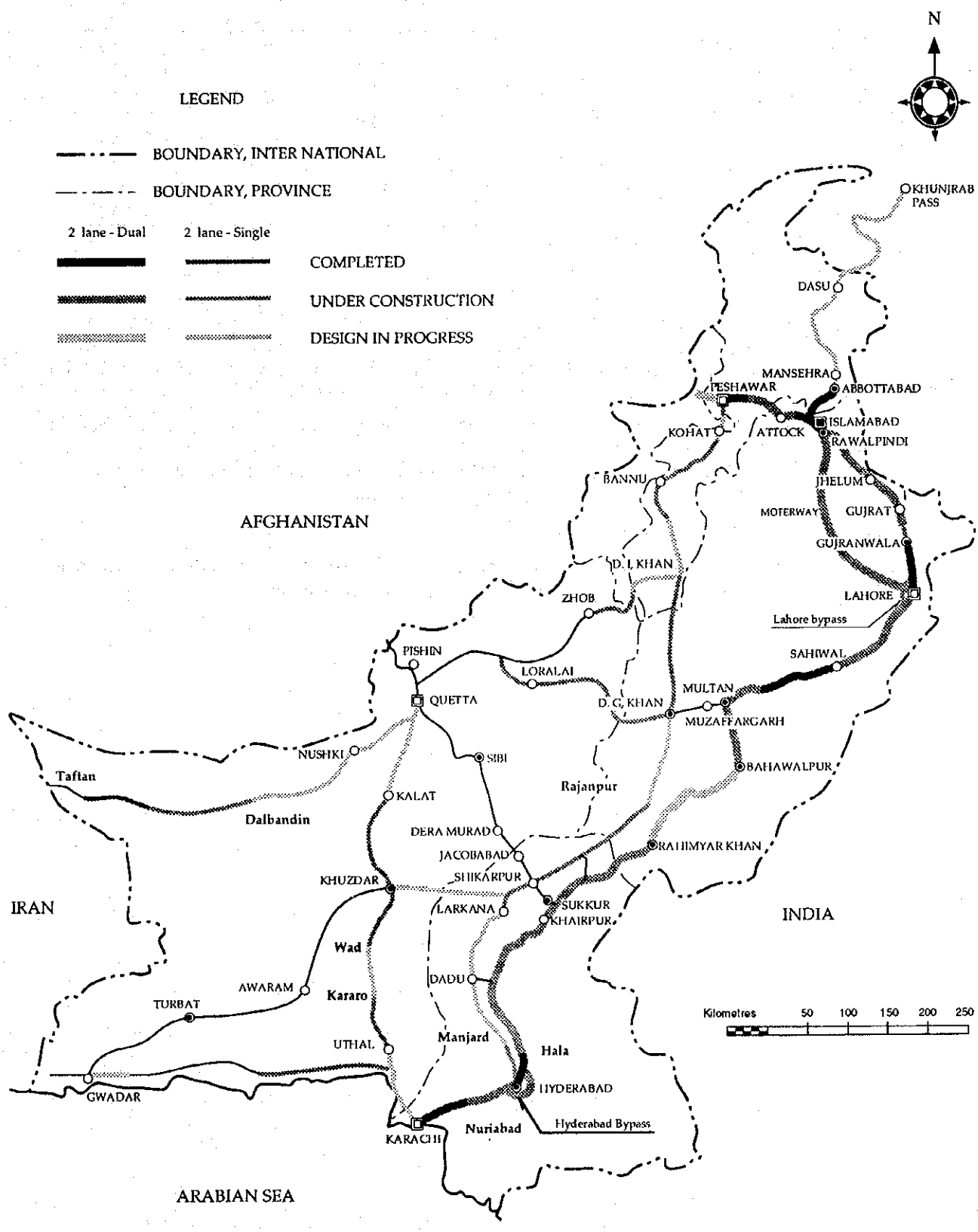


Table 4.1.4 Access Time to Motorway Interchange

COUNTRY	ACCESS TIME TO MOTORWAY INTERCHANGE					
	0-0.5H	0.5-1.0H	1.0-1.5H	1.5-2.0H	MORE THAN 2.0H	
U.S.(WEST)	79 (100)	0	0	0	0	79 (100)
U.S.(EAST)	102 (98)	2 (2)	0	0		104 (100)
GERMANY	147 (96)	6 (4)	0	0	0	153 (100)
ITALY	65 (81)	8 (10)	4 (5)	3 (4)	0	80 (100)
FRANCE	75 (70)	11 (10)	4 (4)	5 (5)	12 (11)	107 (100)
U.KINGDOM	189 (94)	10 (5)	1 (0.5)	0	1 (0.5)	201 (100)
JAPAN	274 (69)	42 (11)	34 (8)	14 (3)	36 (9)	400 (100)
Pakistan M-1	6 (67)	3 (33)	0	0	0	9 (100)

Source : JAPAN Highway Public Corporation, 1987

Figure 4.1.8 shows two areas with different access times from each interchange on the motorway corridor (the area to be serviced by a motorway). The first is the area within 20km radius from the interchanges (access time 0.5 hour) while the second is the area within 40km radius but within the motorway corridor (access time less than one hour).

It can be seen that the area falling within the first category (less than 0.5 hour) include Lahore (provincial headquarters), Sargodha (divisional headquarters), and Rawalpindi; the area in the second category (less than one hour) are Khushab, Jauharabad, Gujranwara and Faisalabad; and that Gujrat, Jhelum and Jhang are in the outside.

3) Access Roads to Motorway

In the formulation of the road network, the accessibility to motorway interchanges from cities should be improved along with the completion of the motorway.

Table 4.1.5 Detour Rate between Major Towns

(NATIONAL CAPITAL - PROVINCIAL H.Q.)

	ISLAMABAD	KARACHI	LAHORE	QUETTA	PESHAWAR
ISLAMABAD		1540/1129 = 1.4	288/265 = 1.1	939/830 = 1.1	167/144 = 1.1
KARACHI			1290/1080 = 1.3	715/579 = 1.2	1395/1091 = 1.3
LAHORE				955/712 = 1.3	436/373 = 1.2
QUETTA					776/598 = 1.3

(PROVINCIAL H.Q. - DIVISIONAL H.Q.)

- PUNJAB -

	LAHORE	GUJRANWALA	FAISALABAD	SARGODHA	MULTAN	RAWALPINDI	BAHAWALPUR	BAHAWALPUR
LAHORE		73/65 = 1.1	135/117 = 1.2	171/163 = 1.0	310/300 = 1.0	289/350 = 1.2	405/343 = 1.2	401/386 = 1.0
GUJRANWALA			150/132 = 1.2	162/142 = 1.1	356/335 = 1.1	216/189 = 1.1	478/383 = 1.2	551/405 = 1.4
FAISALABAD				86/83 = 1.0	224/202 = 1.1	385/230 = 1.7	310/258 = 1.2	336/280 = 1.2
SARGODHA					259/236 = 1.1	266/168 = 1.6	334/305 = 1.2	316/295 = 1.1
MULTAN						547/398 = 1.4	95/86 = 1.1	91/83 = 1.1
RAWALPINDI							643/473 = 1.4	638/450 = 1.4
MAHAWALPUR								186/136 = 1.4

- N.W.F.P. -

	PESHAWAR	ABBOTTABAD	KOHAT	SAIDU	D.I. KHAN
PESHAWAR		190/155 = 1.2	64/48 = 1.3	181/120 = 1.5	330/248 = 1.3
ABBOTTABAD			254/173 = 1.5	228/152 = 1.5	522/333 = 1.5
KOHAT				245/153 = 1.5	266/198 = 1.3
SAIDU					511/345 = 1.4

- BALUCHISTAN -

	QUETTA	SIBI	TURBAT	LORALAI	KHUZDAR
QUETTA		148/106 = 1.4	815/594 = 1.4	217/153 = 1.4	318/264 = 1.2
SIBI			805/603 = 1.3	155/133 = 1.2	308/227 = 1.4
TURBAT				997/720 = 1.4	476/394 = 1.2
LORALAI					535/338 = 1.6

- SIND -

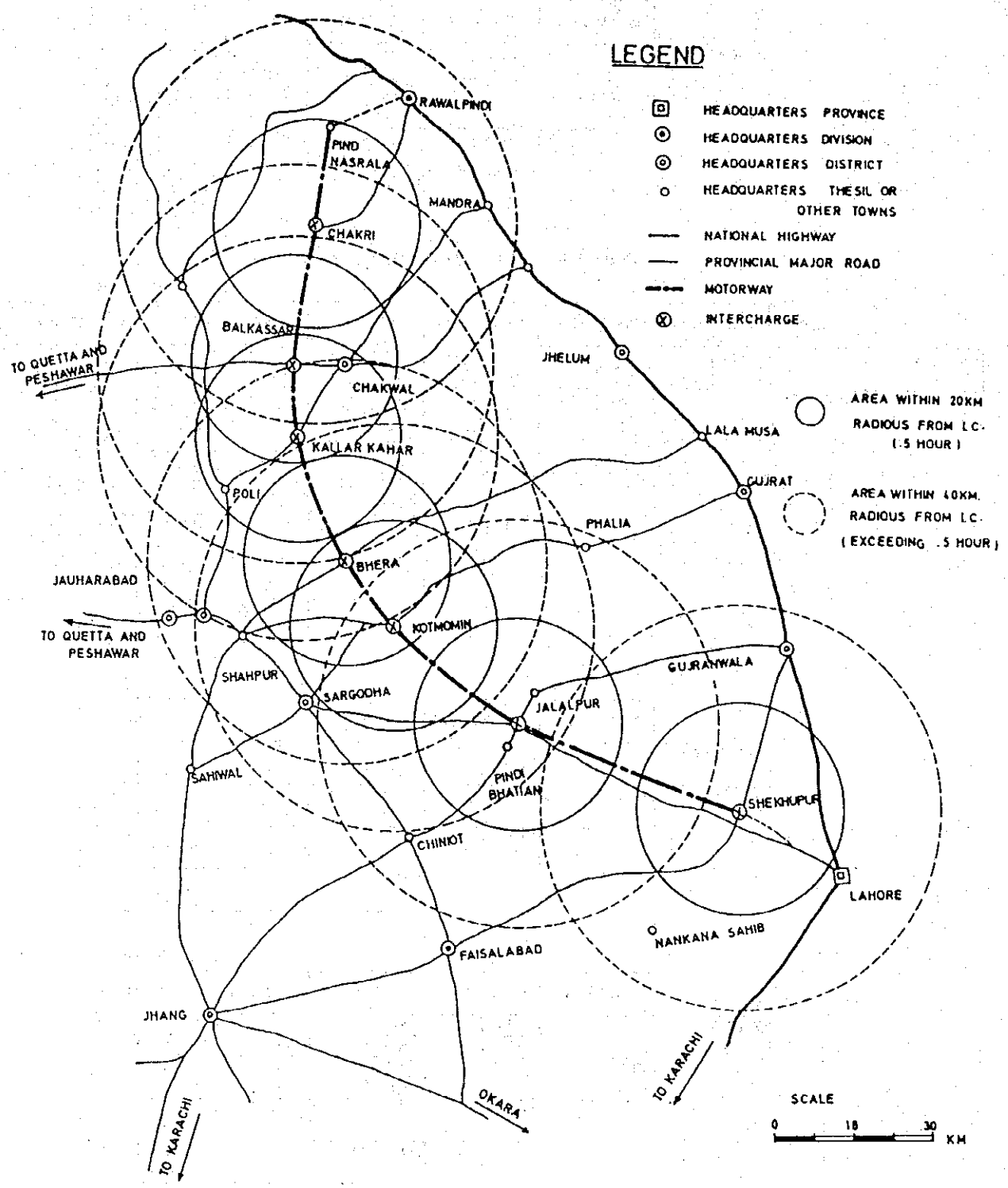
	HYDERABAD
KARACHI	165/152 = 1.1

NOTE :

A/B	C

A : ROAD DISTANCE
B : AERIAL DISTANCE
C : DETOUR RATE

Figure 4.1.8 Areas within 20km and 40km Radius from Intercharges on the Moterway



4.1.2 Road Traffic

(1) Traffic Count Data 1989 and 1992

Traffic count data in 1989 and 1992 on national highways and provincial roads of Punjab and NWFP are shown in Appendix Table 4.1.2 and 4.1.3 respectively. Figure 4.1.9 shows changes in volume on selected survey points. Province of Sindh did not edit the data when the team visited and Balochistan did not conduct regular traffic counts on the provincial highways.

(2) Traffic on National Highways

As shown in Appendix Table 4.1.2, vehicle traffic on national highways increased by 18% from 1989 to 1992 as a whole for the total of motorized vehicles (5.7% per annum on average; 4.7% for cars, 5.2% for buses and 7.1% for trucks). The growth pattern is different among routes and sections as well. Growth rates increased during the years 1989-92 when compared with mid-1980s. According to Appendix Table 1.3.2 in the previous National Transport Study (JICA, 1988), which shows selected traffic count data on Route N-5, the averaged annual rate of increase was 2.2% during 1982-86, but the ratio became 5.7% during the years from 1989 to 1992.

