

CHAPTER 8

SOCIO-ECONOMIC CONSIDERATIONS

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8.1 PRESENT SOCIO-ECONOMIC CONDITIONS

8.1.1 Area

(1) Total Area

The total area of Nicaragua is about 130 thousand km² as shown below, making it the largest of the Central American countries. The territory is administratively divided into 9 Regions, 15 Departments and 143 Municipalities according to the new law, "La Gaceta", promulgated in 1991. Figure 8-1 shows the Municipalities boundaries.

- Land area : 121,428 km²
- Lake area : 16,025 km²
- Total Area of Nicaragua : 137,453.9 km²

(2) Areas by Region and Department

Administratively, Nicaragua comprises 9 Regions. The middle part of the country (including Region I, V and VI) is mountainous highlands, the western coastal area (Regions II, III and IV) is a wide plain, and the eastern coastal area (Region VII, VIII and IX) is made up of tropical forests. The area known as "Zelaya", accounts for 55% of all national land. These areas are shown in Table 3-1 by Region and by Department.

Table 8-1 Area by Region and Department

Region	Area (km ²)	Share (%)	Department	Area (km ²)	Share (%)
I Las Segovias	7,060	5.8	Nueva Segovia	3,123	2.6
			Madriz	1,602	1.3
			Esteli	2,335	1.9
II Occidental	10,033	8.3	Chinandega	4,926	4.1
			León	5,107	4.2
III Managua	3,672	3.0	Managua	3,672	3.0
IV Sur	4,724	3.9	Masaya	590	0.5
			Carazo	1,050	0.9
			Granada	929	0.8
			Rivas	2,155	1.8
V Central	10,622	8.7	Boaco	4,244	3.5
			Chontales	6,378	5.3
VI Norte	18,278	15.1	Jinotega	9,755	8.0
			Matagalpa	8,523	7.0
VII Autónoma Atlántico Norte	32,159	26.5		32,159	26.4
VIII Autónoma Atlántico Sur	27,407	22.6		27,407	22.5
IX Río San Juan	7,473	6.2	Río San Juan	7,473	6.2
Total	121,428	100.0	Total	121,428	100.0



Figure 8-1 Municipality Boundaries

(3) Area by Zone

Taking into account municipality boundaries, thirty three (33) traffic zones are established as shown in the Section 4-3-1. Area by zone is shown in Table 8-2.

Table 8-2 Area by Zone

Zone	Area (km ²)	Region*1	Zone	Area (km ²)	Region*1
1	5,711	9	18	1,732	2
2	1,557	4	19	2,335	1
3	598	4	20	9,755	6
4	929	4	21	49	2
5	6,378	5	22	2,697	2
6	4,244	5	23	2,180	2
7	11,261	8	24	1,602	1
8	1,050	4	25	3,123	1
9	209	4	26	1,762	9
10	381	4	27	4,648	8
11	683	3	28	11,498	8
12	1,637	3	29	8,133	7
13	1,520	6	30 *2	0	2
14	7,003	6	31	1,352	3
15	11,986	7	32 *2	0	10
16	12,040	7	33 *2	0	11
17	3,375	2	Total	121,428	

Note : *1 Corresponding Region

*2 Assumed for transportation analysis

Source : INETER, calculation of each zone by the JICA Study Team

8.1.2 Present Land Use

The most recent land use data reported by IRENA is shown in Table 8-3. The policy governing land use and its potentiality is described in more detail in section 3.1.2 on the basis of the "Lineamientos Estrategicos para el Ordenamiento Territorial (INETER)".

Table 8-3 Present Land Use by Classification

Land Use in Nicaragua (1990) : 12,143,000 Ha.

Land Use	Percentage
Fallow Land	7%
Shrubs	9%
Pine Forests	4%
Broad Leaf	31%
Others (Livestock, Agriculture)	49%

SOURCE : Uso de la Tierra, IRENA 1991.

8.1.3 Population

(1) Present Population Conditions

INEC carried out population censuses in 1950, 1963 and 1971; however, since 1971 no census has been undertaken. As a result, it is not possible to know the precise present population. Therefore, in order to facilitate demographic projections, INEC carried out "A Demographic Survey of Nicaragua (ESDENIC 78, ESDENIC 85)" in 1978, 1985 and 1992.

According to the INEC report, "The Projection of Population 1950-2025", the estimation method was changed in the 1992 survey since the number of young people decreased during the civil war, and Nicaraguans living in foreign countries began to return after the new government was established. The 1992 projection was obtained based on the recent study "A Demographic Survey of Nicaragua (ESDENIC 85)".

In 1992, the population of Nicaragua was estimated to be 4 million, with an average annual growth rate of 2.7% from the years 1980 to 1990. Annual growth rates in the 1950's, 60's and 70's were around 3.1-3.2%; although in the 80's this growth rate was 2.7%, or 0.5% less than previous rate. This is shown in Table 8-4.

Table 8-4 Population by Year

Year	Population	Annual Growth Rate
1950	1,108,894	
1955	1,287,271	
1960	1,501,595	3.1% (1960/1950)
1965	1,758,257	
1970	2,063,840	3.2% (1970/1960)
1975	2,425,542	
1980	2,802,815	3.1% 1980/1970)
1985	3,229,560	
1990*	3,673,044	2.7% (1990/1980)
1991*	3,822,072	
1992*	3,968,500	
1993*	4,113,369	

Note : * Estimate
Source : INEC 1992

Figure 8-2 indicates the composition of groups by sex and by age in 1990. The number of males aged 20-30 years old in the total population is greater than the number of females in the same age range.

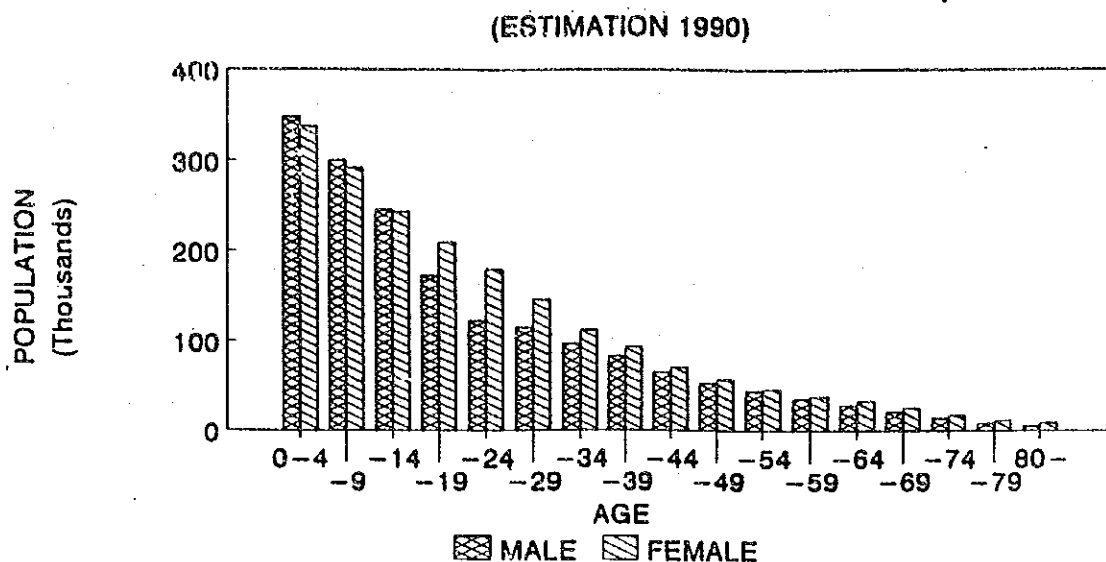


Figure 8-2 Population by Sex and by Age

(2) Population by Region, by Department and by Municipality

The population by municipality was estimated from 1990 to 1993. These numbers are given in the appendices. The population by department was obtained by counting up the population of each municipality included in the same department. Then the population by region was obtained by adding up the above department populations for each Region.

Table 8-5 shows the population by region based on the most recent updating of 1993. The population of Region III (including the capital city, Managua) accounts for 27.9% of the total. The average population density is 33.9 persons per km². 62% of population resides in the western (Pacific) coastal area, which includes Regions II, III and IV.

Table 8-5 Population by Region (1993)

Region		Area (km ²)	Population (person)	Population Density (person/km ²)
I	Las Segovias	7,060	401,408	56.9
II	Occidental	10,033	705,040	70.7
III	Managua	3,672	1,148,776	312.8
IV	Sur	4,724	678,215	143.6
V	Central	10,622	268,615	25.3
VI	Norte	18,278	543,904	29.8
VII	Autónoma Atlántico Norte	32,159	134,978	4.2
VIII	Autónoma Atlántico Sur	27,407	186,789	6.8
IX	Río San Juan	7,473	45,644	6.1
Total		121,428	4,113,369	33.9

The population by department is shown in Table 8-6. Of the 15 departments, the Managua Department is the largest with its population of 1.1 million, followed by the Matagalpa Department with its population of 360 thousand.

Table 8-6 Population by Department

Department	Area (km ²)	Population (persons)	Population Density (persons/km ²)
Nueva Segovia	3,123	126,806	40.6
Madriz	1,602	100,436	62.7
Estelí	2,335	174,166	74.6
Chinandega	4,926	344,977	70.0
León	5,107	360,063	70.5
Managua	3,672	1,148,776	312.8
Masaya	590	217,048	367.9
Carazo	1,050	159,339	151.8
Granada	929	159,259	171.4
Rivas	2,155	142,569	66.2
Boaco	4,244	124,044	29.2
Chontales	6,378	144,571	22.7
Jinotega	9,755	183,278	18.8
Matagalpa	8,523	360,626	42.3
Atlántico Norte	32,159	134,978	4.2
Atlántico Sur	27,407	186,798	6.8
Río San Juan	7,473	45,644	6.1
Total	121,428	4,113,369	33.9

(3) Population by Zone

The population by zone and by year is shown in Table 8-7.

Zone 11, which is located in Managua, has the largest population of 980 thousands. This zone accounts for almost a quarter of the country's total population.

The population of Zone 30 (Puerto Sandino) is assumed to be 0 because it is considered to be an undeveloped area. Zones 32 and 33 are foreign zones.

Table 8-7 Population by Zone

Zone	Area (km ²)	No of Municipality	1990	1991	1992	1993	Population Density (1993)
1	5,711	5	40,209	41,840	43,507	45,028	7.9
2	1,557	9	112,603	117,171	121,682	126,103	81.0
3	598	1	14,703	15,300	15,889	16,466	27.5
4	929	4	142,210	147,980	153,675	159,259	171.4
5	6,378	8	129,097	134,334	139,852	144,571	22.7
6	4,244	6	110,766	115,260	119,996	124,044	29.2
7	11,261	4	104,559	108,801	113,257	117,093	10.4
8	1,050	8	142,283	148,056	153,751	159,339	151.8
9	209	6	68,815	71,607	74,360	77,064	368.7
10	381	3	124,999	130,071	135,077	139,984	367.4
11	683	1	868,015	903,233	935,520	972,072	1,423.2
12	1,637	2	73,961	76,962	79,715	82,828	50.6
13	1,520	4	76,679	79,790	82,821	85,872	56.5
14	7,003	9	245,344	255,297	264,991	274,754	39.2
15	11,986	4	65,905	68,579	71,199	73,806	6.2
16	12,040	2	31,385	32,658	33,910	35,147	2.9
17	3,375	6	265,410	276,179	286,818	297,228	88.1
18	1,732	4	56,108	58,385	60,634	62,835	36.3
19	2,335	6	155,522	161,831	168,659	174,166	74.6
20	9,755	7	163,659	170,299	176,766	183,278	18.8
21	49	1	21,064	21,919	22,764	23,590	481.4
22	2,697	6	223,904	232,989	241,962	250,746	93.0
23	2,180	6	63,078	65,639	68,166	70,641	32.4
24	1,602	9	89,684	93,324	97,259	100,436	62.7
25	3,123	11	113,232	117,826	122,797	126,806	40.6
26	1,762	1	551	573	596	616	0.3
27	4,648	2	39,221	40,812	42,490	43,923	9.4
28	11,498	3	23,014	23,948	24,933	25,773	2.2
29	8,133	1	23,239	24,182	25,108	26,025	3.2
30	0	0	0	0	0	0	0.0
31	1,352	4	83,825	87,227	90,346	93,876	69.4
32	0	0	0	0	0	0	0.0
33	0	0	0	0	0	0	0.0
Total	121,428	143	3,673,044	3,822,072	3,968,500	4,113,369	33.9

Source : Estimate of total, INEC "Projection of Population 1950-2025", December 1992
 Calculated by zone, the JICA Study Team

8.1.4 Employment

According to "Medium-Term Development Strategy 1992-1996", the official unemployment rate has continued to increase, reaching 16% in 1992. However, this same report unequivocally states that official unemployment statistics may not accurately reflect the overall trend of unemployment. On the other hand, the sample survey conducted in Managua shows that the informal sector grew from 48% employment in 1989 to 65% in 1992. Intensive discussions with the staff of IDB, CABEL, and MECE revealed that cur-

rent unemployment may be as high as 60%. In any case, it is safe to conclude that current unemployment is considerably high.