1) The newly classified route N-70, connecting Multan with Q.Saifullah showed a decline in volume except for trucks.

2) On the most important route of the country, N-5, the bus showed the largest growth among the classified vehicles, while the bus on Punjab Provincial highways had small/negative rates of growth in the same period.

(3) Traffic on Provincial Roads

Appendix Table 4.1.3 shows traffic count data selected from the files of Punjab and NWFP Provinces.

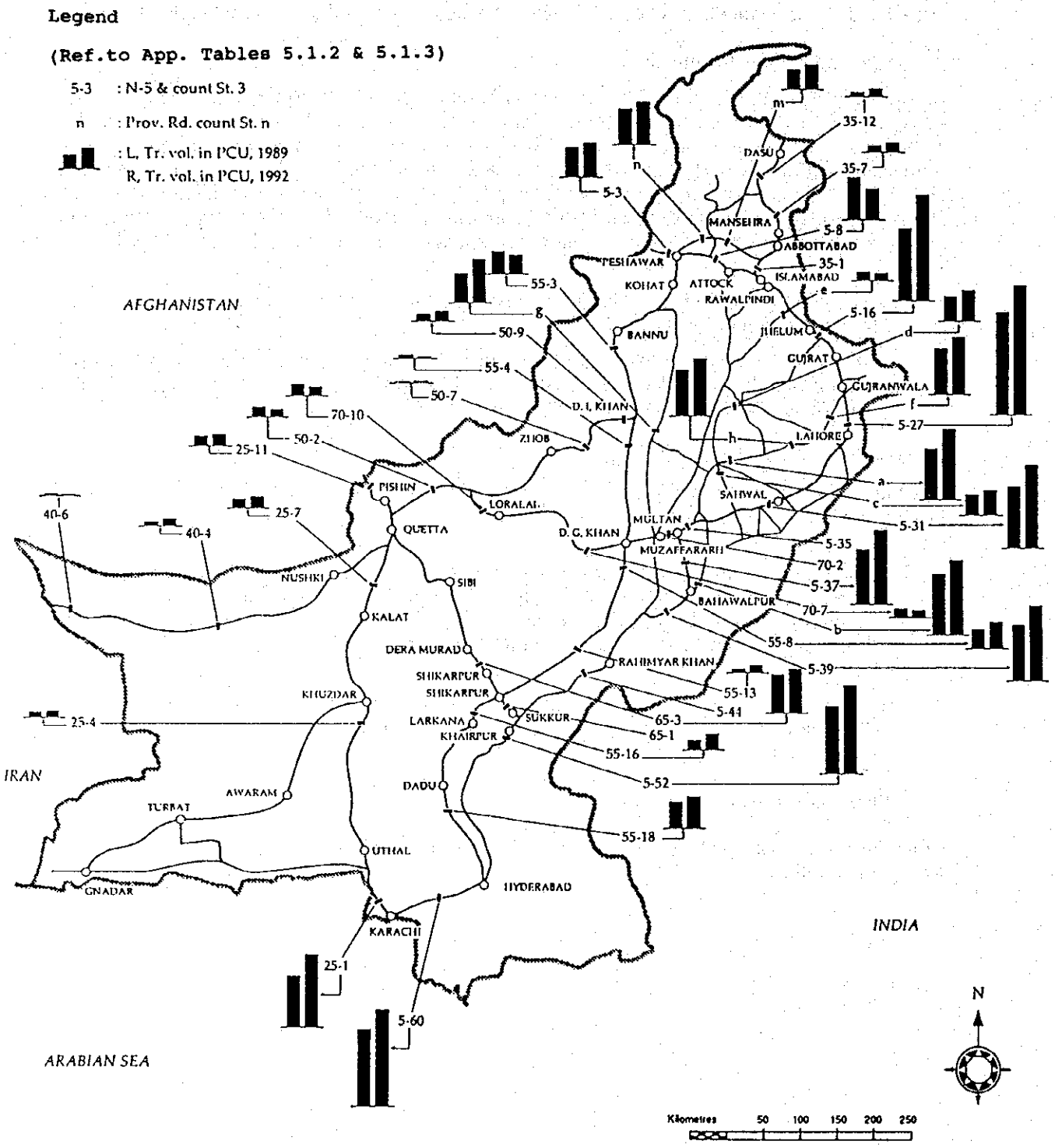
1) The total of motorized traffic increased by 24%, at a rate of 7.4% per annum in the period; cars at 9.1%, bus at 1.3% and trucks at 6.2%. High rates of increase were found for cars but low or negative rates for buses. Low rates of growth of buses were found on provincial road sections around Multan and Gujranwara.

2) C&W of NWFP has conducted traffic count surveys every year in the past. But the surveys did not cover the whole province; the southern part has not been covered by the surveys.

(4) Other Characteristics of Traffic

Other characteristics found in the Road Traffic Origin & Destination Survey 1990 (NTRC, 1992) are as follows:

Figure 4.1.9 Traffic Count Location and Volumes,1989 and 1992 (selected locations)



1) Peak hour

Peak hour volumes appear frequently around 3-5 p.m. covering one third of the count stations where OD survey was conducted in 1990. The peak hour ratio was calculated at 7.5% of the daily volume in 1990.

2) Vehicle composition

The overall vehicle composition of the traffic observed in the two surveys in 1980 and 1990 is shown in Table 4.1.6. The decrease in the proportion of buses is nearly offset by the increase of wagon/pickup. The two types are competing. As shown in Appendix Tables 4.1.2 and 4.1.3, buses on N-5 increased at an average rate of 9.2% per annum from 1989 to 1992, while on other national highways and provincial roads buses showed no increase in those years. Buses are beeing substituted by wagons; only in long distance routes along N-5, they remain and increase the service.

3) Passenger loads

Averaged passenger loads have increased for all categories of vehicles from 1980 to 1990 although the increase in cars is marginal. This might be due to sampling variations (Table 4.1.7).

Table 4.1.6 Composition of Vehicle in Percent

Vehicles	1980	1990	Difference
M/C	4.4%	3.5%	-1.0%
Cars	16.9%	20.4%	3.5%
Wag/Pkup	10.7%	16.8%	6.1%
Buses	18.8%	11.7%	-7.1%
Trucks	47.0%	46.0%	-0.9%
Others	2.2%	1.6%	-0.6%
Total	100.0%	100.0%	0.0%

Source : Road Traffic Origin & Destination Survey 1990 (NTRC, 1992)

Table 4.1.7 Average Passenger Loads, 1980 & 1990

Vehicles	1980	1990	Difference
M/C	...	1.8	...
Car	3.2	3.3	0.1
Wagon	12.0	14.1	2.1
Bus	38.4	42.7	4.3

Source : Road Traffic Origin & Destination Survey 1990 (NTRC,1992)

4) Overall growth of inter-city traffic

The total trips in OD matrices of the previous JICA study 1988 and those updated for 1993 are compared to see the overall tendency of increase from 1986 to 1993. The comparable figures are in Table 4.1.8 where the total vehicle trips are found to have increased 11.6% per annum. The lowest rate of increase is found for bus trips which had a rate of 2.3%, while small- cars and trucks increased at 13% and 16% in the period.

Table 4.1.8 Origin Destination Trips, 1986 & 1993 (Vehicle Trips)

Vehicle Type	Vehicle Trips / Day 1986	1993	Total Increase	Annual Increase
Small Car	33,125	76,377	230.6%	12.7%
Bus	18,583	22,389	120.5%	2.7%
Truck	19,177	53,739	280.2%	15.9%
Total	70,855	152,505	215.1%	11.6%

Source : Road Traffic Origin & Destination Survey 1990 (NTRC, 1992) and the files on NTRC

The higher rates of growth in the table above are not exactly the same as indicated in other data, for example statistical data of vehicles on roads which showed a 9% p.a. increase from 1988 to 93. It should be noted that annual increase rates in Table 4.1.8 are not used for the forecast of trips in th future.

4.1.3 Administration System

(1) Federal

The Ministry of Communications (MOC) is the authority responsible for ports and shipping agencies, NHA, telephones and post service. Within the MOC, the National Highway Board was established in 1978 to encourage the smooth development and rehabilitation of the national highways and other strategic roads. The National Highway Board was converted into the National Highway Authority (NHA) in 1991. Subsequently, the National Highway Council was established to approve the plans and projects prepared by the NHA, with the Prime Minister as its chair person. Ministries of Local Government and Rural Development are also the council members through whom the council can authorize rural road development. The NHA also has four regional offices (Lahore, Karachi, Quetta, Peshawar) in the country. Except for routine maintenance, works for improvement and repairing are executed by contractors by bidding procedure. The administrative organization charts of NHA is shown in Appendix Figure 4.1.1.

(2) Provincial

The Communication and Works Department of the Provincial Government (PCWD) is responsible for the construction and maintenance of the provincial roads. And except urgent repair works, most field works are implemented by contractors after a bidding procedure. PCWD is divided into Provincial Circles headed by a Superintendent Engineer and the circles are subdivided into Divisions headed by an Executive Engineer. The Divisions are further subdivided into Subdivisions headed by a Subdivisional Officer. As an example, the administrative organization chart of PCWD, Punjab is shown in Appendix Figure 4.1.2.

4.1.4 Road Maintenance

In Pakistan, the maintenance system of the national highways consists of routine maintenance (once per year) and periodic maintenance (once per 3 years). These maintenance expenditures incurred and maintained road lengths were Rs.240 million (4,500km) and Rs.129 million (5,000km), respectively, from 1993 to 1994. However, due to increasing maintenance costs throughout the country, it is necessary to modernize the maintenance system, such as rationalizing the maintenance budget by providing maintenance funds on the basis of actual field measurements.

For this reason, NHA has been implementing the Maintenance Backlog Reduction Program (MBRP) and the Resurfacing and Strengthening Program (RSP) at a total cost of Rs. 3.2 billion, equivalent to approximately US$ 110 million from 1991 to 1996. These programs consist of surveys of existing conditions, filing the data for every 1 km section into a computer system, assessing scores in the data, making up programs and designs for rehabilitation, and implementing the programs. Implementation of the programs consists of:

1) Routine Maintenance

Those ordinary maintenance activities which are required once or more times each year to preserve pavements, structures, shoulders, drains and verges against the combined effects of traffic, climate and topography.

For example : - filling of potholes, patches using surface treatment / asphalt, bringing shoulders to required level, clearing of drains / culverts, painting of parapets, etc.

2) Periodic Maintenance

Those ordinary maintenance activities which are required once every two or more years only to reinstate the pavements, structures, shoulders, drains and verges to the conditions they were in at the time of construction, or subsequent reconstruction.

For example : - minor overlays in surface dressing, major overlays in asphaltic concrete on those sections not requiring the base structure to be repaired, shoulder leveling, minor bridge/culvert/drain repairs etc.

3) Rehabilitation / Improvement

Rehabilitation is an extraordinary maintenance activity which may be required intermittently to catch up with any backlog of scheduled routine and periodic maintenance activities.

For example : - major pavement and structural works, like complete strengthening of bases, sub-bases and overlaying. Rebuilding of very badly damaged or collapsed structures.

4) Improvement

Improvement are those extraordinary maintenance (minor improvement), or development (major improvement) activities, which may be required intermittently to strengthen or widen those roads and structures which have been rendered under- designed due to increases in traffic or axle loads. This can also involve modifying the geometric layout of the road to suit the modern conditions.

These programs currently cover the national highway sections of 6,600 km in total by NHA and are not yet extended to provincial highway network in total of 68,100 km which also require similar rehabilitation works. At present provincial C&Ws are in charge of maintenance and repair of the roads under their administration, but have not prepared the inventory data files which would show the surface conditions and others section by section. The inventory filing system should be established with updating practice, and a program of rehabilitation for some years should be studied and implemented by province in a similar way as the new maintenance program of NHA.

4.1.5 Development in the 7th, 8th FYPs and Motorways

(1) Completion of the 7th FYP

The public sector development program in the 7th FYP was allocated of Rs. 61.5 billion for the development of transport and communication (Rs. 53.81 billion for the federal and Rs. 7.69 billion for the provinces). Within this, a road development program which aimed at improvement and widening of the national highway or provincial roads had an allocation of Rs. 27.44 billion. Against the above 7th FYP allocation for the national highway / provincial roads, the expenditure actually incurred was Rs. 36.6 billion as shown in Table 4.1.9.

Table 4.1.9 Project Expenditure of 7th Five Year Plan

(Rs.billion)

Five Year Plan / Province	Expenditure of 7th Five Year Plan	
	Federal Government 1/	Provincial Government
Punjab		8.36
Sind	20.09	4.37
Baluchistan		1.31
NWFP & Others		2.44
Total	20.09	16.48

Souce: C & W of each province, February,1994.

The main road programs and their progress in the Federal Government budget were as follows:

The first program was dualization of route N-5 in addition to improvement of existing road / bridge ; widening / realignment of route N-55 (Indus Highway) ; widening / improvement of national highways and some provincial roads to be executed by NHA. Figure 4.1.7 shows the progress of these highways.