As shown in Table 8-8, the number of people in the work force (defined as individuals 15 years old to 59 years old) gradually increased from 1 million in 1970 to 1.8 million in 1990. The work force account for 47.6% of the total population in 1970 and 48.2% in 1990. Assuming that about 25% of population aged 15 to 59 year olds have no intention to work, the number of employed individuals is estimated to be around 1.3 million as of 1990.

Table 8-8 Population by Age Group

Age Group	1970	1975	1980	1985	1990
0 - 4	399,629	464,417	526,809	609,779	685,062
5 - 9	325,568	381,609	439,161	510,589	521,219
10 -14	275,563	319,898	369,160	424,971	488,519
15 -19	228,660	267,228	305,867	340,475	382,662
20 -24	169,380	221,245	252,327	277,921	302,264
25 -29	133,218	162,227	208,449	238,508	261,031
30 -34	113,328	126,869	152,948	187,602	208,763
35 -39	95,770	107,760	120,083	143,863	175,430
40 -44	82,758	90,671	101,410	113,198	134,830
45 -49	67,523	77,715	84,711	97,216	108,620
50 -54	51,184	62,694	71,585	78,901	90,240
55 -59	40,133	46,810	56,977	66,413	73,383
60 -64	30,718	35,718	41,762	52,084	61,104
65 -69	22,141	26,005	30,509	36,811	46,289
70 -74	14,937	17,233	20,369	25,296	30,729
75 -79	9,832	10,184	11,646	15,278	19,013
80 over	5,487	7,260	8,243	10,646	13,887
15 -59	981,954	1,163,219	1,354,357	1,544,097	1,737,223
Total	2,063,829	2,425,543	2,802,016	3,229,560	3,603,045
Rate of Workable Population	47.6%	48.0%	48.3%	47.8%	48.2%

Source : INEC

Notwithstanding the above, data based on insurance payments, which can be used to obtain much more accurate employment figures, is available. Table 8-9 lists the insurance-paying individuals by economic sector. The number of insurance-paid employment decreased from 311 thousand in 1987 to 215 thousand in 1992. If the above-mentioned assumption is correct, unemployment in 1990 could be estimated at 58.1%, which is very close to economists' estimates.

Table 8-9 Number of Insurance-Paying Individuals

Sector	1987	1988	1989	1990	1991	1992
Total	311,873	295,936	261,209	261,439	228,930	214,675
1) Primary Sector	46,995	42,177	41,516	42,629	33,293	28,042
- Agriculture, Livestock	46,995	42,177	41,516	42,629	33,293	28,042
2) Secondary Sector	78,573	74,416	56,478	54,244	47,328	41,282
- Manufacturing industry	61,837	56,136	45,279	43,402	36,695	33,436
- Construction	14,534	15,873	9,460	9,353	9,219	6,578
- Mining, Quarry	2,202	2,407	1,739	1,489	1,414	1,268
3) Tertiary Sector	186,305	179,343	163,215	164,566	148,309	145,351
- Trading, Restaurants, Hotels	26,019	27,786	22,789	21,608	21,133	21,509
- Transportation, Communication	17,665	12,722	12,208	11,186	9,826	8,832
- Power, Gas, Water	7,949	6,468	5,339	6,033	5,809	6,095
- Bank, Insurance, Real estate	17,108	16,313	16,029	15,851	14,221	11,234
- Communal, Social Services	114,796	113,574	104,591	107,588	95,718	96,308
- Not specified activities	2,768	2,480	2,259	2,300	1,602	1,373

Source : National industry for statistics and census, based on data supplied by the Nicaraguan Institute for Social Security and Welfare (INSSBI)

8.1.5 Number of Registered Vehicles

There was almost no increase in the number of vehicles registered between 1984 and 1990; however, the number of registered vehicles abruptly began to increase when the new government announced tax exemptions for returning Nicaraguans who were bringing back cars with them. In 1992 the number of registered vehicles reached 165 thousand, as shown in Table 8-10 and Figure 8-4. Of this number, passenger cars account for 32.2%, followed by pick-ups, which account for 27.2%.

Table 8-10 Number of Vehicles Registered

Vehicle Type	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993*
Passenger Car	28,006	28,811	29,455	29,713	30,654	31,111	31,162	45,810	53,098	55,934
Jeeps	7,472	7,827	8,138	8,266	8,613	8,660	8,661	15,575	14,060	14,087
Microbus	4,222	3,798	3,272	2,745	2,203	2,215	n.a.	n.a.	2,616	2,072
Bus	1,513	1,361	1,171	983	842	924	3,240	2,740	3,327	3,048
Motorcycle	11,140	11,255	11,606	11,903	12,158	12,306	12,380	19,501	22,221	23,136
Pick-up	18,820	18,756	18,913	18,975	19,409	20,274	20,594	11,700	44,833	42,371
Van	674	674	675	676	677	677	677	1,134	1,347	1,341
Truck	8,889	8,593	8,320	8,036	7,753	9,307	9,506	n.a.	17,347	15,680
Trailer Tractor	n.a.	n.a.	n.a.	n.a.	n.a.	124	755	393	1,157	n.a.
Semi-Trailer	319	371	421	468	511	514	682	830	996	1,024
Tractors	238	251	301	320	454	474	482	n.a.	4,087	8,914
Total	81,293	81,697	82,272	82,085	83,274	86,586	88,139	97,683	165,089	167,976

Source : Parque Automotor Nacional, Direction General de Transporte Terrestre

Note : * As of April 30, 1993

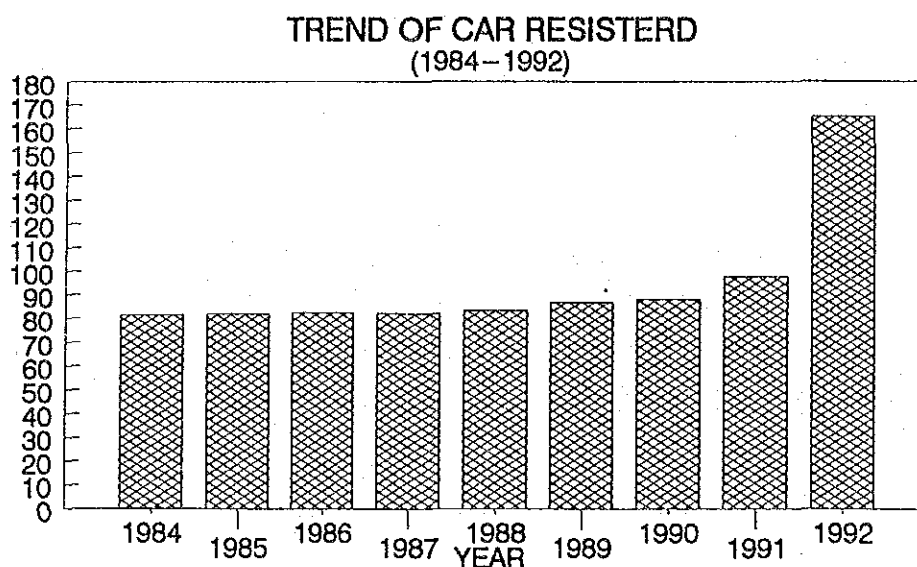


Figure 8-3 Number of Registered Vehicles

8.1.6 Agriculture

The Nicaraguan economy is based on agriculture, which accounts for approximately 25% of the GDP, one-third of the country's total employment, and over 75% of all exports. During the 1980's, the government's agricultural policy was characterized by strong state intervention (generating severe price distortions), massive land redistribution, and concentrated state investment projects. In addition, the slump in world prices of agricultural products and the Hurricane of 1988 negatively influenced the Nicaraguan agricultural production. As a result, the importance of agriculture in Nicaragua's economy has decreased to around 15% of the GDP, and around 33% of total exports, as shown in Table 8-11.

On the other hand, according to Table 8-12, which shows main crop production, the volume of production has been recovering, except sorghum production, even though productivity has not improved. Cultivated area, productivity, and production volume are shown Figure 8-4.

Table 8-11 Value of Agricultural Production

(Unit : Million Córdoba in 1980 price)

Item	1988	1989	1990	1991	1992
Agricultural Production	2,656.8	2,902.1	2,887.0	2,742.2	2,771.7
1) Products for Exportation	1,628.1	1,747.7	1,699.0	1,579.2	1,618.8
- Coffee	805.6	879.8	793.8	662.6	869.3
- Cotton	378.8	293.2	295.9	324.9	209.9
- Cotton Seeds	42.4	29.5	25.1	28.1	18.7
- Sesame	18.8	82.4	73.6	48.5	54.9
- Sugar Cane	264.2	89.1	349.5	367.9	340.4
- Banana	27.4	29.1	31.2	38.4	33.6
- Cigarette (Brown)	24.0	27.3	34.6	32.4	9.0
- Cigarette (Gold)	43.5	58.0	66.9	37.5	45.4
- Soya Beans	14.7	29.7	0.0	14.8	1.7
- Peanut	8.7	29.6	28.3	23.9	24.0
2) Basic Grains	834.9	857.9	830.4	818.8	847.0
- Rice	200.0	193.0	205.9	213.3	215.8
- Black Beans	171.4	221.3	212.8	202.7	201.4
- Corn	330.4	338.5	326.8	315.7	332.8
- Sorghum	133.1	105.1	84.9	87.1	96.9
3) Others	193.8	296.6	357.6	344.2	305.9
GDP	18,473.0	18,159.4	18,113.3	18,049.3	18,192.4
Agriculture./GDP (%)	14.4	16.0	15.9	15.2	15.2
Exportation	3,176.0	4,205.1	4,970.3	4,153.2	4,797.0
Agriculture Exportation/ Total Exportation (%)	51.3	41.6	34.2	38.0	33.7

Table 8-12 Cultivated Area, Productivity, and Production Volume of Main Crops

Main Crops	Unit	1987-88	1988-89	1989-90	1990-91	1991-92
Corn	Area (Mz)	261,240	318,319	326,515	277,737	282,863
	Yield (QQs/Mz)	23.6	20.6	19.5	17.5	18.6
	Production (QQ)	6,160,859	6,571,900	6,370,200	4,851,500	5,248,583
Sorghum	Area (Mz)	109,357	93,390	71,525	65,081	68,620
	Yield (QQs/Mz)	22.0	25.8	23.5	24.7	22.9
	Production (QQ)	2,408,046	2,407,000	1,680,300	1,605,800	1,572,040
Beas	Area (Mz)	96,606	153,689	150,969	160,951	161,828
	Yield (QQs/Mz)	7.7	8.0	9.0	9.6	9.7
	Production (QQ)	740,067	1,228,200	1,360,200	1,550,200	1,577,494
Rice	Area (Mz)	54,900	56,460	65,590	58,255	81,210
	Yield (QQs-Oro)/Mz	27.4	24.9	24.8	28.1	27.6
	Production (QQ-Oro)	1,502,400	1,405,900	1,629,400	1,637,992	2,240,840
Total	Area (Mz)	522,103	621,858	614,599	562,024	594,521
	Yield (QQs/Mz)	20.7	18.7	18.0	17.2	17.9
	Production (QQ)	10,811,372	11,613,000	11,040,100	9,645,492	10,638,957

Source : Ministerio de Agricultura y Ganaderia(MAG)

Unit : Mz - Manzanas
 QQs/Mz - Quintales/Manzanas
 QQ - Quintales

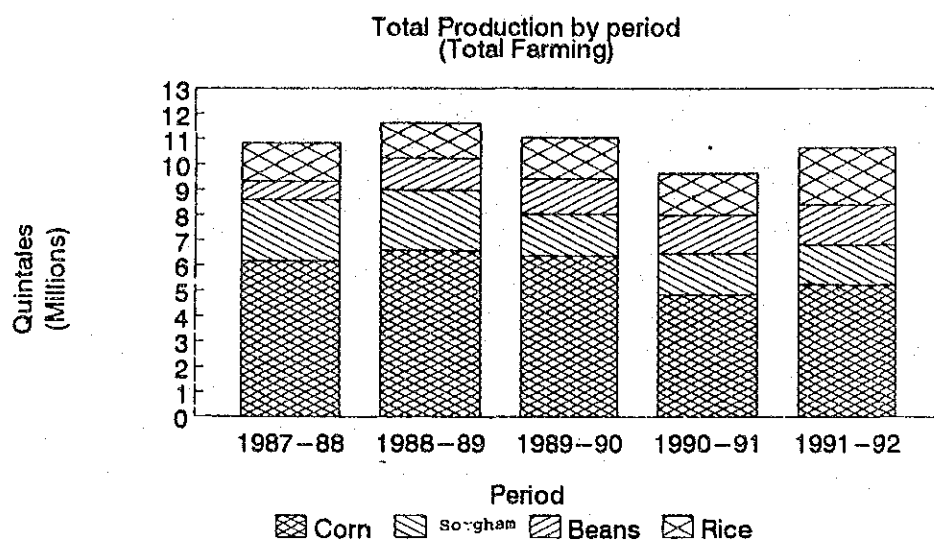


Figure 8-4 Production of Main Crops

Figure 8-5 shows the cultivated area, productivity, and production volume by region. Region V has the largest cultivated area; however, the production volume is greatest in Region VI. Consequently, productivity in Region V is not high. Productivity is highest in Region VI.

8.1.7 Livestock

Table 8-13 and Figure 8-6 show beef consumption. Both unit and weight of beef consumption have been stabilized, the former is at the level of around 300 thousand to 350 thousand; while the latter is at around 90 thousand to 100 thousand. Before 1989 export accounted for more than 60% of total consumption; however, nowadays the weight of exports has decreased to around one-third due to an increase in domestic use.

Table 8-13 Beef Consumption

Year	Export		Domestic Consumption		Total	
	Unit	1000 Lbs.	Unit	1000 Lbs.	Unit	1000 Lbs.
1988	162,371	50,612.7	96,119	26,600.0	258,490	77,212.7
1989	210,601	69,033.3	94,623	26,200.0	305,224	95,233.3
1990	170,248	58,605.0	183,769	46,700.0	354,017	105,305.0
1991	105,183	37,405.8	196,057	54,622.8	301,240	92,028.6
1992	138,701	50,396.2	184,887	51,893.4	323,588	102,289.6

Source : Estrategia Agropecuaria, Forestal y Agroindustrial de Nicaragua 1992-1996
(Ministerio de Agricultura y Ganadería)

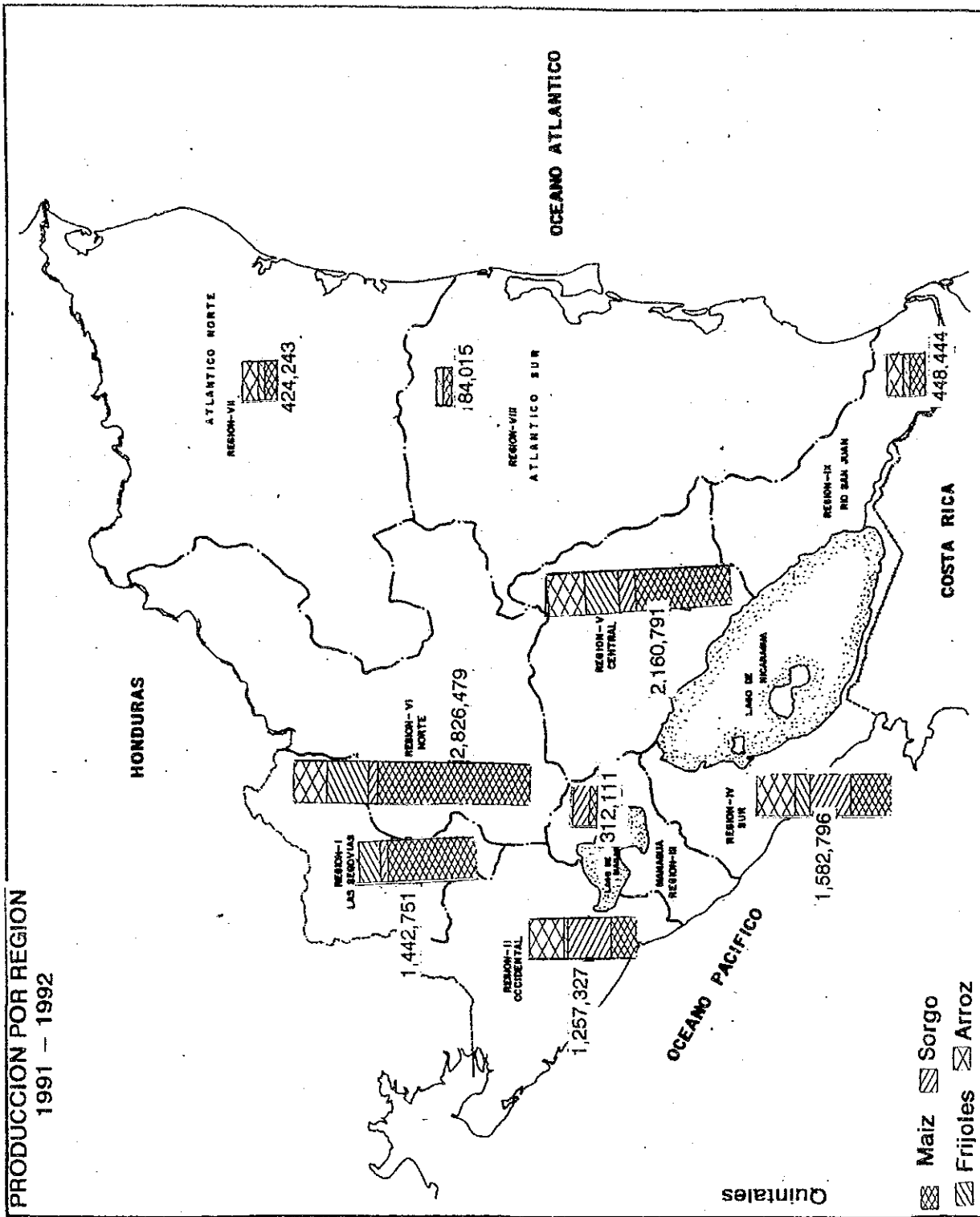


Figure 8-5 Production of Main Crops by Region



Figure 8-6 Beef Consumption

Figure 8-7 shows the export and domestic consumption of beef. Region III accounts for the highest share of livestock.

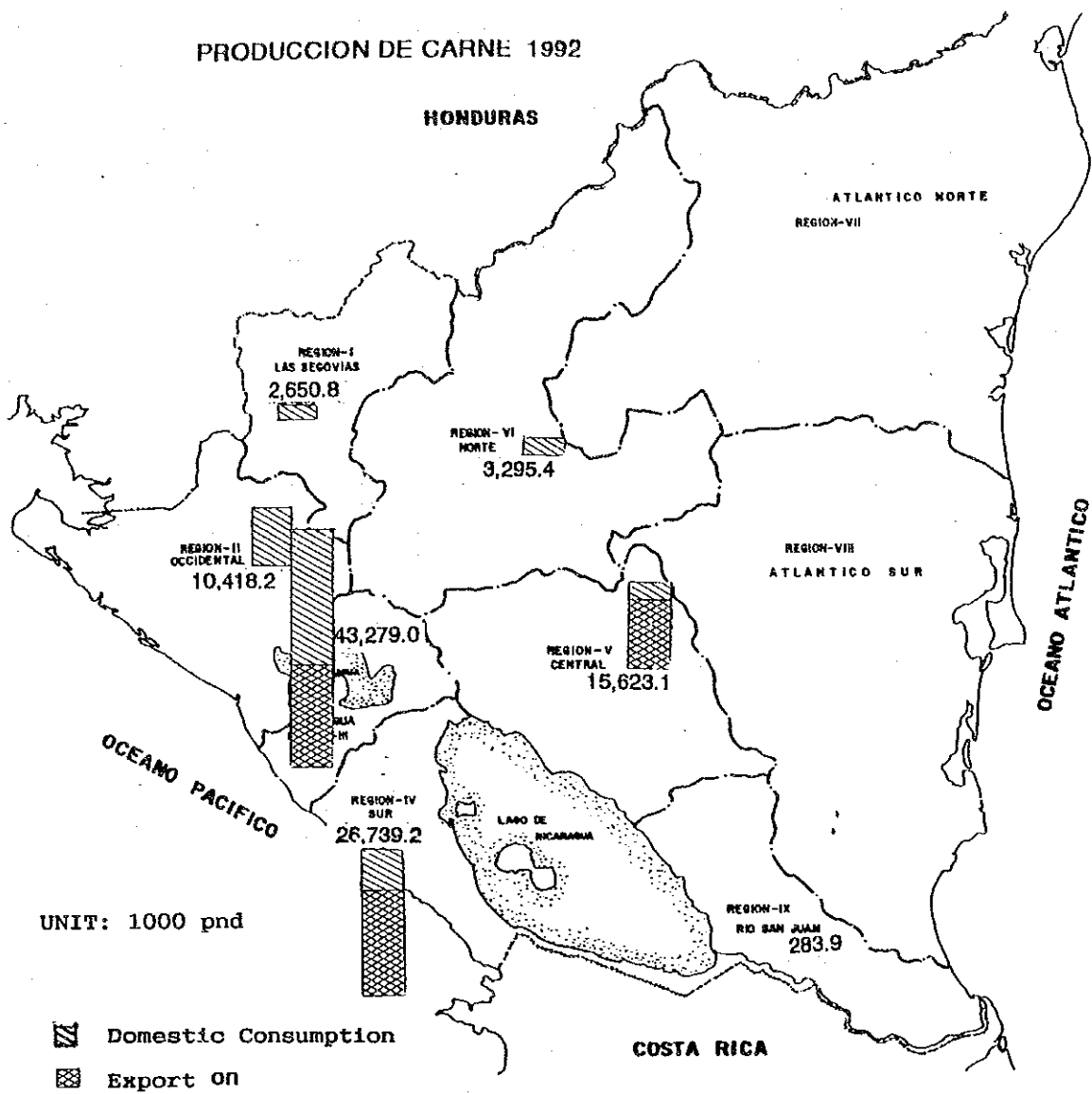


Figure 8-7 Export and Domestic Consumption of Beef by Region

8.2 DEVELOPMENT PLAN

This section discusses some of the development plans prepared by the present government. Although the government is emphasizing the importance of the development of export-oriented secondary industries, it must continue to focus on the primary sector, such as agriculture, accounting for more than 55% of the country's exports. In addition, the government is also emphasizing the need to improve the infrastructure, especially, major national roads. Therefore, the development plans mentioned below mainly concern this primary industry and road construction.

8.2.1 Medium-Term Development Strategy 1992-1996 (1992, Government of Nicaragua)

Prior to the change in government in April 1990, Nicaragua was on the brink of economic collapse due to hyper-inflation, disrupted markets, low productivity, a lack of private investment, etc. This deteriorated economic situation had been caused by the following factors:

- ① Civil war.
- ② Political conflict.
- ③ Interrupted access to the US market.
- ④ Direct involvement of the state in production and trade.
- ⑤ Widespread confiscations.
- ⑥ Unpredictable government intervention in markets.
- ⑦ Lack of monetary and fiscal discipline.
- ⑧ Rigid exchange rate policy.

To respond to the above problems, and set the country on a path of fast, sustainable, and equitable growth, the government's basic strategy has focused on restoring incentives in the private sector. The report "Medium-Term Development Strategy 1992-1996", summarized this strategy as follows:

a) Short Term (1992 and 1993)

- ① Consolidation of macroeconomic and political stability.
- ② Transition from stabilization to sustainable growth.
- ③ Energy employment generation.
- ④ Establishment of a regulatory framework for the national conservation and use of natural resources.

- ⑤ Initiation of institutional framework for public utilities.
- ⑥ Completion of foreign debt negotiations.

b) Medium Term (1994-1996)

- ① Fine-tuning and consolidation of legal, regulatory, and institutional frameworks that defining the private sector.
- ② Expansion of a productive infrastructure to support export-led growth, and provision of support for technological improvements in accordance with private sector priorities.
- ③ Greater investment in the formation of human capital, particularly in education.
- ④ Completion of industrial reforms in the public sector, and establishment of a modern social security system.
- ⑤ Strengthening the family unit to promote long-term savings and investment, to provide social protection for the individual, and to generate basic social values and attitudes.
- ⑥ Consolidation of democratic institutions.

In order to achieve the above targets, the government is striving to promote gradual recovery of per capita private consumption and a substantial reduction in unemployment, while simultaneously maintaining a reasonable deficit. The Nicaraguan GDP must grow at a fast and sustained pace, while maximizing economic efficiency. Toward this end, the government has presented the following medium-term scenario.

Year	1992	1993	1994	1995
GDP Growth Rate(%)	4.0	4.5	5.0	5.0

According to this strategy, transport is essential to the country's goal of increasing production and exports. Therefore, the government's objectives for the transportation sector are:

- ① Rehabilitating existing roads and ports.
- ② Increasing efficiency.
- ③ Improving access of agricultural areas to local and international markets.
- ④ Linking the Pacific and Central parts of the country with the North and South Atlantic parts.

In addition this strategy emphasizes the need for assistance with transport demand analysis, sector financing and pricing, and new regulations and legislation.

8.2.2 Strategic Guidelines for Territorial Arrangement (1992:INETER)

Current problems related to national land stem from the inconsistent political and economic policies of the past several decades. These problems can be summarized as follows:

- ① Unbalanced land use.
- ② Inadequate use of natural resources.
- ③ World slump in prices of natural resources.
- ④ Investment without consistent land use strategy.
- ⑤ Dependence on few export products.

To adequately and efficiently use natural resources, it is necessary to do the following.

- ① Arrange a national development system.
- ② Promote economic diversification in terms of land use.
- ③ Strengthen municipal governments.

From the viewpoint of physical land use planning, the government's new strategy proposes that the national land be divided into eight areas or zones on the basis of the land's specific characteristics and functions. Table 8-14 shows the strategic areas and their populations by zone.