The second program was a long prospect plan to construct a motor way as a north - south link in the country joining Karachi with Lahore via Dera Ghazi Khan - Multan - Faisalabad and extending up to Islamabad and Peshawar. At present, Islamabad - Lahore, which is 335kms in length, is scheduled to be complete by the end of 1995.

The third program was the inclusion of private sector funding for road construction. However, the dualization of the Kharian - Rawalpindi and Chablat - Nowshera sections, which was to be a pilot project did not evoke a favorable response, and therefore it was decided to carry out this work using public sector funding.

The fourth program was the first formal attempt to address the program of the delay of maintenance by launching two maintenance cum rehabilitation projects, namely 'MBRP & RSP' using a loan from World Bank. At present, these projects are under way. NHA intends to extend this to cover the entire national highway network by using the next World Bank Loan or other funds.

(2) The 8th Five Year Plan

The 8th FYP was announced to thr public by Planning Commission in June, 1994, after it was authorized by new cabinet. It envisioned an allocation of Rs. 74.7 billion for the road development projects under which 335km of new Motorway will be constructed and 4,659km of the existing roads upgraded, rehabilitated, dualized and improved, to be worked out by National Highway Authority. The work would cover not only national highways but also selected provincial highways. Other roads under provincial governments are not presented in the 8th FYP of the federal government. The projects to be implemented by NHA during 1993-94 - 1997-98 are shown in Table 4.1.10 at the total of Rs.74.7 billion at 1992/93 prices and their locations and lengths are shown in Tables 4.1.11 ~ 4.1.13 and Figure 4.1.12. Of the projects a major change occurred in the motorway project; the scale has been reduced only to the construction between Lahore and Islamabad. Construction of M-2 and other extensions are postponed for the future.

Table 4.1.10 Projects by NHA for the 8th FYP

Project Name	The 8th FYP Rs. million
(a) Program for Improvement and Widening for increasing the capacity of existing system	14,851
(b) Maintenance Backlog Reduction Program	1,641
(c) Resurfacing and Strengthening Program	773
(d) Improvement of Indus Highway N-55	15,745
(e) Fourth Highway Projects	1,904
(f) Darization of National Highway (N-5)	20,054
(g) Lahore Bypass	2,870
(h) Lahore-Islamabad Moterway	9,460
(i) Kohat Tunnel	1,800
(j) Coastal Road	2,000
(k) Lowari Tunnel	2,000
(l) Other Projects	1,589
Total	74,687

Source : Eighth Five Year plan (1993-98) Report
by Planning Commission, Government of Pakistan.

Table 4.1.11 Breakdown of 8th FYP (a)

Route No.	Location	Length (km)	Allocation (million)
N 25	Uthal-Bela	68	14,851
	Kararo-Wadh	89	
	Wadh-Saryab	160	
	Saryyab-Kalat	80	
	Kalat-Chaman	204	
N 35	Mansehara-Khunjerab	750	
N 40	Mastung-Noshki-Dalbandin	307	
	Dalbandin-Nokundi	85	
	Nokundi-Taftan	41	
N 50	Dhanesar-Mvghalkot	13	
	Mughalkot-Dlkhan	136	
N70	Qilla Saifullah-DGKhan	447	

Source : Eighth Five Year Plan (1993-98) Report by planning Commission.

Table 4.1.11 Breakdown of 8th FYP (b)

RouteNo.	Location	Length (km)	Allocation (million)
N55	Peshawar-Karal	88	15,745
	Karak-Sarai Gambia	59	
	DG Khan-Retrajunction	108	
	Rajampur-Shori Nulah	95	
	Shori Nulah-Gauspur	76	
	Rotodero-Gauspur	99	
	Manhand-Jamshoro	65	

Source: Eighth Five Year Plan (1993-98) Report by Planning Commission

Table 4.1.13 Breakdown of 8th FYP (c)

Route No.	Location	Length (km)	Allocation (million)
	Hala-Rahimyar Khan	483	
	Bahawalpur-mianchamu	167	
N 5	Okara-Lahore	120	20,054
	Kharian-Rawalpindi	107	
	Chablat-Nowshera	72	

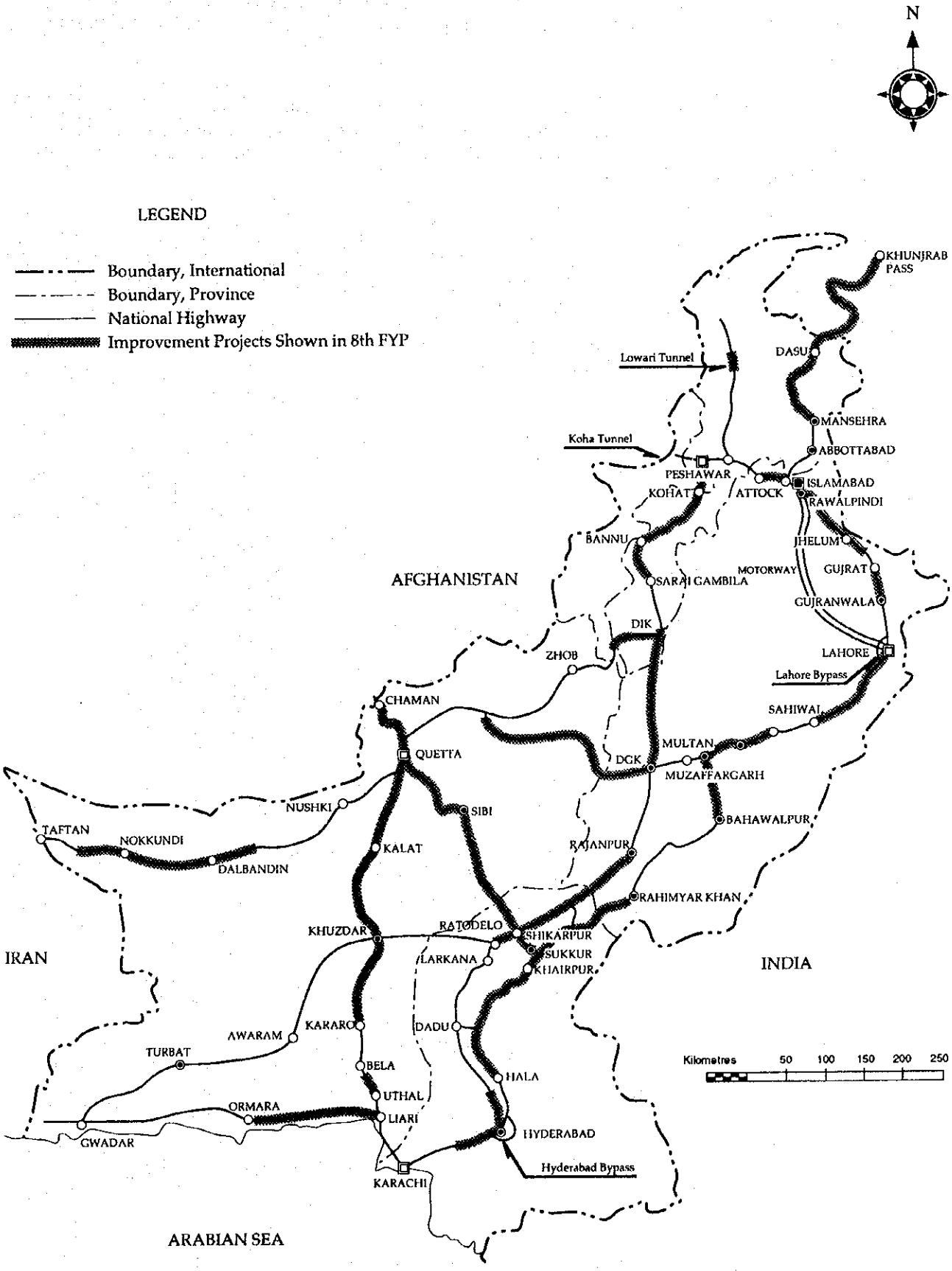
Source : Eighth Five Year Plan (1993-98) Report by Planning Commission.

(3) Motorway projects

A long range ambitious project is the construction of motorways which are designed at international criteria with 4-6 lanes, divided and access controlled. The motorways are expected to link major cities Karachi and Peshawar via Multan, Lahore, Islamabad. A westward extension is proposed from Ratodelo to Gwadar.

Lahore - Islamabad	335 km	under construction
Islamabad - Peshawar	165 km	Det. design completed
Sheikhupura - DG Khan	400 km	planned
DG Khan - Karachi	1000 km	grade up N-55 planned
Ratodelo - Gwadar	930 km	grade up Prov Rds. planned
Total	2830 km	

Figure 4.1.10 NHA Projects for Eighth Five Year Plan 1993-98

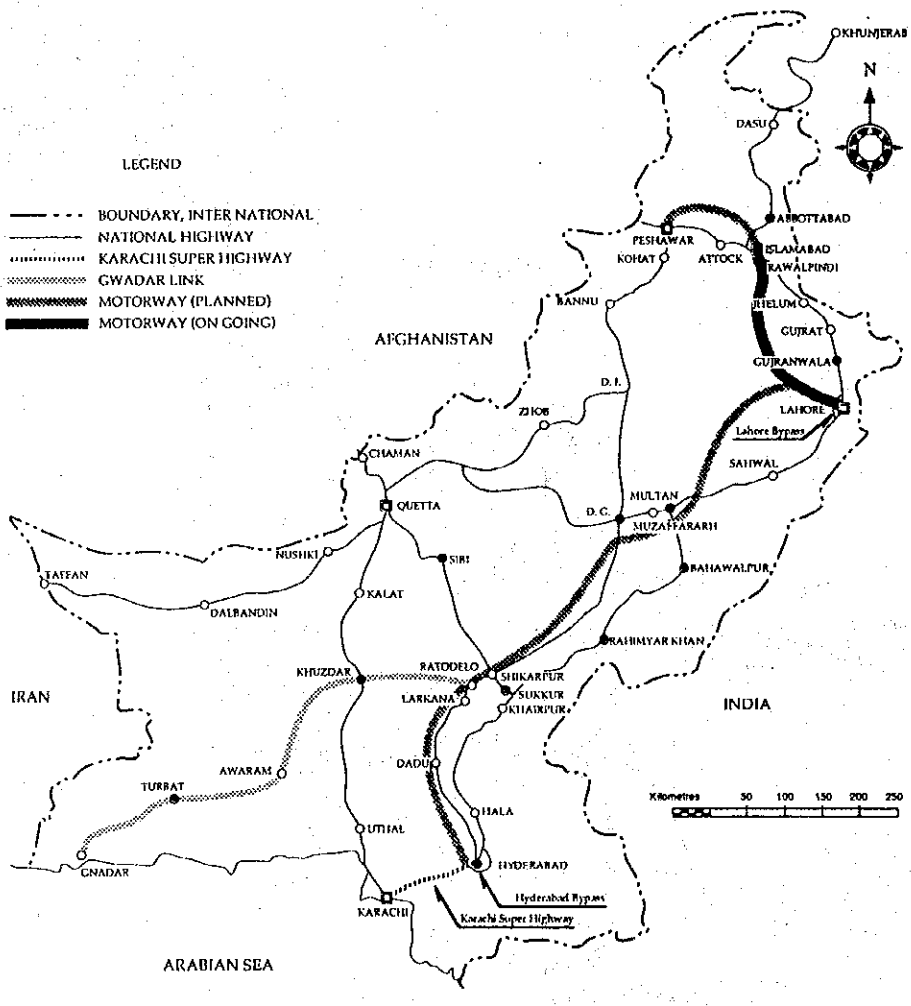


The conceptual network of the motorways is presented in Figure 4.1.11 of which the section between Lahore and Islamabad of 335 km is under construction to be completed by late 1995. However, construction of other sections was postponed in 1994 because of funding constraints of the government.

Study of the Arterial Highway Network of Pakistan to the year 2015 by HAAS Consult (November, 1993) also examined the plan and proposed a staged development of the network over more than 20 years starting from the 8th FYP. But, the staged program need to be revised by the government suspension in 1994.

Traffic estimate in this study up to 2006 indicates vehicle traffic demand will not become high to exceed the capacity of existing inter city trunk roads and would not be sufficient to support the feasibility of immediate construction of other sections. They shall be realized in years beyond 2007 under a long term development policy.

Figure 4.1.11 Motorway Plan



4.2 Road Standard

4.2.1. Functional Classification

The classification of roads can be carried out from various viewpoints; by administrative jurisdictional groupings such as national highways and provincial roads, by pavement types such as metalled (surfaced) roads and shingle roads (gravel-earth roads), and so on. In the past classification by service hierarchy such as primary - secondary - tertiary, basic applicable geometric design standards for each class were clear. However, this classification is not used extensively in statistical analysis of roads in relation to traffic, accidents, maintenance cost, physical formations, etc. In C&W of provinces, classification by surface type (paved and unpaved) and by administrative jurisdiction is used, but road classification by service hierarchy seems to be unused.

The road hierarchy in Pakistan can be essentially divided into two groups : major roads and minor roads, where each type can be further classified by various factors. NHA is responsible fotr most of key major roads and Provincial C&Ws and local authorities for other roads. In the previous NTPS (JICA, 1988), a plan was recommended with a road classification system where each functional class has a few design types which are different in terms of road formation. After that, NHA had a committee meeting in February, 1992, and devised a table of road standards for six road types, which differs a little from the JICA study of 1988. The NHA's standards are shown in Appendix Table 4.2.1. Those tables categorize geometric standards into several types.

In this 1994 study, review of past studies was conducted to reclassify the roads, design standards, traffic capacities, etc. The functions were defined taking into account the corridor, city size, network characteristics, administrative system, traffic, social/economic potential, education, welfare, etc.

It should be understood that each function category of road has several types of geometric standards, since the classified road usually extends for distances with sections having different service features due to physical conditions, economic activities, and traffic flow. The function classification is summarized as follows;

- Motor way -

They are divided highways with full access control, allowing high speed travel. They will be developed to connect the national capital, provincial headquarters, international seaports and airports, and other important areas of political, economic and cultural activity. Highways classified in this category are routes that form part of the basic framework of the national trunk road network and are designed to provide high speed and long distance travel, and smooth traffic flow. And they are initially constructed as 4-lane divided roads with provision for the addition of one or more lanes on each carriage way.

At the moment, a motorway between Islamabad and Lahore of 335km (M-1) is under construction with a program to be completed by the year 1995. Studies and works for other motorways were suspended by the Government in 1994.

- Primary Road -

They are roads that form part of the basic framework of the national trunk road network or cater for movements between provinces or divisions. And they provide relatively high speed travel with minimum interference for through traffic movements. They are divided in three categories i.e. primary road I , primary road II and primary road III.

The primary road I consists of a network with the following service characteristics :

- Corridor movement with trip length and density suitable for substantial national and inter-province travel,
- Movement between national capital and provincial headquarters,
- Linkage to international seaports, airport and major international boundary connections.

The primary II and III consist of a network with the following service characteristics in line with the primary I.

- Movements between the provincial headquarters and between the divisional headquarters and linkage to other major traffic generators such as industry or resort areas.
- Providing alternative route to the primary I.

Primary III is separated from primary I and II by the traffic movement within a province rather than between provinces.

- Secondary Roads -

They are roads which serve as feeder roads for the primary roads. They cater for movement between districts with relatively short trip lengths. These roads thus cater to many trips related to daily movements in a community.

- Tertiary Roads -

They are formed to extend the benefits of fast and reliable communications to the agriculture areas, and they are basically of low volume road and their primary function is to serve as a collector road for the secondary network.

The functional road classification has also been identified using the Pakistan functional urban hierarchy as shown in Figure 4.2.1. Table 4.2.1 shows network and traffic characteristics for each road function. Classification proposed in 4.2.5 of this chapter uses Primary I to III classes.

Figure 4.2.1 Relationship between the Urban Hierarchy and Proposed Functional Road Classification

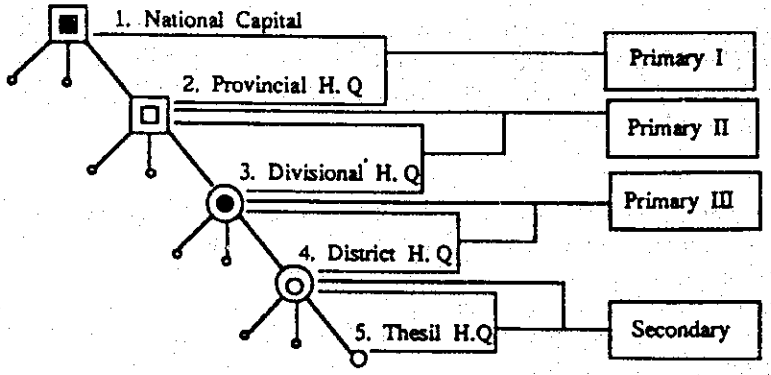


Table 4.2.1 Proposed Road Function Classification (Inter-City)

CLASSIFICATION OF ROAD		NET WORK CHARACTERISTICS					TRAFFIC CHARACTERISTIC								
		TRAVEL ACTIVITY SERVICED			ADMINISTRATIVE CLASSIFICATION		TRIP LENGTH			TRAFFIC VOLUME			SPEED		
		INTER PROVINCE	INTER DIVISION	INTER DISTRUCT	NATIONAL HIGHWAY	PROVINCIAL ROAD	LONG	MEDIUM	SHORT	LARGE	MIDIUM	SMALL	HIGH	MEDIUM	LOW
MOTORWAY / EXPRESS WAY	1	◎			◎		◎	○		◎	○		◎	○	
PRIMARY I	2	◎			◎		◎	○		◎	○		◎	○	
PRIMARY II	3	◎	○		○	◎	○	◎		○	◎		○	◎	
PRIMARY III	4	○	◎			◎		○	◎		○	◎		◎	○
SECONDARY	5		○	◎		◎			◎			◎			◎

Source : JICA Study, 1994. ABBREVIATION ◎ : Normal ○ : Extended

4.2.2 Geometric Road Standards

Principal design standards for roads were drafted and agreed by the NHA committee in February 1992, which are shown in Appendix Table 4.2.1. The NHA's standard table presents selected indices for the six road types. The indices have been reviewed in this JICA study and the maximum daily traffic capacity in pcu / day was revised as discussed in Appendix Note 4.2.1. The results are shown in Table 4.2.2. The relationship between the functional classification and design standard types is shown in Table 4.2.3. The table indicates that a classified road may be divided into several sections, and those sections can have different road types. The reasons for these different road types are natural conditions, changes in land use and/or traffic volume among the sections, etc.

In reality, application of these standards is limited to new construction and large-scale improvement because of physical, socio-economic, and budgetary constraints. However, it is desirable that a road which falls into one category has a uniform road standard and that, for the benefit of traffic, all sections of the road are made following the same road standard. It may require many years to bring a conformity between the classification and the standards, but there will be user benefits generated by this kind of conformity. There will be difficulty if the national highway network is improved following the standardization policy in a short period since it requires a great deal of money. But, the classification system would be beneficial for supplying uniform service to vehicles and users, and NHA and provincial C&W can utilize the data such as road conditions, traffic, accidents, etc. for planning and programing. Keeping and updating the data would give the administration a sound base for road development and maintenance policies.

On the other hand, the provinces have different road types and no functional classification has been used yet. Road administration needs to be restructured so that the whole road system can meet the growing traffic demand. Filing system for road and traffic data, road classification and road standards should be strengthened and clarified.

Coordination between NHA and provincial C&W Departments should be encouraged in order to have common policies and a data sharing system.

Table 4.2.2 Proposed Design Standard

Design Classification		Number of Lanes	Design Speed (km/h)	Planning Guideline: Traffic Volume Limits (Max) (PCU/Day)	Planning Guideline: Levels of Service	Planning Guideline: V/C Ratio	Planning Guideline: Carriage Way Width (m)	Typical Cross Section: Shoulder Width (m)	Typical Cross Section: Median Width (m)	Typical Cross Section: Formation Width (m)	Typical Cross Section: Row (m)	Type of Pavement
Motorway Expressway		4 Lanes Divided Access Controlled	F: 120 H: 90	86,000	C	-	14.60	3.50	Variable	32.00 Minimum	100.00	AC or CC
Class I	①	4 Lanes Divided	F: 110 H: 100 M: 80	75,000	C	0.70	14.60	3.00	Variable	27.60 Minimum	63.00	AC
Class II	②	2 Lanes Hard Shoulder	F: 100 H: 80 M: 60	19,000	C	0.70	7.30	3.00	-	15.30	63.00	AC
Crass III	③	2 Lanes Soft Shoulder	F: 100 H: 80 M: 60	19,000	C	0.70	7.30	3.00	-	15.30	63.00	A/TST
Crass IV	④	2 Lanes Soft Shoulder	F: 80 H: 60 M: 50	16,000	C	0.70	6.00	3.00	-	14.00	33.00	A/TST
Class v	⑤	1 Lane Soft Shoulder	F: 60 H: 50 M: 40	3,150	D	0.85	3.63	2.00	-	9.70	25.00	TST

Source : JICA Study, 1994.

Abbreviation
F : Flat
H : Hilly
M : Mountains
AC : Asphalt Concrete
TST : Triple Surface Treatment
CC : Cement Concrete

Table 4.2.3 Functional Classification and Design Standard (Inter City)

Functional Classification of Road		Design Standard: Motorway Expressway	Class I	Class II	Class III	Class IV	Class V
Motorway Expressway	①	◎	-	-	-	-	-
Primary I	②	-	◎	◎	○	-	-
Primary II	③	-	-	○	◎	○	-
Primary III	④	-	-	-	-	◎	-
Secondary	⑤	-	-	-	-	◎	○
Tertiary	⑥	-	-	-	-	○	◎

Source : JICA Study, 1994.

Abbreviation
◎ : Preferred Standard
○ : Possible Standard
- : Not Acceptable

4.2.3 Pavement Standard

Pavements of roads in Pakistan are designed to the standards set forth in the AASHTO GUIDE for Design of Pavement Structures 1986. Pavements for motor ways are designed for a design life of 20 years, and all other roads are designed for a design life of 10 years. Equivalent standard axles (ESAL) are one of the two principal factors (ESAL,Design CBR) determining the pavement design, and this is to be calculated by conversion to a standard axle of 18,000 lbs (8,165 kgs).

Currently, road damages caused by overloading exceeding the rear axle load of 8,165kgs adopted in Pakistan has given rise to increased maintenance costs and a shortening of pavement life. Therefore, the following should be conducted :

- Axle load surveys to find the actual truck loading practices,
- Determine new pavement design parameters and models revised according to the surveys,
- Enactment of regulation to control excessive truck loading over the determined axle loads.

Current world wide regulation on the range of magnitudes for standard axle load is shown in the Table 4.2.4. It is an urgent necessity to develop a policy which takes into acount the practical and fair regulation to control over-loading and simultaneous revision of pavement design criteria.

Table 4.2.4 Current Regulations World Wide on Standard Axle Load

Country Name	Single Axle (Tones)	Tandem Axle (Tones)
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
Luxembuorg	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

Source : International Road Federation, 1989

4.2.4 Traffic Capacity

In Pakistan road capacity is estimated, when need arises, by applying the method of Highway Capacity Manual (TRB, 1985), where different Pakistanese traffic characteristics from the USA have been taken into consideration. In the previous National Transport Study (JICA, 1988) a table of standard road capacity was proposed which would be used as a base in the country. National Highway Authority has been examining basic road standards by classifying roads into several classes in 1992, and the basic standards were agreed by the committee in NHA. Meanwhile, NTRC has studied the road capacity in the past. An example is "Planning Standards for Roads in Pakistan (NTRC-157, 1992)".

Since the beginning of this National Transport Plan Study in February 1994, discussions have been held with persons concerned in NHA, NTRC and Provincial C&W to make up a table showing basic capacities for different width roads in view of the studies mentioned above. The following Table 4.2.5 is the summary of those capacity by road type. The calculation process is shown in Appendix Note 4.2.1. This has been incorporated in the geometric standards in the section 4.2.2 of this chapter.

Table 4.2.5 Standard Road Capacity

(in pcu)

Roads	Lane No.	vol/tane	vi/hr	vol/day
		1) both wys.		CAPAi
M-way Acs. Cotr.	4 lanes	1,488	5,950	86,000
1 highway div	4 lanes	1,313	5,250	75,000
2 highway undiv	2 lanes	672	1,343	19,000
3 highway undiv	2 lanes	564	1,128	16,000
4 highway undiv	2 lanes	517	1,034	15,000
5 highway undiv	2 lanes	436	873	13,000
6 highway	1 lane	-	224	3,200

Source : JICA Study Team, 1994

It should be noted that this analysis is applicable to intercity roads. When roads to be studied are in urban areas, different values should be applied for parameters in Appendix Note 4.2.1, after checking local conditions and traffic data.

4.2.5. Application of Functional Classification and Geometric Standard

The Pakistani roads should be categorized by the functional classification discussed in 4.2.1 of this chapter. The proposed classification for the major roads are in Figure 4.2.3. and Appendix Table 4.1.5. Those are summarized in Table 4.2.6 and Fig 4.2.2-A. While the classification can be unchanged for many years as long as the regional economic structure is more or less stable, the road design standard for the classified route need to be revised to provide better service level because of various factors, such as engineering aspects, increased traffic, and so on.

Classification of roads by design standard has been stated in 4.2.2 of this chapter and a proposed classification is shown in Appendix Table 4.1.5. They are also summarized in Table 4.2.7 and Figure 4.2.2-B. Civil works to upgrade the class of roads may be technically feasible, but will require a large amount of investment. Since works cannot be done at once, the program should be placed as a long term target and be reviewed periodically by taking into account relevant data. .