Table 8-14 Development Strategy by Development Zone

Zone	Development Strategy	Area (km ²)*	Rate	Population**	Rate
Z1	Development area to be controlled	10,943	8.0%	1,360,405	34.0%
Z2	Development area to be consolidated	4,187	3.0%	386,866	9.7%
	A. Corridor Chinandega-San Rafael del Sur	3,092		324,843	
	B. West side of the department of Rivas and Ome	1,095		62,023	
Z3	Expansion area to be developed	8,266	6.0%	195,873	4.9%
Z4	Area of containment to be developed	24,336	17.7%	711,869	17.8%
Z5	Integration area to the socioeconomic development	34,455	25.1%	235,659	5.9%
Z6	Local development areas	10,435	7.6%	96,570	2.4%
Z7	Recovery and conservation area	20,448	14.9%	639,704	16.0%
	A. Latifoliated	11,476		578,189	
	B.	8,972		61,515	
Z8	Natural ecosystem reserve areas	24,284	17.7%	372,285	9.3%
	A. Volcanic subzone of conservation	4,093		208,279	
	B. Reserve subzone of humid ecosystems	8,448		92,287	
	C1. Biological reserve - Bosawas	8,147		69,210	
	C2. Biological reserve - SI-A-PAZ	3,596		2,509	
Total		137,354	100.0%	3,999,231	100.0%

Note : * - Included lake, river, and seashore

** - Figure in 1992 (Latest figure is 3,968,500 according to INETER, See Table 8-8)

Source : "Lineamientos estrategicos para el ordenamiento territorial" INETER

8.2.3 Agriculture, Forestry and Agroindustrial Strategy in Nicaragua 1992-1996 (1991, Ministerio de Agricultura Y Ganaderia)

Agricultural development reforms consist of the strengthening of institutional responsibility, the minimization of government intervention in agricultural activities, and careful watching for the development. The following is a summary of the necessary key variables.

- Institutional organization
- Planning and Information
- Technology Transfer and Training
- Participation and coordination
- Foreign cooperation

(1) Institutional Organization

An efficient and effective institutional system is indispensable for encouraging agricultural development. To facilitate the encouragement and consolidation of new development, based on the initiative and creative participation of farmers and ranchers, it is necessary to ensure consistency with macroeconomic policies and inter-institutional coordination, while guaranteeing the optimal allocation of resources to benefit the various economic agents involved.

(2) Policy Characteristics

The following is a summary of the policy characteristics.

- a. Promote the encouragement and development of the agricultural, forestry and agro-industrial sectors. The Ministry should take the lead in coordinating activities.
- b. The responsibility of the government is to ensure physical, economic and social access to basic, nutritious foods for the most vulnerable population groups.
- c. Facilitate and support the activities of ranchers and their organizations.
- d. Facilitate the transfer of technology, and help pass information on to the medium and small -scale ranchers by seeking foreign assistance, as well as coordinating and cooperating with international institutions (bilaterally and multilaterally).
- e. Participate in the management of price policies, supplies and services of products.
- f. Supervise foreign price competitiveness to properly assess its impact.
- g. Pass market information on to farmers and ranchers.
- h. Facilitate trade and distribution of goods, and promote the creation of a system that will allow consumers to purchase goods directly from producers.

- i. Guarantee the right of land ownership, property right, while promoting distribution of land to people who will use.
- j. Promote the reforestation and the recovery of the ecosystems of adversely affected areas.
- k. Promote the free association of farmers and foreign investors.
- l. *Establish an organization of farmers, which will promote the distribution of resources, especially to medium and small-scale farmers.*
- m. Support integration in the agro-industrial chain for farmers
- n. Promote farmer training with the participation of the government, while allowing farmers and their associations to work on their own.
- o. Encourage farmers to make their own decisions on production and trade through the organization, integration and trading.
- p. Maintain efficiency and rationality in management and the use of foreign resources.

In order to carry out the above strategy, the agriculture and forestry public sectors must evaluate their current structures.

An Ad-hoc Commission established by the Ministry of Agriculture is in charge of the above-mentioned actions. The important fields in this definition are:

- Agricultural National Commission
- Regional Delegation of the Ministry of Agriculture (MAG).
- Agricultural Services
- Foreign Cooperation
- Protection and Agricultural Sanitation
- Planning
- Nicaraguan Food Program
- Administration and Finances
- General Secretary's Office

Based on the above policies, the projected production of main crops is shown in Table 8-15. The total production volume is planned to increase from 24,030.5 thousand qq. in 1991/92 to 52,089.5 thousand qq. in 1996/97 (2.1 times). Meanwhile, the volume of crop exports is expected to increase 2.8 times from 1991/92 to 1996/97, which would bring valuable foreign currencies into Nicaragua in the near future. At the same time, production of beef is also forecast to increase, although its growth rate will not be as large as that of crop production, as shown in Table 8-16.

Table 8-15 Crop Production Projections

(Unit : ×1,000)

Product	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97
1) Exportation						
- Coffee	948.0	974.0	1,056.3	1,279.3	1,666.5	2,122.5
- Banana (Box)	6,220.0	6,500.0	9,600.0	13,000.0	17,670.0	21,090.0
- Sugar Cane(Ton)	3,218.0	2,828.0	2,862.0	2,675.0	2,452.5	2,452.5
- Tobacco (Raw)	25.0	39.0	40.5	56.0	56.0	56.0
- Cotton (Raw)	2,100.0	2,700.0	3,700.0	4,560.0	5,130.0	5,700.0
- Sesame	240.0	315.0	400.0	450.0	550.0	550.0
- Soy beans (qq)	125.0	250.0	450.0	600.0	750.0	750.0
- Peanut (qq)	122.5	180.0	260.0	382.5	472.5	472.5
2) Basic Grain						
- Rice (qq)	2,100.0	2,280.0	2,450.0	2,550.0	2,710.0	2,928.0
* Irrigation Rice	1,240.0	1,330.0	1,480.0	1,560.0	1,680.0	1,848.0
* Dry Season Rice	860.0	950.0	970.0	990.0	1,030.0	1,080.0
- Bean (qq)	1,500.0	1,596.0	1,705.0	1,805.5	2,000.0	2,144.0
- Corn (qq)	6,400.0	6,846.0	7,260.0	7,820.0	8,400.0	8,750.0
- Sorghum (qq)	1,941.0	2,367.5	2,619.0	2,812.5	3,145.0	3,515.0
* Red Sorghum	1,085.0	1,400.0	1,554.0	1,720.0	2,025.0	2,340.0
* White Sorghum	396.0	455.0	540.0	555.0	570.0	600.0
* Sorghum	460.0	512.5	525.0	537.5	550.0	575.0

Source : Ministry of Agriculture

Table 8-16 Future Livestock Production

Production	U/M	1992	1993	1994	1995	1996
1) Cattle						
- Production of Beef	Mill. Lbs.	77.8	80.2	80.8	86.2	89.4
* Exportation		52.0	54.0	56.0	58.0	60.0
* Domestic Consumption		25.8	26.2	24.8	28.2	29.4
- Production of Milk	Mill. Gls	45.7	49.5	49.8	53.3	57.3
2) Poultry						
- Production of Meat	Mill. Lbs.	23.0	25.0	27.0	29.0	30.0
- Production of Eggs	Mill. Doz.	21.6	24.0	26.0	28.0	30.0
3) Pigs						
- Production of Meat	Mill. Lbs.	17.5	19.2	21.8	23.0	24.0

Source : Ministry of Agriculture

8.2.4 Forestry Action Plan Nicaragua (1992, PAF-NIC)

In order to lay the foundation for the decision-making process at the government level, "The Forestry Action Plan for Nicaragua (PAF-NIC)" was set up to establish policies and strategies that would sustain forestry development. The following five programs are proposed:

- Forestry activities related to land use
- Management of Natural forests and Industrial Development
- Firewood and Energy
- Conservation of forest ecosystems and biodiversity
- Institutional reinforcement

(1) Present Situation

Recent estimates indicate that Nicaragua has 4.3 million hectares of forest. Over the past decade, the forest cover has been substantially reduced at an alarming rate. Only 60% of the seven million hectares of forest in 1950 still remain. The deforestation rate has been estimated at 100,000 hectares a year. If this situation continues, most of the remaining rain forests will disappear within the next 10-15 years.

The forest industry in Nicaragua consists primarily of some 75 sawmills with an actual production of 90,000 cubic meters of sawn wood, a level which cannot satisfy the growing demand for forest products.

(2) Forest Activities Related to Land Use

In order to conserve and properly utilize forest resources, the above mentioned PAF-NIC has begun to provide a basis for management and the use of the forest land. The main program goals for the first five-year period are:

- To establish 70,000 hectares of industrial plantations.
- To place 100,000 hectares at the agricultural frontier and buffer zones under agro-forestry production.
- To execute a national forest inventory.

The main strategy is related to the establishment of incentives to promote reforestation for industrial purposes. Such measures include:

- Discontinue the policy of distributing forest land for agricultural and cattle-grazing purposes
- Eliminate credits for agricultural and ranching activities that advance the agricultural frontier

(3) Management of Natural Forests and Industrial Development

The forest management goals for the next five-year program are:

- To manage and control forest fires in 300,000 hectares of natural pine forest.
- To protect 2,000,000 hectares of broadleaved forests designated for productive purposes against the advancement of the agricultural frontier, taking into account environmental aspects, accessibility, extraction techniques, and the economic feasibility of the use of these forests

The goals for the industrial development for the next 5-10 years are to reach a processing capacity of 200,000 m³ ssc of broadleave, both volumes referring to roundwood.

(4) Firewood and Energy

The use of forest for firewood and energy is to contribute to energy generation for industrial purposes and for residential consumption. For this purpose the following goals have been set:

- Establish two projects for the generation of energy for industrial purposes, one in the mining area, and the other integrated with a forestry industry.
- Satisfy the demand for firewood in the Pacific and Central regions by increasing the efficiency of the domestic use of firewood, from the present 10% to at least 15%.
- Establish 25,000 hectares of firewood plantations in the Pacific and Central regions.
- Establish a program to control forest fires, and place 40,000 hectares of dry tropical forest under forest management plan.

8.2.5 Summary of the Five-Year Plan for 1991-1995 and Other Years (1991: MCT, General Division Economic Planning)

(1) General

MCT has presented a preliminary plan for investment for a 5-year period, from 1991 to 1995. Table 8-17 summarizes the objectives of each item.

The following shows each of the goals of investment:

- ① Rehabilitation of 493 km of paved roads corresponding to 33% of the existing paved road network.
- ② Enlargement of the paved road network to 269 km.
- ③ Construction of 3,622 m of road bridges and 704 m of railway bridges, reconstruction of 186 km of railway.
- ④ Construction of 500 m of jetties in Corinto, dragging of 2,490,000 m³; construction of 227 m of wharfs, construction of 400 m of breakwaters.
- ⑤ Rehabilitation of the Augusto Cesar Sandino Airport.
- ⑥ Assistance activities for construction of 61,500 houses, and acquisition of 722 units of equipment mainly for urban transportation

The paved road plans are summarized in Table 8-18.

Table 8-17 Objectives of the Five-Year Plan by MCT

Item	Investment (Objective)
Paved roads	1) Rehabilitation 2) Covering 3) Construction
Unpaved roads	1) Rehabilitation 2) Improvement
Bridges	1) Construction
Railways	1) Railway 2) Bridge
Ports	1) Construction of jetties 2) Dragging 3) Construction of wharfs 4) Construction of ferries 5) Construction of Breakwaters
Airports	1) Rehabilitation
Public Housing	1) Houses Constructed 2) Bank of materials 3) Rural roof plan 4) Urban parcel
Equipment	1) Buses 2) Equipment for the maintenance of roads 3) Structures for bridges of 30 m 4) Harbor equipment 5) Aerial communication equipment 6) Railway equipment

Table 8-18 Paved Roads Plans

(Unit : km)

Plans	1991	1992	1993-1995	1995 -	Total
Rehabilitation	7	80	406	997	1,490
Repaving	258	516	2	776	
Construction	18	106	145	111	380
Total	25	444	1,067	1,110	2,646

The paved road investment program for 1992 is given in Table 8-2-6.

Table 8-19 Investment Program for 1992

Work Type	Section	Length
Rehabilitation	Pedrecitas-Nejapa	4 km
	Nejapa-Izapa	51 km
	Managua-Masaya	6 km
	Nueva Guinea-Bluefields	19 km
	Subtotal	80 km
Repaving	Region I, II, IV, V, VI (asphalt)	258 km
Construction		106 km
Total		444 km

(2) Aid Program for Road Project

In Nicaragua, some road projects have already completed, others are still underway, while others are still in the planning stages under existing bilateral or multilateral aid programs.

Table 8-20 shows these projects.