Figure 4.2.2-A Roads by Function Classification

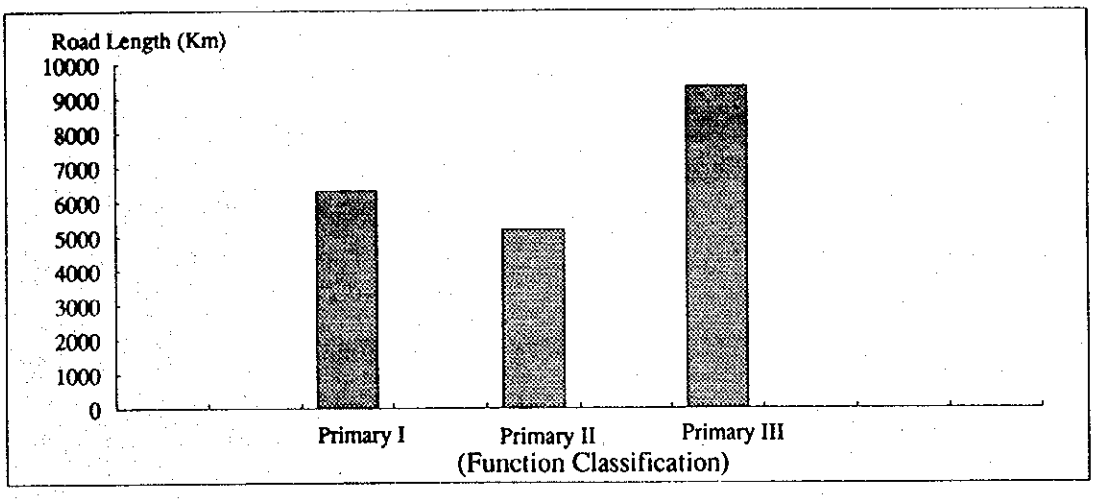


Figure 4.2.2-B Roads by Design Classifiction

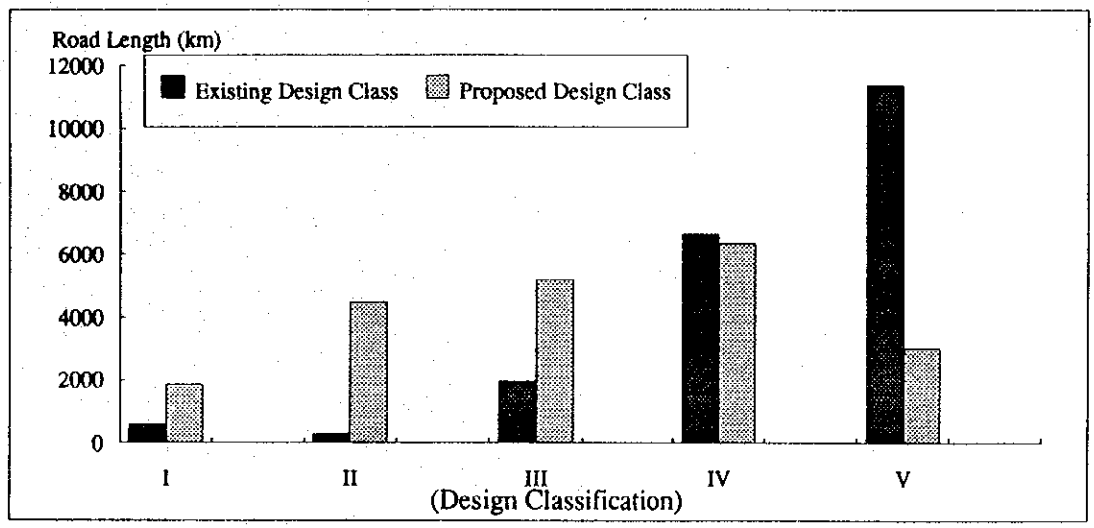


Table 4.2.6 Roads by Function Classification

(In Km)

Function Classification		Primary I	Primary II	Primary III	Secondary	Total
Road Length	0	6325	5216	9337	0	20878

Source : Appendix Table 5.1.5

Table 4.2.7 Roads by Design Classificatiom

(In Km)

Design Classification	I	II	III	IV	V	Total
Existing Design Class	596	300	1951	6664	11367	20878
	(2.9%)	(1.4%)	(9.3%)	(31.9%)	(54.5%)	(100.0%)
Proposed Design Class	1852	4471	5192	6352	3011	20878
	(8.9%)	(21.4%)	(24.9%)	(30.4%)	(14.4%)	(100.0%)

Source : Appendix Table 5.1.5

Figure 4.2.3 Proposed Function Classification of the Major Roads

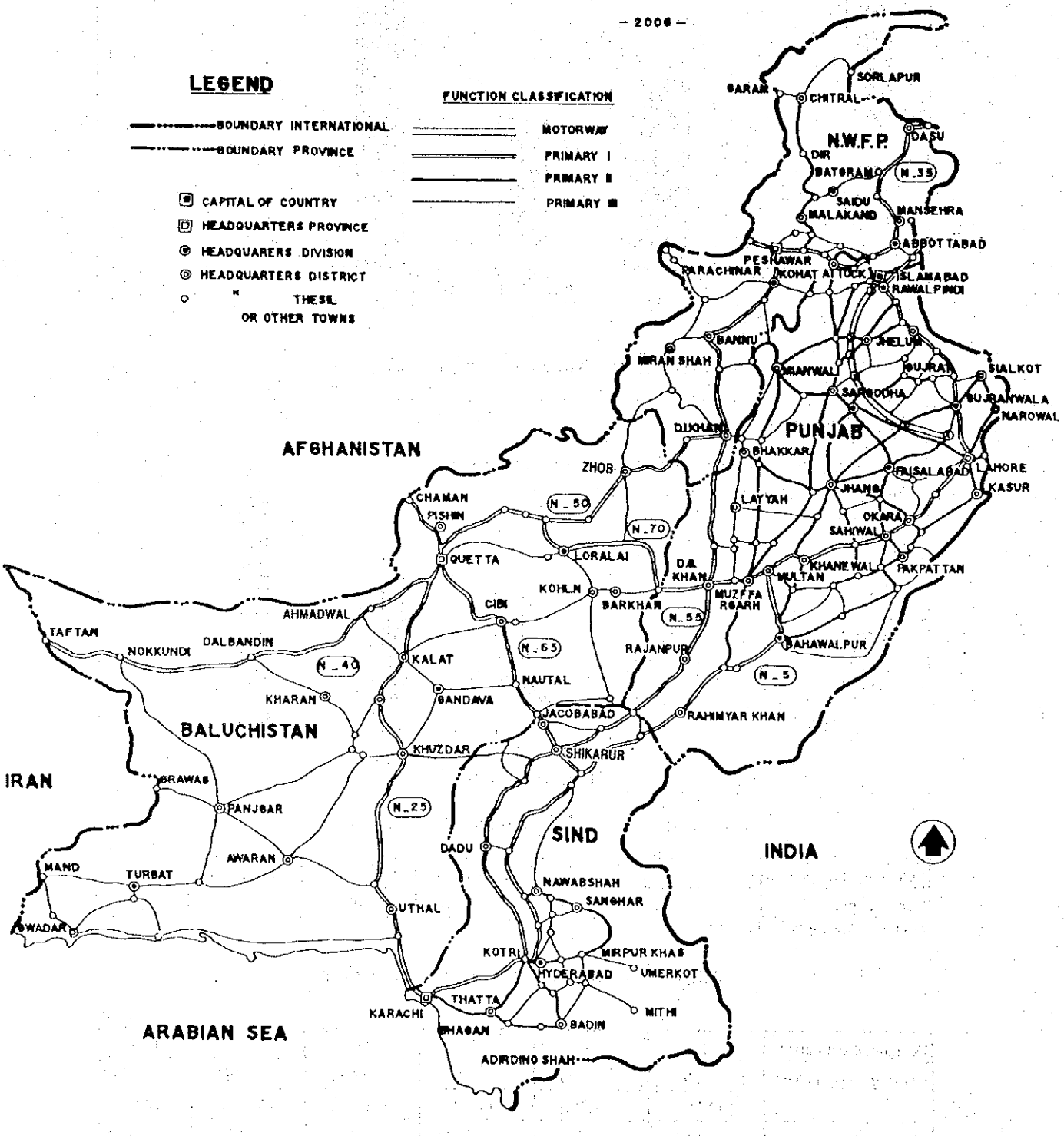
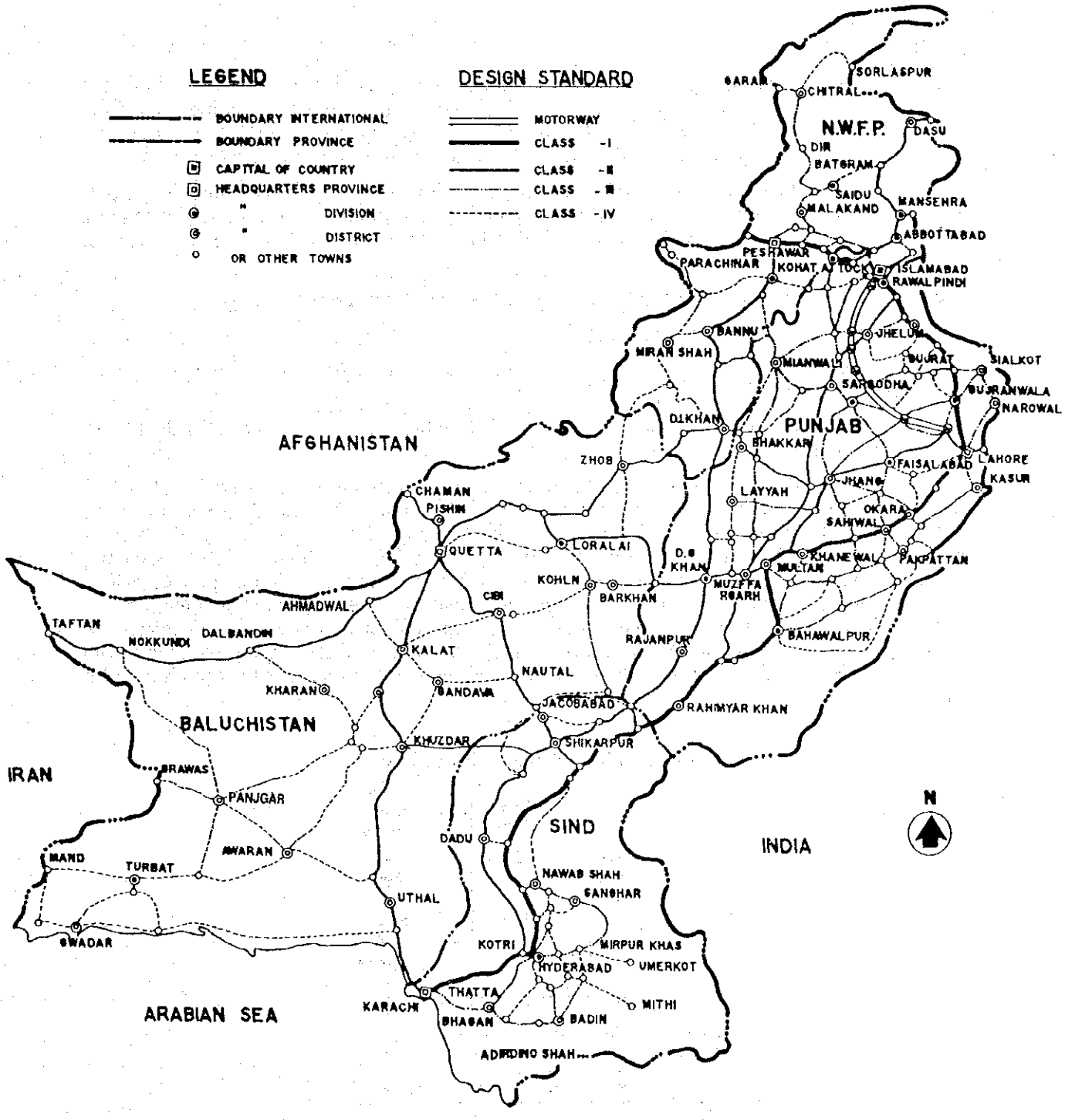


Figure 4.2.4 Proposed Design Standard of the Major Roads



4.3 Road Development Plans

4.3.1 Approach

(1) Background

The road development master plan is usually processed out through the steps shown in Figure 4.3.1. Alternative network plans should be formulated for the purpose of comparison from various viewpoints. Cost should be estimated enabling realistic alternatives to emerge. An economic benefit/cost analysis is conducted for the selection of most economical projects.

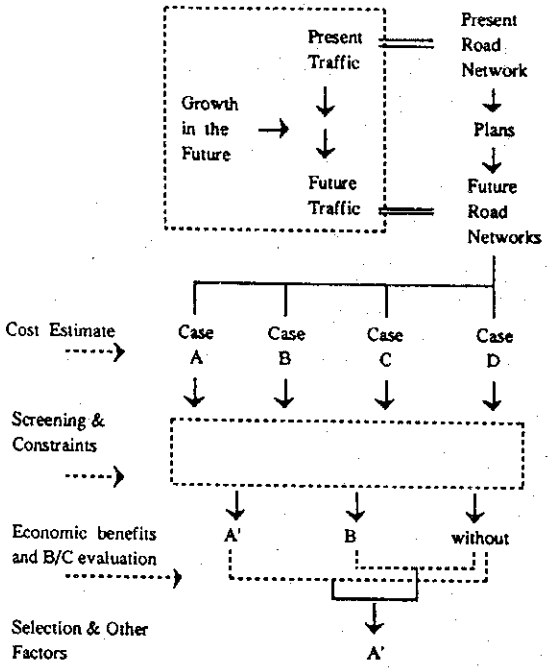
In Pakistan, road development has gained a top priority for the federal government in the past decade because railway service was not well maintained and users tended to depend mainly on road transport even over long distances. Road vehicles have increased at an average rate of 9% per annum.

The Federal government responded to this demand increase by measures such as :

1) Conversion of NHB to NHA in 1991.
2) A four year program of Rs. 81.95 billion for 1991-95 to improve national highways and other trunk roads.
3) Construction of an access-controlled motor way between Lahore and Islamabad. 335 km long to be completed in 1995.

Regarding the federal government's road budget, planned expenditures increased from Rs. 25.5 billion of the 7th FYP to 74.7 billion of the 8th FYP (290%). The rapid expansion of the budget has led to a number of projects being implemented in many places. Under the present circumstances, problem arises as to whether the on-going projects should be reassessed and recommendations given to continue until completion, halt the work for a certain period, change the design and cost and so on. This study considers that the review of major ongoing projects by the federal government is not necessary. It is expected that they will be completed on schedule. However, there are minor projects which have not been started yet and included in the analysis. This study may assess these projects and recommend them for the 8th FYP or 9th FYP.

Figure 4.3.1 Planning Procedure



(2) Committed Projects

There are several large-scale projects under way committed by NHA. Most of them depend on loans from WB, ADB, OECFJ and Korea as well as domestic funds from the federal government. They are targeted for completion in the 8th or 9th FYP. They are named "committed projects" in this study. Most committed projects are supposed to be completed in the 8th FYP and placed in the network of 1998 to formulate the "network with committed projects, 1998". Examples of those projects are construction of dual carriage way of N-5, improvement of N-55, Islamabad-Lahore Motor way, and others.

(3) Recommended Projects

The traffic assignment result on the network including the "committed projects" for 1998 was studied to find road sections showing the congestion (V/C) ratio of more than 1.0. Those are named "recommended projects" in a sense that the section should be improved/widened to have a larger capacity. If the assigned vehicles exceed the road's daily capacity, improvement work for the section is recommended to be executed in the 8th FYP.

4.3.2 Candidate Projects for Short-term 1993 - 1998

Figure 4.3.2, Table 4.3.1 and Appendix Table 4.3.1 present the recommended projects together with the "committed projects" for 1998. It should be noted that projects "committed and recommended" have taken into account on going projects to be completed by 1998 in the current 8th Five Year Plan period, but they are not exactly the same as the federal government plan. The reason is that recommended projects were selected by the result of traffic assignment, not directly from the FYP.

4.3.3 Candidate Projects for Medium-term 1999 - 2006

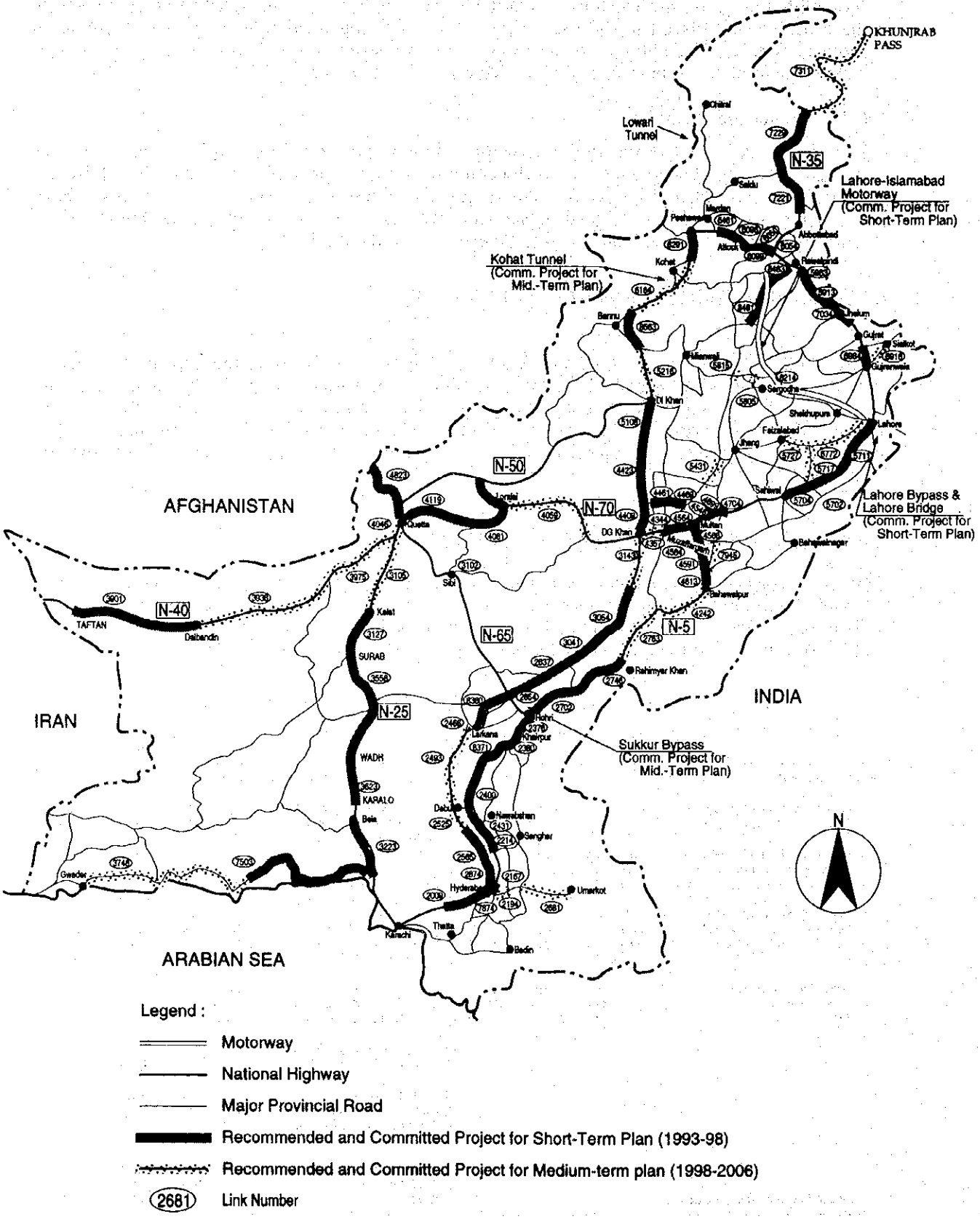
Candidate projects for the medium term (the 9th Five Year Plan period and the years up to 2005-06) were determined in the similar way as for the short term. Those are composed of "committed projects" and "recommended ones" to be completed by 2005-06. Examples of the committed projects for this period are Sukkur Bypass, the remaining sections of N-5 and N-55.

Table 4.3.1 Cost of Recommended Projects

(Cost in Rs million, 1993)

Short Term	Link	Km	Priject Cost (Rs Mill.) Fin.	Econ.	Medium term	Link	Km	Priject Cost (Rs Mill.) Fin.	Econ.
Reccomended Projects (The 8th FYP)					Reccomended Projects (Medium term period)				
1 N-70, Muzaf-Multan (4lanes)	4564	34	681.4	545.1	1 N-70, Muzaf-Ghazi G(4 lanes)	4344	23	461.0	368.8
Tot. Nat. Highways			681.4	545.1	2 N-70,Ghazi G-DGKhan(")	4357	34	1031.0	824.8
					3 N-70, Lorelai- Rakini (widen)	4059	189	1708.6	1366.9
2 Bal. Sanjawi-Loralqai(widen)	4081	27	159.3	127.4	Tot. Nat. Highways			3200.6	2560.48
3 Bal. Quetta-Sanjawi (widen)	4119	185	1091.5	873.2					
4 Pun. Chauk Munda - (widen)	4461	28	165.2	132.2	4 Hyderab-Tando (widen)	2194	36	721.4	577.1
					5 Umarkot-Mirpur (widen)	2681	74	637.9	510.3
5 Pun. - Cahauk Munda(widen)	4469	32	188.8	151.0					
6 Pun. Sihal - (widen)	8481	90	531.0	424.8	6 Atharan-Garh M (widen)	5431	44	330.4	264.3
7 Pun. - Rawalpindi(widen)	8483	40	236.0	188.8	7 Okara-(north) (widen)	5702	4	23.6	18.9
					8 Jalanwala- Okara (widen)	5717	59	348.1	278.5
Total Nat. Highways	-	34	681.4	545.1	9 Jalanwala- Faiza (widen)	5727	37	741.5	593.2
Total Province	-	402	2371.8	1897.4	10 Sargoda-(north) (widen)	5805	5	37.6	30.1
Total	-	436	3053.2	2442.6	11 Kushab-(east) (widen)	5815	3	52.6	42.1
					12 Jalanwala-(east) (widen)	6772	100	751.0	600.8
					13 Gujranw-Sialkot (widen)	6918	59	508.6	406.9
					14 Kotri-(south) (widen)	7874	10	86.2	69.0
					15 Gujranw-Kanewal (widen)	7945	57	428.1	342.5
					16 Sargoda-(north) (widen)	8214	17	146.5	117.2
					Total National Hiway.	-	248	3200.6	2560.5
					Total Province	-	505	4813.5	3850.8
Notes: Fin cost * 0.8 = Ec cost					Total	-	751	8014.1	6411.3

Figure 4.3.2 Recommended Projects for Short-term Plan and Medium-term Plan



4.4 Traffic Assignment

4.4.1 Highway Assignment

The assignment of vehicle OD trips on the highway network was conducted by System 2 computer software. System 2 was licensed to NTRC in this occasion of National Transport Plan Study (JICA, 1994). Program packages are installed in a desk-top computer in NTRC, together with the input and output files used in this study. The details of simulation by the computer are stated in Appendix 4.4.1 and the selected inputs and outputs are the followings:

1) Figure 4.4.1 Zoning (51 zones)

2) Figure 4.4.2 Road network linking the zones

3) Figure 4.4.3 A hardcopy of computer screen showing 1993 congestion on the 1993 network

4) Table 4.4.1 Summary of Trips, 1993, 1998 and 2006

5) Figure 4.4.4 and Table 4.4.2
Summary of assignment of traffic 1993, 1998 and 2006 on the existing network 1993. Those results demonstrate changes in road lengths classified by V/C ratio classes from 1993 to 1998 and 2006.

The class 1.25- is an example where congested sections increase in the future. From the assigned result in each link, sections having a volume/capacity ratio larger than 1.00 in 1998 can be identified as the projects for the 8th FYP.

The identified sections should increase the capacity by improvement and a network for 1998 including those can be used for assignments with committed and recommended projects, as shown in Table 4.4.3 and 4.4.4.

Table 4.4.1 Summary of Trips, 1993, 1998 and 2006

(trips/day)

		1993	1998	2006
Vehicles				
	M/C	6,350	8,083	11,241
	Car	51,676	72,275	112,357
	Wagon	24,701	34,635	56,655
	Bus	22,389	29,254	42,002
	Truck	53,736	64,088	86,343
	Total	158,852	208,335	308,598
PCU				
	M/C	2,096	2,667	3,710
	Car	51,676	72,275	112,357
	Wagon	37,052	51,953	84,982
	Bus	67,167	87,762	126,006
	Truck	171,955	205,082	276,298
	Total	329,946	419,739	603,353

Note : Intra-zone trips are not included.