Table 8-20 Road Projects in Nicaragua (1993)

Project (Road Section)	Distance	Content	Aid Organization	Type of Fund	Stage	Remarks
Guasaule-Chinandega	75km	Pavement Improvement	CABEI	Loan	D/D	Under request for fund assistance
Izapa-León-Chinandega	66km	Pavement Improvement	CABEI	Loan	D/D	Under request for fund assistance
Nejapa-Las Conchitas-Nandaime	56km	Pavement Improvement	CABEI	Loan	F/S, D/D	Under selection of consultants
Masaya-Granada	17km	Pavement Improvement	CABEI	Loan	F/S, D/D	Under selection of consultants
Nejapa-Izapa	57km	Road Improvement	CABEI	Loan	C	Under construction
Nejapa-Izapa		Reconstruction of 4 bridges	Japan	Grant Aid	D/D, C	Completion of design work
Nandaime-Peñas Blancas	82km	Road Improvement	DANIDA	Grant Aid	C	Under selection of consultants for supervision
Managua-Masaya	26km	Pavement Improvement	CABEI	Loan	C	Under request for construction fund for the first stage(15km)
San Benito-El Rama	260km	Asphalt Concrete Overlay	DANIDA	Grant Aid	C	Conclusion of contractor selection
Muy Muy-Puerto Cabezas	245km	Gravel Pavement	DANIDA	Grant Aid	C	Under selection of contractor
Puerto Cabezas-Waspam	135km	Gravel Pavement	DANIDA	Grant Aid	C	Under selection of contractor
REMECAR	900km	Construction of Gravel Road	NORDICO, IDB	Grant Aid, Loan	D/D, C	Completion of design work for the first stage (245km)
Guasaule Bridge		Construction of New Bridge	EEC	Grant Aid	C	Completion

Note : F/S - Feasibility Study
D/D - Detailed Design
C - Construction

8.3 FUTURE SOCIO-ECONOMIC FRAMEWORK

8.3.1 GDP

As described in Section 8.2.1, the government projects the following future growth scenario for the country's GDP.

Year	1992	1993	1994	1995
GDP Growth Rate	4.0%	4.5%	5.0%	5.0%

However, in order to achieve this growth rate, the following objectives must be achieved.

- ① The maintenance of macroeconomic stability.
- ② Successful implementation of transition policies and structural reforms to improve incentives in the private sector, and increase international competitiveness.
- ③ The maintenance of a political climate favorable to private investment.
- ④ Substantial and flexible foreign aid to finance the transition to self-sustained growth.
- ⑤ Attraction of private foreign capital to gradually replace foreign aid in the medium term.

Nicaragua has substantial physical capital and land, as well as a great deal of experience, however, it will not be easy to achieve the above growth rate in the foreseeable future, especially considering the existing prolonged worldwide economic recession. In the report "Medium-Term Development Strategy 1992-1996", the government itself admits this growth rate is optimistic. Moreover, after engaging in comprehensive discussions with the staff of IDB, CABEL, and MED on the future economic situation in Nicaragua, the JICA Study Team was suggested that the government target growth rate was higher than expected and a reasonable growth rate would be 2.5% at most.

Besides expressing the above opinion, the JICA Study Team considered GDP growth rates over the past years as shown in Table 8-21, as well as the 2.1% growth rate for 1993, which is the government's latest estimation, and set the future GDP growth rate at 2.5%.

Table 8-21 GDP Growth Rate in Central American Countries

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Guatemala	5.3	3.5	1.0	-3.5	-2.7	0.6	-0.6	0.3	3.3	3.5	4.0	3.5
El Salvador	-1.5	-9.6	-8.3	-5.6	0.8	2.3	2.0	0.6	2.6	0.5	1.1	3.4
Honduras	6.7	2.6	1.5	-2.0	-0.2	2.8	3.2	3.1	4.2	3.8	2.1	-1.0
Nicaragua	-25.8	4.6	5.4	-0.8	4.6	-1.6	-4.1	-1.0	-0.7	-10.9	-2.9	-5.7
Costa Rica	4.9	0.6	-3.6	-7.3	2.9	8.0	0.7	5.5	5.1	3.4	5.5	3.6
Central America	0.1	1.0	0.9	-4.1	0.1	2.4	0.2	1.6	3.5	2.2	2.9	2.1

Source : Central Banks and Ministry of Planning

8.3.2 Future Population

Future population was forecast by the following procedures:

(1) Future Population by Municipality

Using the population data presented in Section 3.2.1, the future population by Municipality was estimated applying the parameters obtained by the following regression analysis.

$$Y_i = a_i + b_i \times X_i$$

where; Y : Population
X : Year
a, b : Parameter
i : Municipality

The parameter values are listed in the Appendices because there are so many models; nonetheless, each model shows the high correlation coefficient value.

(2) Modification by the Control Total

By adding up the future municipality populations projected in the above model, the total population of Nicaragua could be obtained. However, in Nicaragua the total population has already been projected by the INEC (Statistics and Census Institute of Nicaragua). According to their projections, the population of Nicaragua will be 5.1 million by the year 2000 and 6.7 million by the year 2010, as shown in the last row of Table 8-22. There was no guarantee that the JICA Study Team's population projections will equal those of the INEC. Therefore, the JICA Study Team's population estimates for each municipality were corrected by using INEC's estimates as control totals.

(3) Future Population by Traffic Zone

With the modified future population totals by Municipality, the JICA Study Team estimated future population by zone. The zone populations could be obtained by adding up the Municipality populations in each of the zones. Table 8-22 shows the estimated future population by zone.

Table 8-22 Population Estimation 1995-2025 by Zone

Zone	Area (km ²)	No of Municipality	1995	2000	2005	2010
1	5,711	5	48,233	56,202	64,605	73,218
2	1,557	9	134,986	157,236	180,691	204,741
3	598	1	17,626	20,532	23,595	26,736
4	929	4	170,473	198,572	228,195	258,564
5	6,378	8	154,960	180,637	207,699	235,445
6	4,244	6	132,958	154,994	178,214	202,024
7	11,261	4	125,500	146,289	168,205	190,672
8	1,050	8	170,556	198,669	228,298	258,682
9	209	6	82,489	96,083	110,415	125,109
10	381	3	149,841	174,539	200,575	227,269
11	683	1	1,039,030	1,209,300	1,388,847	1,572,924
12	1,637	2	88,535	103,044	118,345	134,032
13	1,520	4	91,896	107,027	122,979	139,335
14	7,003	9	294,020	342,426	393,460	445,784
15	11,986	4	78,991	92,004	105,720	119,787
16	12,040	2	37,618	43,817	50,350	57,050
17	3,375	6	318,163	370,610	425,898	482,581
18	1,732	4	67,261	78,349	90,038	102,022
19	2,335	6	186,789	217,816	250,513	284,035
20	9,755	7	196,131	228,422	262,467	297,372
21	49	1	25,252	29,416	33,805	38,306
22	2,697	6	268,405	312,649	359,288	407,108
23	2,180	6	75,616	88,080	101,221	114,695
24	1,602	9	107,715	125,606	144,462	163,793
25	3,123	11	135,996	158,585	182,394	206,799
26	1,762	1	659	767	881	997
27	4,648	2	47,080	54,883	63,107	71,538
28	11,498	3	27,626	32,205	37,030	41,978
29	8,133	1	27,855	32,444	37,283	42,243
30	0	0	0	0	0	0
31	1,352	4	100,345	116,793	134,134	151,916
32	0	0	0	0	0	0
33	0	0	0	0	0	0
Total	121,428	143	4,402,605	5,127,996	5,892,714	6,676,755

Source : Estimation of Total - INEC "Projection of Population 1950-2025", December 1992
 Estimation by zone - The JICA Study Team

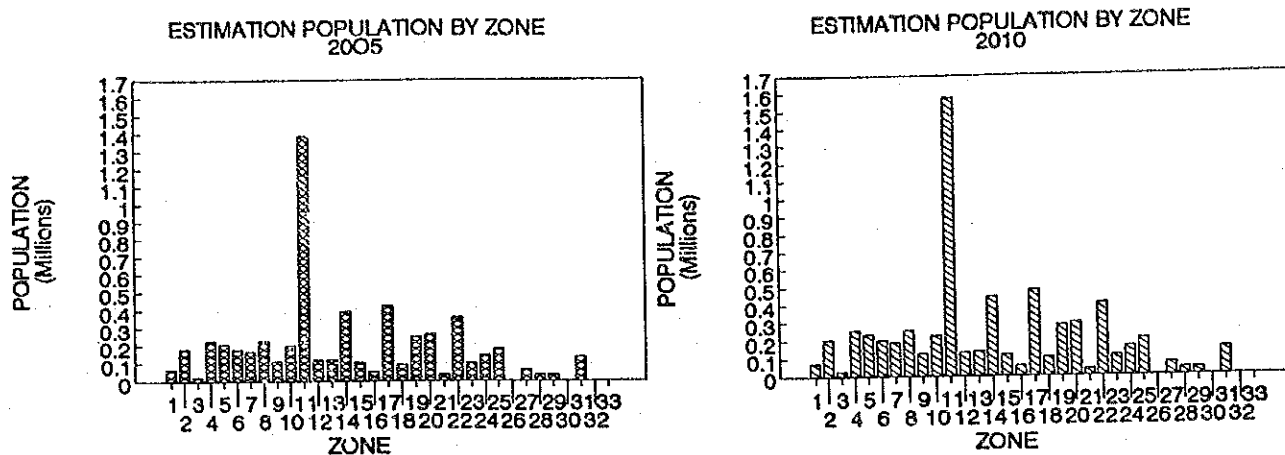


Figure 8-8 Population Estimates by Region

8.3.3 Vehicles Registered

As shown in Section 8.1.5, the number of vehicles registered has been increasing every year, except in 1987, in spite of the decrease in the GDP and per capita income. In particular, the number of vehicles registered in 1992 increased 1.7 times compared with the previous year, although this was exceptional as the government offered a tax exemption to Nicaraguan returning to Nicaragua with cars. In order to estimate number of vehicles registered in the future, a regression analysis was performed by vehicle type. The following model was used.

$$V_i = a_0 + a_1 \text{ GDP} + a_2 \text{ POP} + a_3 \text{ Year}$$

where;

V_i : Number of Type i Vehicles Registered

GDP : Gross Domestic Product

POP : Population

Year : Christian Calendar

$a_0 - a_3$: Parameters

The estimated parameters are shown in Table 8-23.

Table 8-23 Model and Parameters for Vehicles Registered

Vehicle Type	Constant	GDP	Population	Year	Correlation Coefficient
Passenger Car	-1209586.0		626.5748	0.7540023	0.9619
Mini Bus	1088.176	2.140887	-0.8159749		0.9175
Large Bus	-1032.099	0.9544054			0.9518
Pick-up	144248.9		2.938447	-67.71228	0.9068
Medium-size Truck	-25186.53	5.161532	5.562036	1.519141	0.8460
Heavy Truck	10578.64	0.133112	0.5570213	-6.225064	0.9831
Others	-91275.76			46.11765	0.9520

Using the above models, the future number of vehicles registered could be projected. The results are summarized in Table 8-24. In 2010 the number of vehicles registered is projected to about 200 thousand, up from 140 thousand in 1993 (about 1.5 times). Looking at vehicle types, the number of trucks registered is projected to increase more than 2.5 times, although, the number of minibuses is projected to decrease. The latter is a typical trend seen in most developing countries.

Table 8-24 The Number of Vehicles Registered in 2000 and 2010

Vehicle Type	1993	2000	2010	2000/1993	2010/1993
Passenger Car	70,030	79,146	91,953	1.130	1.313
Mini Bus	2,072	1,649	1,622	0.796	0.783
Large Bus	3,408	3,724	5,502	1.093	1.614
Pick-up	43,712	47,417	54,825	1.085	1.254
Medium-size Truck	15,680	24,339	41,234	1.552	2.630
Heavy Truck	1,024	1,686	2,930	1.646	2.861
Others	3,914	6,340	9,812	1.620	2.507
Total	139,840	164,301	207,878	1.175	1.487

3.3.4 Increase in Agricultural Production through Redevelopment

(1) Future Agricultural Production

The Ministry of Agriculture projected future agricultural production for the target year of 1996 in its report entitled "Estrategia Agropecuaria, Forestal Y Agroindustrial de Nicaragua, 1992-1996". However, considering the severe worldwide economic environment of the agricultural market and the slow economic growth of Nicaragua, this targeted production volume seems overly optimistic. On the other hand, if stable economic growth is sustained and the infrastructure, i.e. roads, is improved, agricultural production will increase at a much higher rate than the GDP growth rate indicated in Section 8.3.1. Therefore, in the Study, two agricultural production projections were offered for the country's major agricultural products, they are, coffee, cotton, sugar, banana, rice, maize, sorghum

and beans; one is a projection that follows the GDP growth rate, and the other is a projection that follows the government's agricultural redevelopment target. In the latter case, the target year chosen was 1996; however in the Study, this target year was changed from 1996 to 2010, since it was considered that the government target could not be achieved by 1996, as already mentioned above. The difference between the former projection and the latter is assumed to be based on the indirect effects of road improvements. In Chapter 9, this difference is converted into an increase in traffic generation/attraction as an increase in trips surpassing the normal traffic growth. Table 8-25 shows the above mentioned two projections for all agricultural products.

Table 8-25 Projections for Agricultural Products

Production	1993	2000 Target	2000 Normal	2010 Target	2010 Normal
Coffee	974.0	1,344.2	1,157.8	2,128.0	1,482.1
Cotton	2,700.0	3,673.0	3,209.0	5,700.0	4,108.0
Sugar	2,828.0	2,666.9	2,856.9	2,452.5	2,898.7
Banana	3,840.0	5,409.1	3,879.2	8,824.7	3,936.0
Rice	2,280.0	2,543.0	2,710.0	2,973.0	3,469.0
Maize	6,846.0	7,573.9	6,916.0	8,750.0	7,017.2
Sorghum	2,365.2	2,785.6	2,389.4	3,519.0	2,424.3
Beans	1,596.0	1,802.3	1,612.3	2,144.0	1,635.9

Note : Normal - Projection with a GDP growth rate of 2.5%.
Target - Projection with the government's modified target

(2) Agricultural Production by Zone

Future agricultural production projected in the above section was broken down into zones. Interviews with the Ministry of Agriculture reveal that the above products are now being produced mainly in the following regions, and in the future production volume in the same region is expected to increase.