Figure 4.4.1 Zone Structure

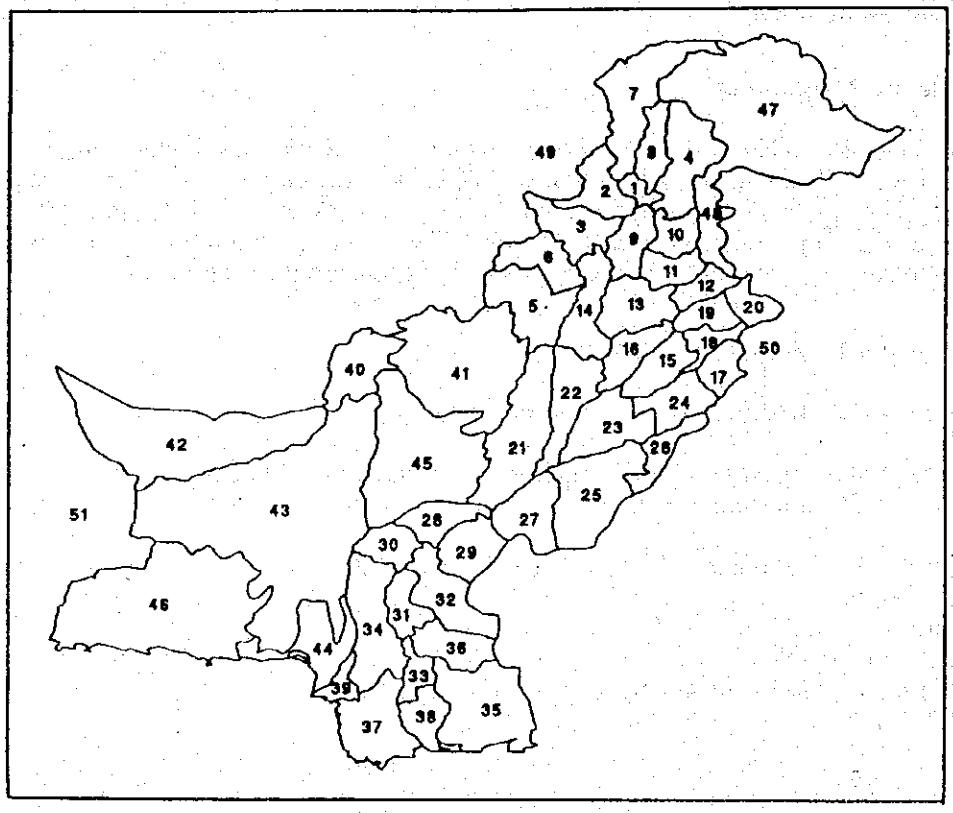


Figure 4.4.2 System 2 Highway Network (Showing roads & Centroids)

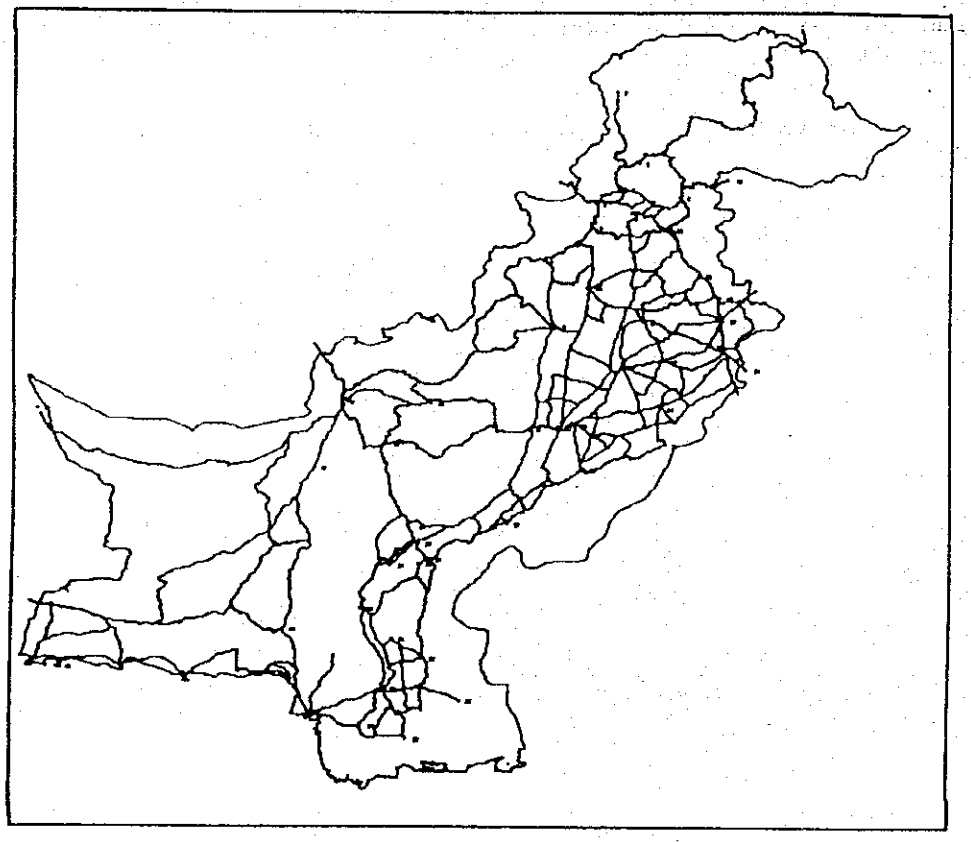


Figure 4.4.3 Traffic Flows on the 1993 Network

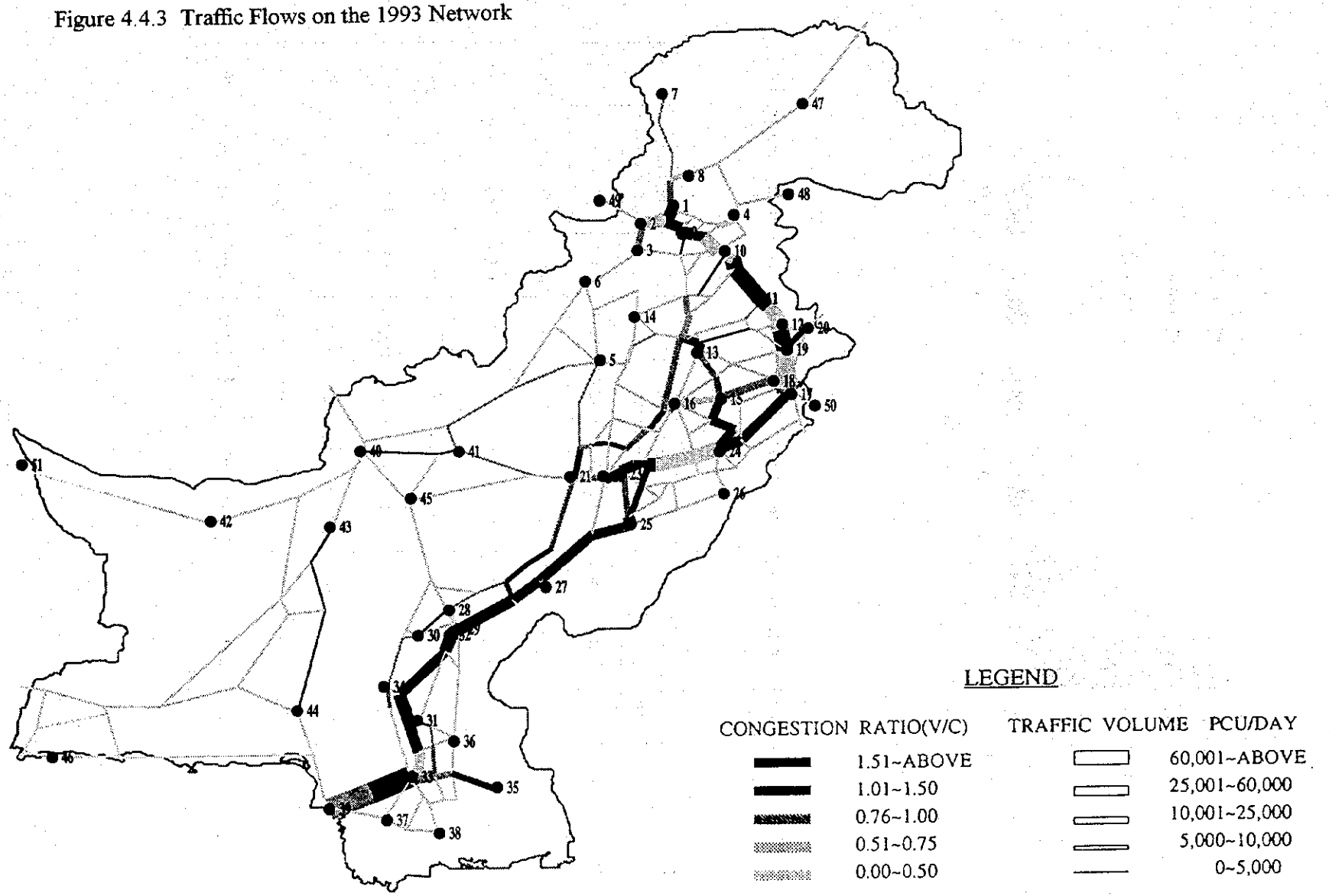


Figure 4.4.4 Summary of Traffic Assignment on the 1993 Network (V/C Ratio and Length, 1993,1998 and 2006)

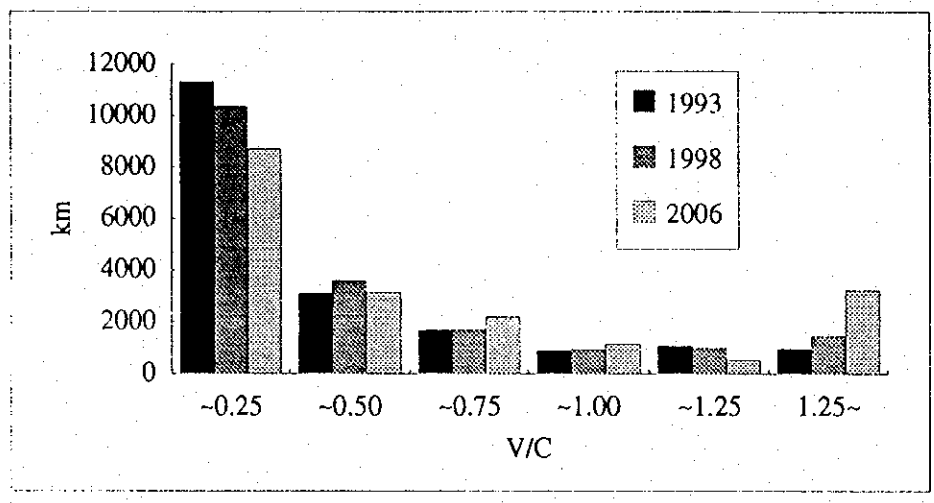


Table 4.4.2 Summary of Traffic Assignment on the 1993 Network (V/C Ration Length, 1993, 1998 and 2006)

	A.1993				B.1998				C.2006			
Rt / V/C		National Highways				National Highways				National Highways		
	Prov	N-5	Other	Total	Prov	N-5	Other	Total	Prov	N-5	Other	Total
~0.25	8936	206	2188	11330	6888	142	1683	8713	8298	187	1848	10333
~0.50	1253	302	1539	3094	2336	64	754	3153	1693	239	1666	3597
~0.75	1025	169	477	1670	768	220	1213	2201	930	242	508	1679
~1.00	349	511	0	860	645	166	349	1159	454	308	182	944
~1.25	234	420	406	1060	423	76	26	525	401	578	4	982
1.25~	366	273	326	965	1105	1212	911	3229	389	327	728	1444
Total	12163	1878	4936	18976	12163	1878	4936	18976	12163	1878	4936	18976

4.4.2 Results

Examination of Figure 4.4.4 and Table 4.4.2 together with relevant data could develop the following two candidate project groups for recommendation.

(1) For the current 8th FYP

1) Committed projects

The definition of the committed projects are discussed in 5.3 of this chapter. To repeat, they mean the most important projects under construction to be achieved by mobilizing local and foreign funds. They are as--

a. Dualization of N-5 Highway
b. Motorway between Lahore - Islamabad
c. Lahore Bypass
d. Lahore Provincial Bridge
e. N-55 Highway Improvement
f. N-25 Highway Improvement, etc.

The network including those committed projects and trips estimated for 1998 were used for the assignment. The result is shown in Table 4.4.3.A and Figure 4.4.5, through which the sections having V/C >1.00 were identified.

2) Recommended projects

After the traffic assignment on the network 1998 including the committed projects, it was found there were some sections having V/C ratio >1.00. Those sections were considered to be improved and recommended as the candidate projects of widening/improvement subject for economic assessment. They are mostly composed of provincial highways (in Figure 4.3.2). Table 4.4.3.B and Figure 4.4.5 present the summary of congestion distribution in 1998 when the network includes recommended projects with improved capacity, in which all road sections of the network are V/C <1.00.