Table 8-26 Agricultural Production by Zone

Products	Production Region
Coffee	I, II, III, IV, V, VI
Banana	II
Sugar cane	II, III, IV
Cotton	II
Beans	II
Maize	II, IV
Rice	II, III, IV, VI
Sorghum	I, II, III, IV, VI

The above products are carried to consumers around in the country or to ports, from which they are to export, by vehicles. This means that the volume of agricultural production is strongly related to traffic generation/attraction in the production areas. Therefore, using the traffic generation/attraction obtained in the traffic survey, future agricultural production was distributed into zones within the afore-mentioned production regions. Needless to say, the traffic generation/attraction used here was limited to the vehicle generation/attraction carrying only agricultural products. According to the traffic survey, the vehicles used to carry agricultural products included pick-ups, medium-size trucks and trailers. Therefore, in the Study, it is assumed that these three vehicle types would be carrying an increase in production resulting from agricultural redevelopment.

As a result, the expansion rate of the projected production volume resulting from agricultural redevelopment to that resulting from normal growth (2.5% of GDP growth) was estimated by zone, and is shown in Table 8-27 with the relevant data listed in the Appendices.

These projections were used to estimate the increase in trip generation/attraction resulting from the road improvement discussed in Chapter 9.

Table 8-27 Trip Expansion Rate Resulting from Redevelopment and Natural Growth of Agricultural Production

Zone	Pick-up				Medium-size Truck					Heavy Truck		
	GD/GN	GD/GN	AD/AN	AD/AN	GD/GN	GD/GN	AD/AN	AD/AN	GD/GN	GD/GN	AD/AN	AD/AN
	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010	2000	2010
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	1.065	1.177	1.067	1.182	1.064	1.176	1.066	1.180	1.077	1.213	1.077	1.213
3	1.065	1.177	1.067	1.182	1.064	1.176	1.066	1.180	0.000	0.000	0.000	0.000
4	1.065	1.177	1.067	1.182	1.064	1.176	1.066	1.180	1.079	1.218	1.077	1.213
5	1.080	1.198	1.080	1.198	1.081	1.201	1.081	1.199	1.079	1.196	1.078	1.193
6	1.080	1.198	1.080	1.198	1.081	1.201	1.081	1.199	1.079	1.196	1.078	1.193
7	1.061	1.144	1.061	1.144	1.061	1.144	1.061	1.144	1.061	1.144	1.061	1.144
8	1.065	1.177	1.067	1.182	1.064	1.176	1.066	1.180	1.077	1.213	1.077	1.213
9	1.065	1.177	1.067	1.182	1.064	1.176	1.066	1.180	1.077	1.213	1.077	1.213
10	1.065	1.177	1.067	1.182	1.064	1.176	1.066	1.180	1.077	1.213	1.077	1.213
11	1.051	1.132	1.051	1.132	1.050	1.129	1.052	1.133	1.053	1.136	1.052	1.133
12	1.051	1.132	1.051	1.132	1.050	1.129	1.052	1.133	1.053	1.136	1.052	1.133
13	1.092	1.241	1.094	1.244	1.094	1.244	1.093	1.243	1.100	1.266	1.100	1.266
14	1.092	1.241	1.094	1.244	1.094	1.244	1.093	1.243	1.100	1.266	1.100	1.266
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	1.235	1.679	1.230	1.662	1.247	1.710	1.249	1.717	1.217	1.624	1.202	1.580
18	1.235	1.679	1.230	1.662	1.246	1.710	1.249	1.717	1.217	1.624	1.202	1.580
19	1.079	1.205	1.081	1.211	1.079	1.207	1.080	1.207	1.090	1.241	1.091	1.243
20	1.079	1.205	1.081	1.211	1.079	1.207	1.080	1.207	1.090	1.241	1.091	1.243
21	1.235	1.679	1.230	1.662	1.246	1.710	1.249	1.717	1.217	1.624	1.199	1.571
22	1.235	1.679	1.230	1.662	1.247	1.711	1.249	1.718	1.217	1.624	1.202	1.580
23	1.235	1.679	1.230	1.662	1.246	1.710	1.249	1.717	1.217	1.624	1.202	1.580
24	1.079	1.205	1.081	1.211	1.079	1.207	1.080	1.207	1.090	1.241	1.091	1.243
25	1.079	1.205	1.081	1.211	1.079	1.206	1.080	1.207	1.090	1.241	1.091	1.243
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	1.245	1.710	1.220	1.631	1.254	1.733	1.249	1.717	0.000	0.000	1.202	1.580
31	1.051	1.132	1.051	1.132	1.050	1.129	1.052	1.133	1.255	1.778	1.235	1.713

Note : GD - Trip generation by redevelopment
GN - Trip generation by normal growth
AD - Trip Attraction by redevelopment
AN - Trip attraction by normal growth

CHAPTER 9

PROJECTION OF FUTURE TRAFFIC DEMAND

CHAPTER 9 PROJECTION OF FUTURE TRAFFIC DEMAND

9.1 PROJECTION METHOD

Future traffic demands are usually projected using models that represent the quantitative relationship between vehicular trips and socio-economic variables. Such models assume that this relationship will remain the same in the future. To apply such quantitative models, some key data for each zone is necessary. However, in Nicaragua data on the zonal level is not available, except for population data. Nevertheless, future traffic demands can be projected using the simple projection procedures shown in Figure 9-1.

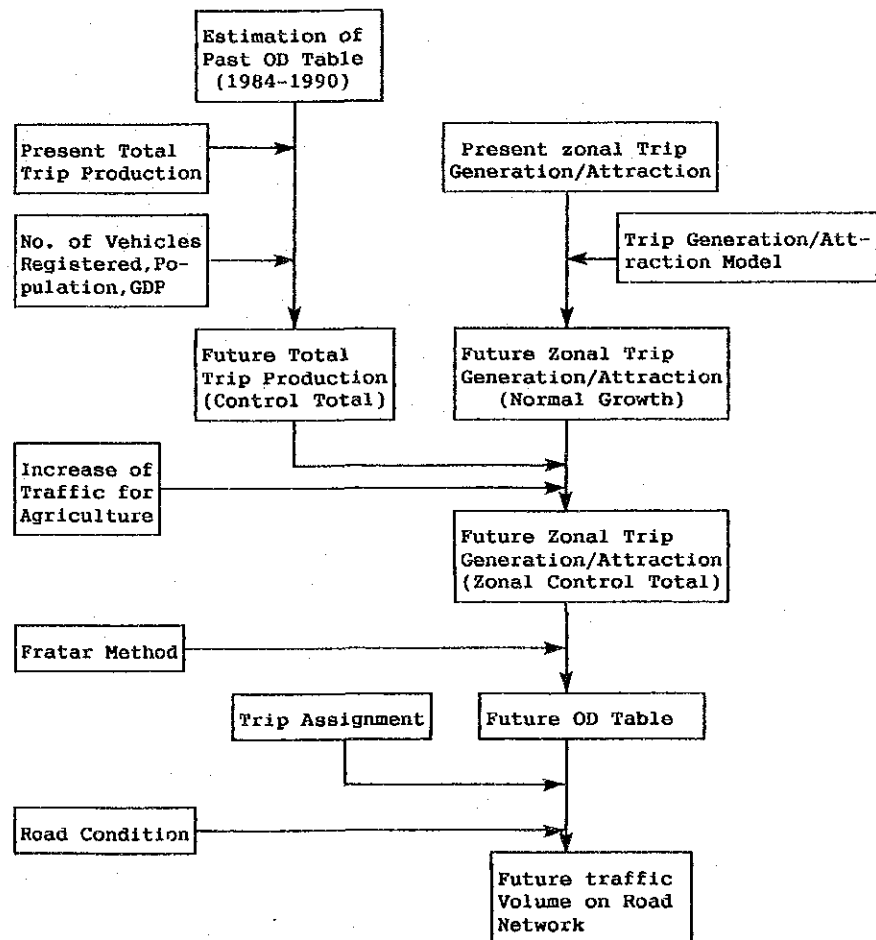


Figure 9-1 Future Traffic Demand Projection Procedures

9.1.1 Estimation of Past O-D Tables

In order to forecast future traffic demands, it is necessary to understand past trends. On the base of the present O-D Table formulated in the Study, past O-D Tables for 1984 to 1990 were created with the past traffic volume on the following road sections as shown in Table 9-1.

Table 9-1 Past Traffic Volume Trends

Station No. 100 (San Benito-Managua)

Year	Traffic Volume (vehicle/day)				Ratio for 1993			
	P1	P2	P3	P4	P1	P2	P3	P4
1990	1,617	216	635	185	0.709	0.507	0.571	1.075
1989	1,467	186	1,636	169	0.643	0.436	1.471	0.982
1988	1,620	153	730	170	0.711	0.360	0.657	0.986
1987	1,816	165	897	204	0.796	0.387	0.807	1.189
1986	1,805	186	909	257	0.792	0.437	0.817	1.493
1985	1,654	179	759	137	0.726	0.419	0.683	0.794
1984	1,788	197	853	129	0.784	0.462	0.767	0.749
1993	2,280	426	1,112	172	1.000	1.000	1.000	1.000

Station No. 107 (Sébaco - San Isidoro)

Year	Traffic Volume (vehicle/day)				Ratio for 1993			
	P1	P2	P3	P4	P1	P2	P3	P4
1990	868	76	261	155	1.091	0.342	0.906	2.309
1989	807	75	277	149	1.014	0.340	0.961	2.226
1988	927	66	334	136	1.165	0.297	1.160	2.028
1987	929	70	450	135	1.167	0.313	1.563	2.021
1986	850	71	376	114	1.068	0.319	1.307	1.699
1985	820	76	335	77	1.030	0.344	1.164	1.147
1984	827	81	307	58	1.039	0.364	1.066	0.870
1993	796	222	288	67	1.000	1.000	1.000	1.000

Station No. 400 (Managua - Masaya)

Year	Traffic Volume (vehicle/day)				Ratio for 1993			
	P1	P2	P3	P4	P1	P2	P3	P4
1990	2,908	438	602	128	0.357	0.352	0.437	0.154
1989	4,047	383	587	104	0.496	0.308	0.427	0.126
1988	4,561	325	626	120	0.559	0.261	0.455	0.146
1987	5,144	369	872	79	0.631	0.296	0.633	0.095
1986	5,312	361	775	95	0.652	0.289	0.563	0.115
1985	4,645	365	725	74	0.570	0.293	0.527	0.090
1984	4,847	420	711	64	0.595	0.337	0.517	0.077
1993	8,152	1,246	1,376	827	1.000	1.000	1.000	1.000

Station No. 1205 (León - Chinandega)

Year	Traffic Volume (vehicle/day)				Ratio for 1993			
	P1	P2	P3	P4	P1	P2	P3	P4
1990	1,576	142	372	338	0.715	0.268	1.037	0.377
1989	1,342	114	344	319	0.609	0.215	0.959	0.356
1988	1,516	127	505	432	0.688	0.239	1.407	0.483
1987	1,774	126	603	333	0.805	0.237	1.680	0.372
1986	1,666	135	559	330	0.756	0.253	1.558	0.368
1985	1,473	158	532	270	0.669	0.297	1.482	0.302
1984	1,594	161	600	260	0.723	0.303	1.671	0.290
1993	2,204	531	359	896	1.000	1.000	1.000	1.000

Source : Traffic Volume (1984-1990) - MCT, Traffic Volume (1993) - The JICA Study Team
 Note : P1 - Passenger Car, P2 - Bus, P3 - Medium-size Truck, P4 - Large Truck

Based on the above O-D Table, past total trip production was estimated from 1984 to 1990 as shown in Table 9-2. These results indicate that past total production has decreased with fluctuation.

Table 9-2 Past Trip Production

Year	Total Trip Production (vehicle/day)
1984	24,908
1985	23,936
1986	26,772
1987	27,017
1988	23,513
1989	21,545
1990	18,680

Note : Excluding intra-zonal traffic volume

9.1.2 Future Total Trip Production

Future total trip production in the objective area was projected for six vehicle types, taking into consideration economic growth and the government's development policy.

Total trip production is expected to grow mirroring the increase in the GDP, population, the number vehicles registered, etc., as well as development or redevelopment of economic activities. Therefore, the relationship between the total trip production and other socio-economic variables was analyzed first applying linear regression analysis to the trip production model. Consequently, parameter values were obtained by vehicle type. These are shown in Table 9-3.