(2) For the mid-term period (1999 - 2006)

1) Committed projects

The committed projects to be completed in this mid-term period are:

a. N-5 Dualization for remaining sections
b. Lahore Bypass for phase II
c. Kohat Tunne
d. N-55 improvement for the remaining sections
e. Sukkur Bridge

Figure 4.4.5 Summary of Traffic Assignment in 1998

(V/C Ratio and Length)

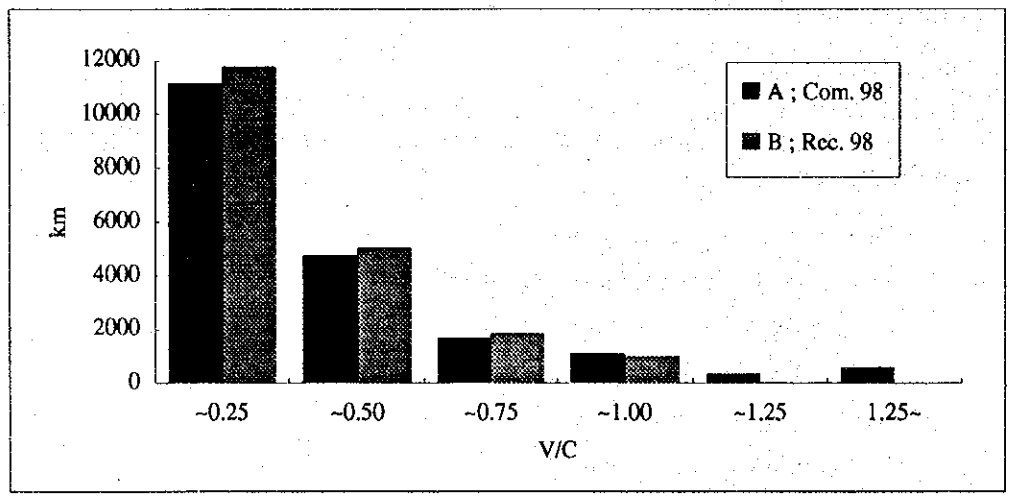


Table 4.4.3 Summary of Traffic Assignment in 1998
(V/C ratio and Length)

A, Commited Case 1998

Rt / V/C	Prov	National Highway			Total
	O	MWY	5	Other	
~0.25	8416.5	335	349	2069.5	11170
~0.50	1810.9	-	1099	1859.2	4769.1
~0.75	1086.5	-	340.5	236	1663
~1.00	521.5	-	129	436	1086.5
~1.25	317	-	-	27	344
1.25~	558	-	-	34	592
Total	12710.4	335	1917.5	4661.7	19624.6

B, Recommended, 1998

Rt / V/C	Prov	National Highway			Total
	O	MWY	5	Other	
~0.25	8822	335	351	2264	11772
~0.50	1851.4	-	1133	2041.2	5025.6
~0.75	1092	-	338.5	405	1835.5
~1.00	642.5	-	129	220	991.5
~1.25					
1.25~					
Total	12407.9	335	1951.5	4930.2	19624.6

Figure 4.4.6 Summary of Traffic Assignment in 2006
(V/C Ratio and Length)

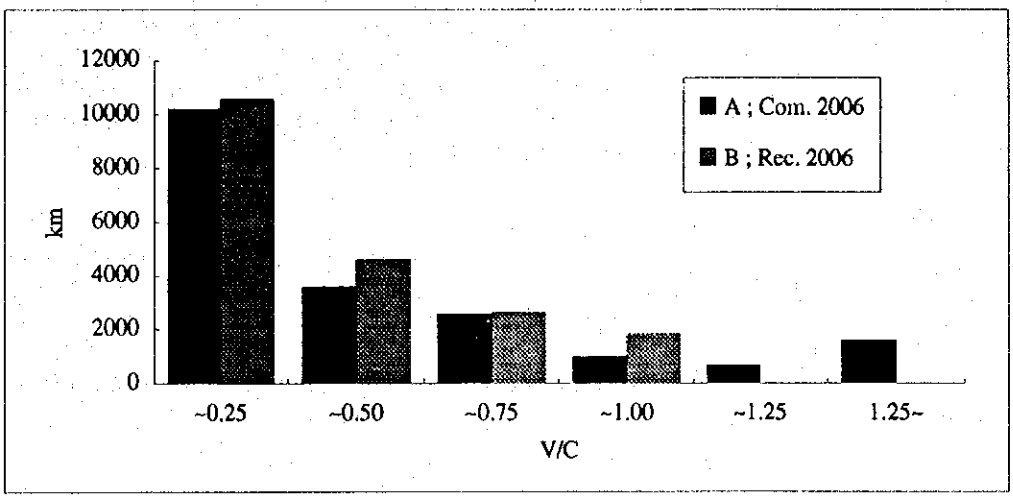


Table 4.4.4 Summary of Traffic Assignment in 2006
(V/C Ratio and Length)

A, Commited Case 2006

Rt / V/C	Prov	National Highway			Total
	O	MWY	5	Other	
~0.25	7256	335	518.5	2108.5	10218
~0.50	2085.6	-	488	1027.2	3600.8
~0.75	1022.3	-	656	907	2585.3
~1.00	652	-	266	82	1000
~1.25	368.5	-	-	290	658.5
1.25~	1326	-	-	277	1603
Total	12710.4	335	1928.5	4691.7	19665.6

B, Recommended, 2006

Rt / V/C	Prov	National Highway			Total
	O	MWY	5	Other	
~0.25	7500.5	335	389.5	2357.5	10582.5
~0.50	2896.6	-	577	1125.2	4598.8
~0.75	1044.3	-	696	907	2647.3
~1.00	1269	-	266	302	1837
~1.25					
1.25~					
Total	12710.4	335	1928.5	4691.7	19665.6

2) Recommended projects

Assuming the 1988 network is improved with committed and recommended projects in the 8th FYP period, there comes the second group of committed projects for the medium term as described above. However, it was found in the computer simulation that there were some sections on which traffic exceeded the capacity, being V/C >1.00, since the traffic was forecasted to grow at approximately 5 % per annum in the whole country from 1994 to 2006. Those sections with V/C >1.00 are subject for widening and improvement in the medium term period during 1999 to 2006 as recommended projects (in Fig 4.3.2).

(3) Summary

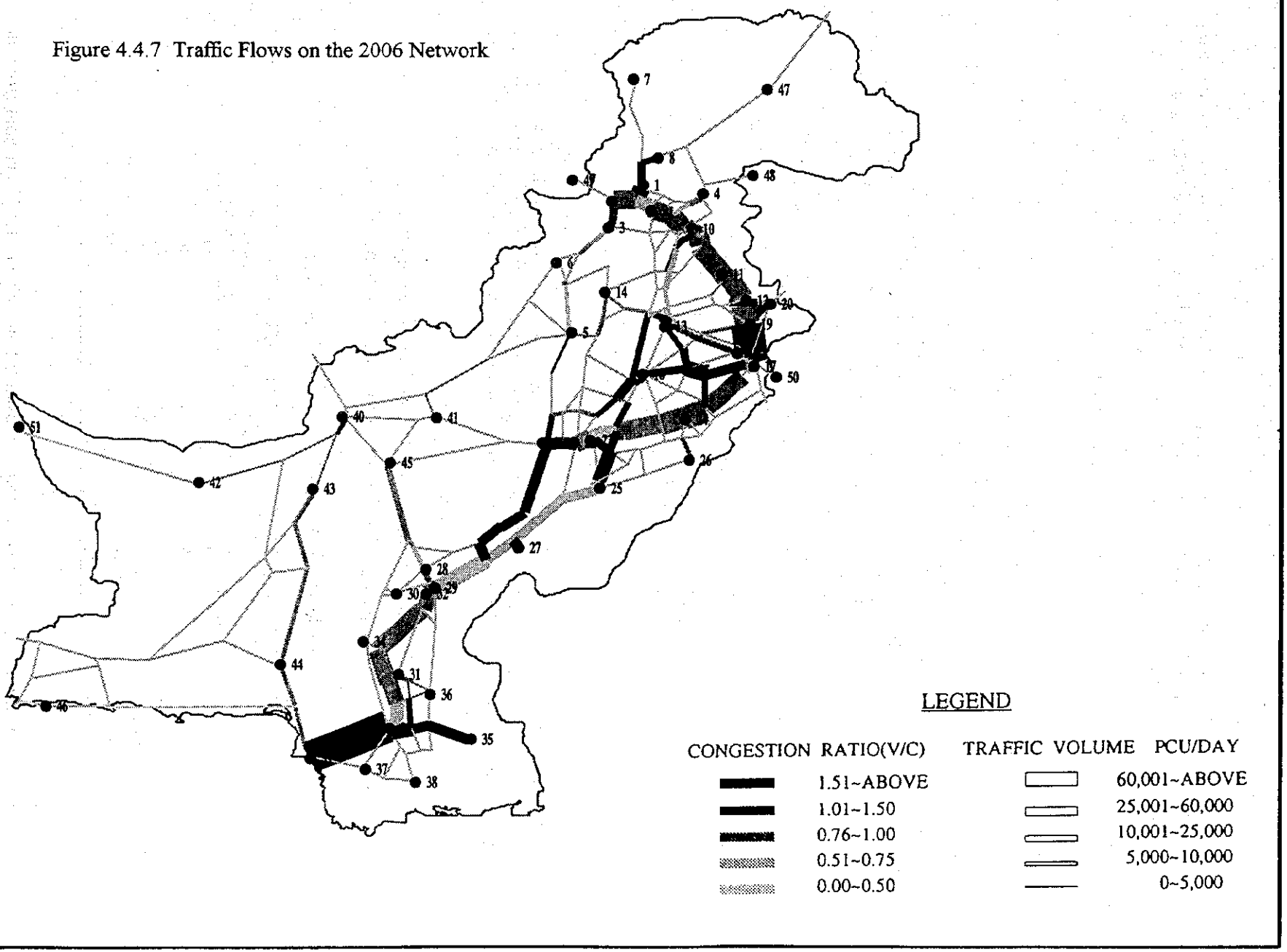
A hardcopy of the computer screen showing the traffic flows in 2006 with committed and recommended projects are shown in Figure 4.4.7. Committed and recommended projects for 1998 and 2006 are shown in Appendix Table 4.3.1 and Figure 4.3.2. Table 4.4.5 shows the summary of traffic flows in VOC, PCU-hr and PCU-km for 1993, 1998 and 2006. The table shows those indices go up if no improvement on the 1993 network is assumed, but they can be reduced if improved.

The recommended projects are forwarded to the following section 4.5 for economic assessment.

Table 4.4.5 Traffic Flow Summary, 1993, 1998 and 2006

Case	Unit/day	1993	1998	2006
1. Assign on 1993 Net				
Total VOC	Rs.mill	219.23	268.49	395.02
Total pcu-km	million	85.20	101.23	147.21
Total cu-hrs	million	3.46	4.81	10.88
2. Committed				
Total VOC	Rs.mill	-	234.17	359.69
Total pcu-km	million	-	101.55	146.86
Total cu-hrs	million	-	3.32	6.32
3. Recommended				
Total VOC	Rs.mill	-	213.70	301.27
Total pcu-km	million	-	96.47	140.46
Total cu-hrs	million	-	1.97	3.51

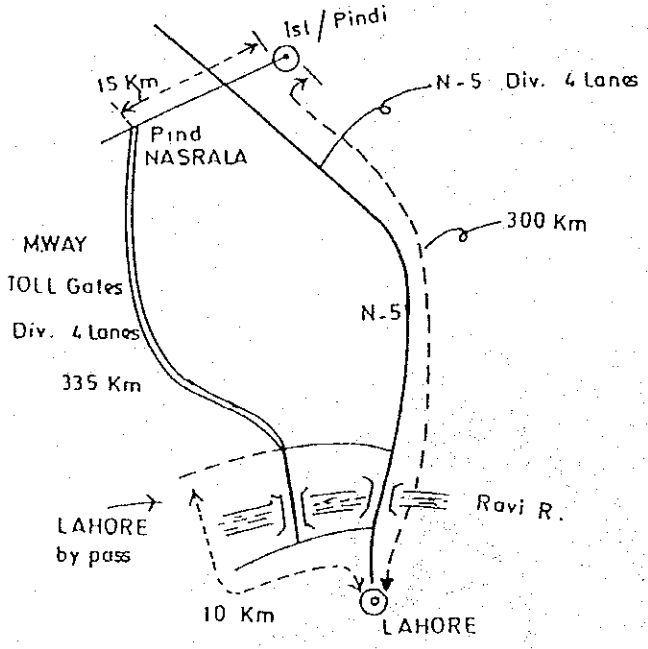
Figure 4.4.7 Traffic Flows on the 2006 Network



(4) Motorway Traffic

Motorway between Islamabad and Lahore is under construction and will be completed in late 1995. It is planned the Motorway be managed as a toll road with gates on entrance/exit points. This is the second inter-city toll road next to Karachi Super Highway.

Figure 4.4.8 Motorway and N-5



Traffic estimate on the Motorway is difficult because there are unknown elements yet to be clarified. Under the circumstances, an estimate was conducted with som assumptions and the result is summarized as under, while the process of the estimate is described in Appendix 4.4.1.

- Year : 1998
- Roads : N-5 dualization and other committed projects are completed.
- Tolls : Two times higher per km than the current Karachi Super Highway

Table 4.4.6 Assumed Toll Fee on Motorway

Type	Karachi Sup Hiwy 145 km	Motorway 335 km	
		Same as Karachi Sup Hiwy	2 times higher than Kch Sup
M/C	3	7	14
Car	8	18	38
Wagon	8	23	46
Bus	15	35	70
Truck	15	35	71
Average Rs	12	26	53

- Diversion : Toll fee was converted to hours by using a time value of Rs.32 per hour from the VOC estimate of this study. Then a percent split to Motorway was estimated for main zone pairs by comparing the travel time via Motorway including the converted toll, and the time via dualized N-5 and other major roads.

The results are shown in Figure 4.4.9 which indicates substantial difference in traffic volume depending on the toll fee. Traffic volume running the Motorway is larger if the toll is low than the traffic on N-5 or parallel provincial road because of the diversion. However, M-1 is assumed to levy the toll. On average, the volume on M-1 will be about 2,500 PCU per km/day assuming a toll of Rs. 53 for 335 km.

Drivers seem to be sensitive on the toll fee. However, it should be noted the estimate is based on provisional setting and the model of diversion need to be calibrated.

Figure 4.4.9 Traffic on Moterway, 1998