Table 9-3 Parameter Values for the Trip Production Model

Parameter	Passenger Car	Micro Bus	Large Bus	Pick-up	Medium-size Truck	Large Truck	Others
Constant	-29280.04	-1541.436	-1412.093	140135.9	-302785.1	-69.92942	-309.7064
A1	-	0.435655	0.423933	-	-	0.042695	0.080972
A2	6.459041	-	-	1.706036	2.380879	-	0.039595
A3	-	-	-	-69.5423	151.1052	-	-
A4	0.548592	-	-	-	-	-	-
A5	-	0.144459	-	-	-	-	-
A6	-	-	0.483736	-	-	-	-
A7	-	-	-	-	-	-	-
A8	-	-	-	-	-	-	-
A9	-	-	-	-	-	0.473217	-
A10	-	-	-	-	-	-	-
Correlation Coefficient	0.6836	0.9056	0.8643	0.5447	0.6275	0.8577	0.7180

Note : A1 - Population, A2 - GDP, A3 - Year, A4 - No. of Passenger Car, A5 - No. of Micro Bus
A6 - No. of Large Bus A7 - No. of Pick-up, A8 - No. of Medium-size Truck
A9 - No. of Large Truck, A10 - No. of Other type of vehicles

Future total vehicle trip production was forecast using the above production model (the constant values of the above parameters being adjusted in 1993). The total trip production was forecast to reach 41,953 trips in 2000 (1.4 times of the 1993 figure) and 62,325 trips in 2010 (2.2 times). Table 9-4 shows future trip production by vehicle type. These values are used as the "Control Total" for vehicular trip generation and attraction by zone.

Table 9-4 Future Trip Production by Vehicle Type

Vehicle Type	1993	2000	2010	2000/1993	2010/1993
Passenger Car	10,427	16,283	27,313	1.555	2.608
Micro Bus	1,492	1,650	2,321	1.106	1.556
Large Bus	2,174	2,540	4,057	1.168	1.866
Pick-up	9,498	12,361	15,723	1.301	1.655
Medium-size Truck	4,711	6,257	9,244	1.328	1.962
Heavy Truck	2,249	2,584	3,239	1.149	1.440
Others	229	278	428	1.213	1.868
Total	30,825	41,953	62,325	1.361	2.022

9.1.3 Future Zonal Trip Generation and Attraction

The future trip generation and attraction by zone was forecast using the trip generation model and trip attraction model. Since only population data is available on a zonal level, the following simple model was used.

$$GT_i = A_i + B_i \times POP_i$$

$$AT_i = C_i + D_i \times POP_i$$

where; GT : Trip Generation
 AT : Trip Attraction
 POP : Population
 i : Vehicle Type
 A,B,C,D : Parameters

The values of parameters were obtained by regression analysis. The results are summarized in Table 9-5.

With the above trip generation model and trip attraction model, the future trip generation and trip attraction were forecast by vehicle type. Zone 17 (León), Zone 21 (Chinandega), Zone 10 (Masaya), and Zone 8 (Jinotepe) show highest growth rate. The results are summarized in Table 9-6.

Table 9-5 Values of Parameters of Generation and Attraction Models

Type of Vehicle	Trip	Aj or Cj	Bj or Dj	γ
Passenger Car	Generation	-2.47233	1.457728	0.7029
	Attraction	-2.413177	1.447462	0.6923
Micro Bus	Generation	-4.859936	1.571722	0.8865
	Attraction	-4.281951	1.536073	0.8998
Large Bus	Generation	-3.937422	1.503646	0.8674
	Attraction	-3.818874	1.504206	0.9012
Pick-up	Generation	-3.460204	1.729744	0.8461
	Attraction	-2.681962	1.577929	0.9339
Medium-size Truck	Generation	-1.956399	1.329263	0.9253
	Attraction	-1.874336	1.303386	0.8932
Large Truck	Generation	-2.944543	1.144482	0.3217
	Attraction	-2.672161	1.114779	0.3935
Others	Generation	-3.456535	0.9831205	0.2094
	Attraction	-2.949806	0.8943135	0.2018

Note : Aj , Bj, Cj, Dj - Parameter
 γ - Correlation Coefficient

Table 9-6 Future Trip Generation and Attraction by Zone

Zone	1993		2000		2010		2000/1993		2010/1993	
	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)
1	58	59	79	78	109	114	1.360	1.328	1.886	1.928
2	832	1,030	1,198	1,465	1,858	2,246	1.440	1.422	2.233	2.181
3	41	40	60	58	97	89	1.466	1.447	2.358	2.218
4	1,994	2,123	2,783	2,939	4,182	4,334	1.395	1.384	2.097	2.041
5	332	310	469	430	694	629	1.411	1.387	2.089	2.029
6	396	365	565	502	831	741	1.427	1.376	2.099	2.030
7	205	189	282	254	403	376	1.377	1.342	1.967	1.987
8	1,853	1,457	2,675	2,080	4,133	3,242	1.444	1.428	2.230	2.225
9	664	634	939	867	1,407	1,322	1.414	1.367	2.119	2.085
10	3,940	4,145	5,644	5,921	8,564	9,190	1.433	1.428	2.174	2.217
11	12,484	12,026	17,331	16,762	25,949	25,274	1.388	1.394	2.079	2.102
12	577	599	807	839	1,215	1,287	1.399	1.400	2.106	2.148
13	349	361	482	496	697	718	1.382	1.374	1.998	1.989
14	663	745	917	1,022	1,312	1,480	1.383	1.372	1.978	1.986
15	6	12	8	16	12	25	1.383	1.368	1.923	2.054
16	2	5	3	7	4	11	1.399	1.378	1.975	2.101
17	1,277	1,257	1,832	1,817	2,873	2,861	1.435	1.446	2.250	2.276
18	59	59	87	87	135	137	1.479	1.467	2.283	2.322
19	626	710	891	992	1,332	1,499	1.423	1.397	2.127	2.111
20	164	173	233	235	330	336	1.423	1.356	2.011	1.943
21	252	307	364	439	564	681	1.443	1.432	2.239	2.217
22	1,558	1,672	2,269	2,390	3,590	3,736	1.456	1.430	2.304	2.234
23	360	288	524	430	833	687	1.456	1.493	2.315	2.386
24	307	273	440	378	657	561	1.433	1.386	2.141	2.055
25	378	342	529	480	769	715	1.400	1.403	2.035	2.090
26	1	0	1	0	2	0	1.302	-	1.657	-
27	1	3	1	4	2	7	1.310	1.489	1.675	2.416
28	1	0	1	0	2	0	1.310	-	1.675	-
29	0	1	0	1	0	2	-	1.332	-	1.971
30	28	28	18	6	10	16	0.657	0.214	0.357	0.571
31	705	793	713	1,083	1,487	1,612	1.012	1.366	2.109	2.033
32	380	452	446	502	557	660	1.173	1.111	1.466	1.460
33	332	367	407	420	555	579	1.226	1.143	1.672	1.576
Total	30,825	30,825	43,000	43,000	65,164	65,164	1.395	1.395	2.114	2.114

Note : (G) - Trip Generation, (A) - Trip Attraction

9.1.4 Traffic Increment Through Increasing Agricultural Production Resulting from Redevelopment Policy of the Government

Since the new government was established in 1990, redevelopment of agriculture has been emphasized as a national project in order to fuel the domestic economy and increase exports. Therefore, under this policy vehicles carrying agricultural products are expected increase more than the normal growth rate noted above.

In section 8.2.3, agricultural production based on "normal growth" and "planned growth" is estimated by zone. According to the O-D survey conducted in the Study, almost all agricultural products are carried by pick-ups, medium-size trucks and trailers. The number of vehicles carrying agricultural products (not counting those carrying other goods and commodities) is expected to increase after the new agricultural redevelopment policy begins to have an effect. Therefore, it is assumed that vehicle volume resulting from the agricultural redevelopment policy will increase at the same rate as the agricultural production itself. Table 9-7 summarized this estimate vehicle volume increase through the analysis shown in Section 8.3.5.

9.1.5 Future O-D Table Forecast

Using the afore-mentioned vehicle trips by zone, a future O-D table was forecast by applying the Fratar Method based on the present O-D pattern as an initial value for the years 2000 and 2010.

(1) The Fratar Method

Generally speaking, three models may be used to project future trip distribution.

- ① Present Pattern Model
- ② Gravity Model
- ③ Opportunity Model

The Fratar Method is one of the present pattern model, and its basic assumptions are as follows:

- ① The distribution of future trips from a given zone of origin will be proportional to the present trip distribution in that zone.
- ② The distribution of these future trips will be modified by the growth factor of the zone to which these trips are attracted.

Table 9-7 Vehicle Volume Increase Resulting from Agricultural Redevelopment

Year Zone	Pick-up				Medium-Size Truck				Large Truck			
	2000		2010		2000		2010		2000		2010	
	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)	(G)	(A)
1	0	0	0	0	0	0	0	0	0	0	0	0
2	15	16	41	44	10	13	27	34	0	1	1	4
3	0	1	1	2	0	0	1	1	0	0	0	0
4	41	56	111	151	13	18	36	50	5	4	15	11
5	10	9	25	22	6	3	16	6	0	0	0	0
6	11	8	27	20	9	3	23	8	0	1	1	2
7	3	2	8	5	5	2	12	4	0	0	0	1
8	31	19	85	52	12	11	32	30	2	1	5	3
9	13	9	36	26	7	6	19	17	5	6	14	16
10	95	69	260	187	21	20	57	53	8	7	22	20
11	162	175	417	448	58	68	150	175	39	33	99	84
12	8	7	21	17	3	4	8	12	0	0	0	0
13	15	16	40	41	6	6	16	15	0	0	1	1
14	31	30	82	79	10	9	26	23	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	84	93	243	267	24	24	68	69	2	4	6	12
18	5	4	13	11	2	2	6	6	1	0	3	1
19	15	16	40	41	9	10	24	27	1	1	2	3
20	7	5	14	13	5	2	13	5	0	0	0	0
21	10	17	30	48	5	7	13	19	11	9	33	25
22	91	99	262	285	18	19	53	55	25	19	73	55
23	19	20	54	59	6	3	18	8	1	2	2	5
24	9	7	19	20	5	3	13	8	1	0	2	0
25	13	9	33	24	5	6	12	17	1	0	1	1
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0
30	1	0	4	1	2	1	6	1	0	5	0	14
31	7	9	19	22	5	6	10	16	3	12	14	36
Total	696	696	1,885	1,885	246	246	659	659	105	105	295	295

Note : (G) - Trip Generation, (A) - Trip Attraction

Below, this method is explained.

a) Step 1 : Present O-D Table (Given)

The present O-D Table uses the following symbols:

	1	2	.....	j	.....	k	Generation
1	x_{11}	x_{12}	.....	x_{1j}	.....	x_{1k}	g_1
2	x_{21}	x_{22}	.....	x_{2j}	.....	x_{2k}	g_2
.
.
i	x_{i1}	x_{i2}	.....	x_{ij}	.....	x_{ik}	g_i
.
.
k	x_{k1}	x_{k2}	.....	x_{kj}	.....	x_{kk}	g_k
Attraction	a_1	a_2	.....	a_j	.....	a_k	t

b) Step 2 : Future Trip Generation and Attraction

In the future O-D Table, trip distribution is unknown; nevertheless, the trip generation and trip attraction of each zone should be projected before applying this method. The following symbols are attached to the future O-D Table.

	1	2	.....	j	.....	k	Generation
1	X ₁₁	X ₁₂	.....	X _{1j}	.....	X _{1k}	G ₁
2	X ₂₁	X ₂₂	.....	X _{2j}	.....	X _{2k}	G ₂
.
.
i	X _{i1}	X _{i2}	.....	X _{ij}	.....	X _{ik}	G _i
.
.
k	X _{k1}	X _{k2}	.....	X _{ki}	.....	X _{kk}	G _k
Attraction	A ₁	A ₂	.....	A _j	.....	A _k	T

c) Step 3 : Mathematical Calculation

Mathematically, the Fratar method can be expressed as follows:

$$X'_{ij} = x_{ij} \times F_i \times (L_i + L_j)/2$$

$$L_i = \sum_j x_{ij} / (\sum_j x_{ij} \times F_j)$$

$$L_j = \sum_i x_{ij} / (\sum_i x_{ij} \times F_i)$$

$$F_i = G_i / g_i$$

$$F_j = A_j / a_j$$

In the above equation until $\sum_j X_{ij} = G_i$ and $\sum_i X_{ij} = A_j$, the convergency calculation is continued. Usually, the calculation is stopped when the error ratio gets to within 5%.

(2) Future O-D Table

Tables 9-8 and 9-9 show the future O-D Tables. About 40% of all traffic will be concentrated in Zone 11 (Managua), with the next highest concentration being in Zone 10 (Masaya) by the year 2010. The trip distribution is shown in Figure 9-2.

Table 9-8 Future O-D Table in 2000

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total	
1	0	0	0	1	0	0	0	1	0	3	68	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	74	
2	0	0	10	40	1	0	0	86	9	44	786	1	0	0	0	0	1	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0	198	1181	
3	0	18	0	0	0	0	0	1	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	
4	1	40	0	0	1	0	0	94	78	691	1814	7	1	12	0	0	2	0	3	0	2	4	1	0	0	0	0	0	0	0	3	0	6	2760	
5	1	9	1	4	0	61	0	1	0	17	312	15	10	3	0	0	0	0	4	0	0	1	0	1	0	1	0	0	0	0	3	0	9	482	
6	0	12	0	9	67	0	1	0	0	12	442	2	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	553	
7	0	0	0	5	1	0	0	0	0	8	264	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	278	
8	1	129	0	169	4	4	4	0	0	0	2250	14	2	1	0	0	1	0	0	2	0	17	0	1	1	3	0	0	0	0	0	0	1	2654	
9	3	31	0	166	0	0	0	0	0	0	712	0	0	14	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	928	
10	1	94	0	825	14	22	0	14	43	0	4259	128	9	46	4	0	16	0	44	4	13	57	0	7	0	0	0	0	0	0	3	5	5613		
11	63	957	44	1630	307	401	242	1815	686	4845	0	631	151	503	6	3	1064	18	372	161	288	1198	105	64	127	0	3	0	1	5	998	432	143	17263	
12	0	0	0	17	3	5	0	24	3	113	576	0	5	20	0	0	5	0	4	2	1	4	8	0	1	0	0	0	0	0	0	0	0	791	
13	0	0	0	1	5	1	0	0	10	12	126	0	0	200	1	0	28	0	57	11	0	10	0	0	0	2	0	0	0	0	0	0	0	464	
14	0	2	0	12	0	0	0	1	0	21	588	8	172	0	0	0	13	1	81	4	2	12	0	0	0	0	0	0	0	0	0	1	0	899	
15	0	0	0	0	0	0	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	
16	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
17	0	5	0	2	1	0	0	6	2	93	810	2	49	21	0	0	0	52	18	6	53	630	49	0	1	0	0	0	0	0	0	1	5	1807	
18	0	0	0	0	0	0	0	0	0	0	19	0	1	4	1	0	39	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	77
19	2	0	0	1	7	0	0	0	2	9	381	6	53	105	0	0	13	0	0	34	0	5	0	73	169	0	0	0	0	0	0	1	1	0	867
20	0	0	0	1	0	0	0	0	10	5	128	0	0	35	0	0	4	0	37	0	0	0	0	0	0	3	0	0	0	0	0	0	0	223	
21	0	7	0	7	0	0	0	1	4	5	295	0	0	2	0	0	32	0	0	0	0	0	61	0	1	5	0	0	0	0	0	1	0	551	
22	0	18	0	3	0	0	0	2	0	13	1257	2	13	3	0	0	564	5	11	0	52	0	260	16	0	0	0	0	0	0	0	0	25	0	2244
23	0	8	0	0	0	0	0	0	0	0	136	0	0	4	0	0	10	4	0	0	14	320	0	0	0	0	0	0	0	0	0	3	0	17	516
24	0	0	0	1	2	0	0	0	0	0	72	5	0	9	0	0	180	0	0	0	0	2	0	0	0	157	0	0	0	0	0	0	1	0	429
25	0	0	0	0	1	0	0	0	0	2	150	0	4	0	0	0	0	0	149	0	3	1	0	205	0	0	0	0	0	0	0	0	2	517	
26	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
27	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
28	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	1	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
31	0	0	0	2	0	0	0	8	3	0	686	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	700
32	0	0	0	3	0	0	0	2	2	2	364	0	0	8	0	0	0	0	0	2	0	0	25	0	1	0	0	0	0	0	0	0	0	28	437
33	0	112	0	10	1	0	0	9	0	0	233	0	0	0	0	0	2	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	21	0	398
Total	72	1442	55	2911	415	494	248	2066	852	5895	16696	821	481	994	12	51	1794	80	964	225	429	2364	423	369	470	0	3	0	1	5	1071	491	409	42558	

Table 9-9 Future O-D Table in 2010

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	Total	
1	0	0	0	2	0	0	0	2	0	5	95	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	105	
2	0	0	17	64	2	0	0	142	15	74	1223	2	0	0	0	0	2	0	4	0	2	4	0	0	0	0	0	0	0	0	0	0	281	1832	
3	0	32	0	0	0	0	0	2	0	0	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93		
4	1	68	0	0	2	0	0	148	120	1080	2673	11	2	18	0	4	0	0	5	0	4	6	2	0	0	0	0	0	0	0	5	0	9	4158	
5	1	15	2	8	0	93	0	2	0	27	453	23	15	6	0	0	0	0	7	0	0	2	0	1	0	0	0	0	0	0	6	0	14	675	
6	0	20	0	15	101	0	2	0	0	21	642	4	9	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	818	
7	0	0	0	8	2	0	0	0	0	12	373	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	395	
8	2	208	0	261	6	7	6	0	0	0	3467	23	3	2	0	0	2	0	0	4	0	28	0	1	8	0	0	0	0	0	77	2	0	4107	
9	5	48	0	248	0	0	0	0	0	0	1087	0	0	22	0	0	2	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1594	
10	2	149	0	1255	22	33	0	21	64	0	6441	192	15	68	8	0	27	0	69	7	22	90	0	11	0	0	0	0	0	0	5	9	8	8518	
11	93	1447	68	2337	442	583	359	2802	1042	7494	0	967	210	720	10	3	1618	27	558	227	428	1819	164	94	184	0	5	0	1	13	1474	551	191	25933	
12	0	0	0	25	5	8	0	36	5	177	859	0	7	29	0	0	8	0	5	3	2	8	14	0	2	0	0	0	0	0	0	0	0	1193	
13	0	0	0	1	7	2	0	0	15	17	174	0	0	283	2	0	45	0	89	17	0	17	0	0	4	0	0	0	0	0	0	0	0	673	
14	0	4	0	19	0	0	2	0	2	30	797	13	245	0	0	0	20	2	123	6	4	19	0	0	0	0	0	0	0	0	2	0	0	1288	
15	0	0	0	0	0	0	0	0	0	0	8	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	
16	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
17	0	8	0	4	2	0	0	9	4	144	1231	4	78	34	0	0	0	0	84	28	9	87	1027	76	0	2	0	0	0	1	2	8	0	2842	
18	0	0	0	0	0	0	0	0	0	0	28	0	0	2	6	2	0	64	0	0	0	0	10	0	0	0	0	0	0	0	14	0	0	126	
19	2	0	0	2	11	0	0	0	4	13	366	9	90	157	0	0	22	0	0	50	0	7	0	113	235	0	0	0	0	0	2	2	0	1305	
20	0	0	0	2	0	0	0	0	15	8	174	0	0	52	0	0	7	0	56	0	0	0	0	0	6	0	0	0	0	0	0	0	0	320	
21	0	12	0	12	0	0	0	2	7	9	336	0	0	4	0	0	56	0	0	0	0	102	0	2	9	0	0	0	0	0	2	0	0	553	
22	0	30	0	6	0	0	0	4	0	21	1931	4	20	6	0	0	928	8	19	0	87	0	424	26	0	0	0	0	0	0	0	39	0	3553	
23	0	15	0	0	0	0	0	0	0	0	214	0	0	7	0	0	16	6	0	0	22	511	0	0	0	0	0	0	0	0	5	0	26	822	
24	0	0	0	2	3	0	0	0	0	0	105	7	0	17	0	0	0	0	275	0	0	3	0	0	0	232	0	0	0	0	0	2	0	646	
25	0	0	0	2	0	0	0	0	0	4	213	0	5	0	0	0	0	0	223	0	4	2	0	303	0	0	0	0	0	0	0	0	3	759	
26	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
27	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
28	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
31	0	0	0	15	6	0	0	29	11	6	1368	6	0	6	0	1	9	4	8	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1471
32	0	0	0	2	0	0	0	3	3	3	449	0	0	8	0	0	0	0	3	0	0	30	0	0	0	0	0	0	0	0	0	0	0	39	540
33	0	165	0	15	0	0	0	15	0	0	901	0	0	0	0	0	4	0	0	0	0	12	0	0	0	0	0	0	0	0	0	31	0	543	
Total	106	2221	87	4305	613	728	369	3221	1307	9145	25258	1265	701	1452	22	8	2830	131	1472	325	662	3699	680	551	702	0	5	0	1	14	1594	644	571	64689	

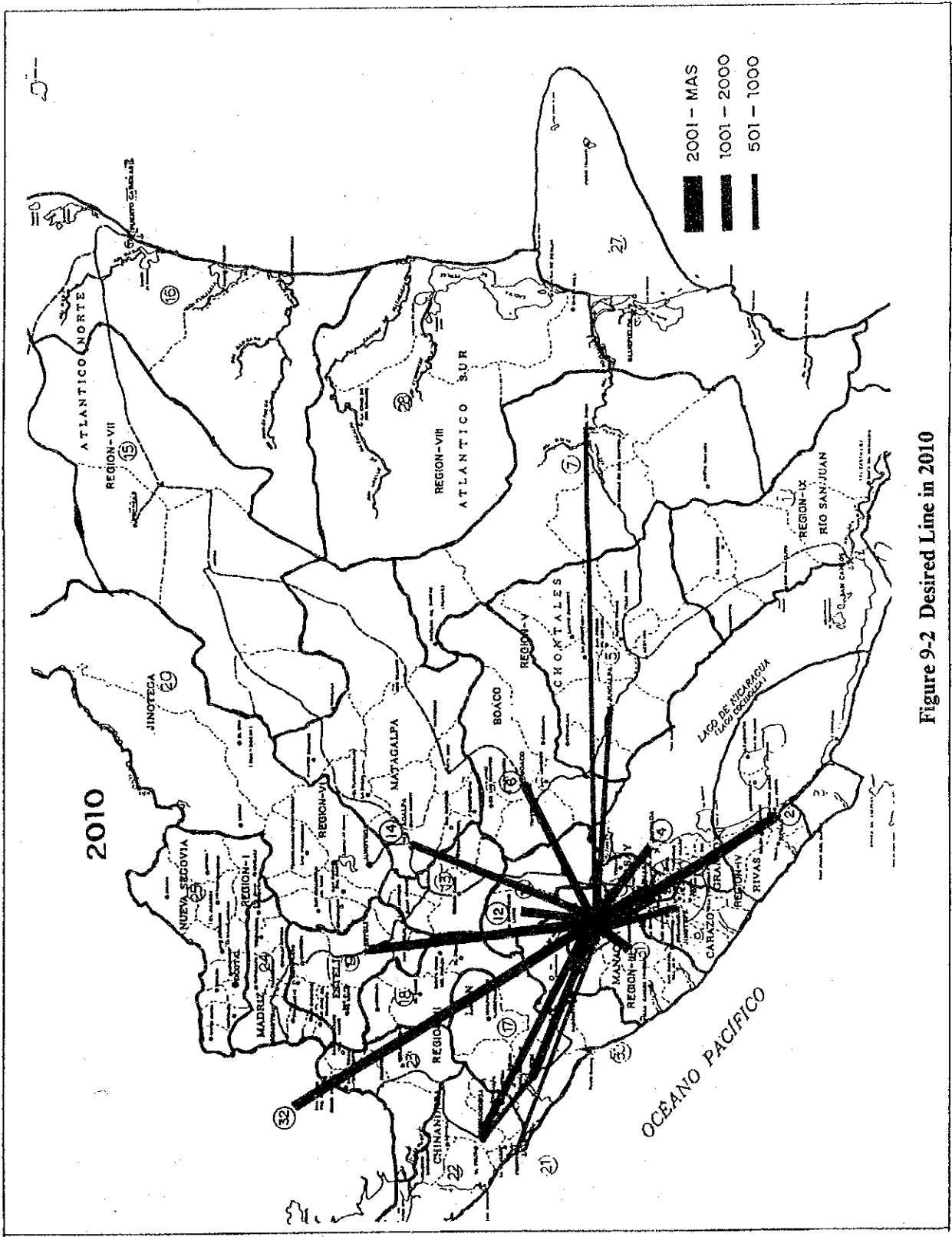


Figure 9-2 Desired Line in 2010

9.2 FUTURE TRAFFIC ASSIGNMENT

(1) Traffic Assignment Model

With the future O-D table forecast above, traffic volume on the road network was estimated using the QV traffic assignment method. In this QV Method the travel time of each O-D pair is calculated using the QV formula, which expresses the relationship between the traffic volume and running speed on each link of the road network. The QV formula is determined by taking into account the characteristics of each road section, including the number of lanes, design speed, geographical conditions, etc. Generally, this formula takes the following form.

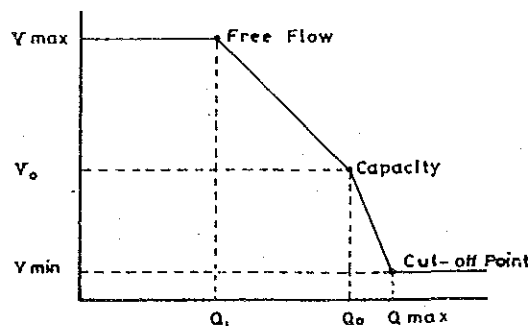


Figure 9-3 Q-V Formula

(2) Traffic Assignment Results

Traffic assignment was performed for "Without Project Case", and for the seven sub-networks defined in section 10.3. At this time, all the road improvement projects indicated in section 10.7 were considered. Future traffic volume on the road section, Managua-Masaya, was projected to increase to 22,000 vehicles from 12,000 vehicles in 1993. The assignment results are shown in Figure 9-4 for major roads, comparing traffic volume in 2010 with that in 1993.

Traffic assignment results also indicated the average speed and average congestion rate. These are shown in Table 9-10. Present average speed is 47.5 km/h, however, if nothing is done in the future, the average speed will decrease to 44.1 km/h in 2010. On the other hand, average congestion would increase from 0.34 in 1993 to 0.75 in 2010. Of the seven sub-networks, Sub-network-1 shows the highest project effect in terms of both average speed and average congestion.

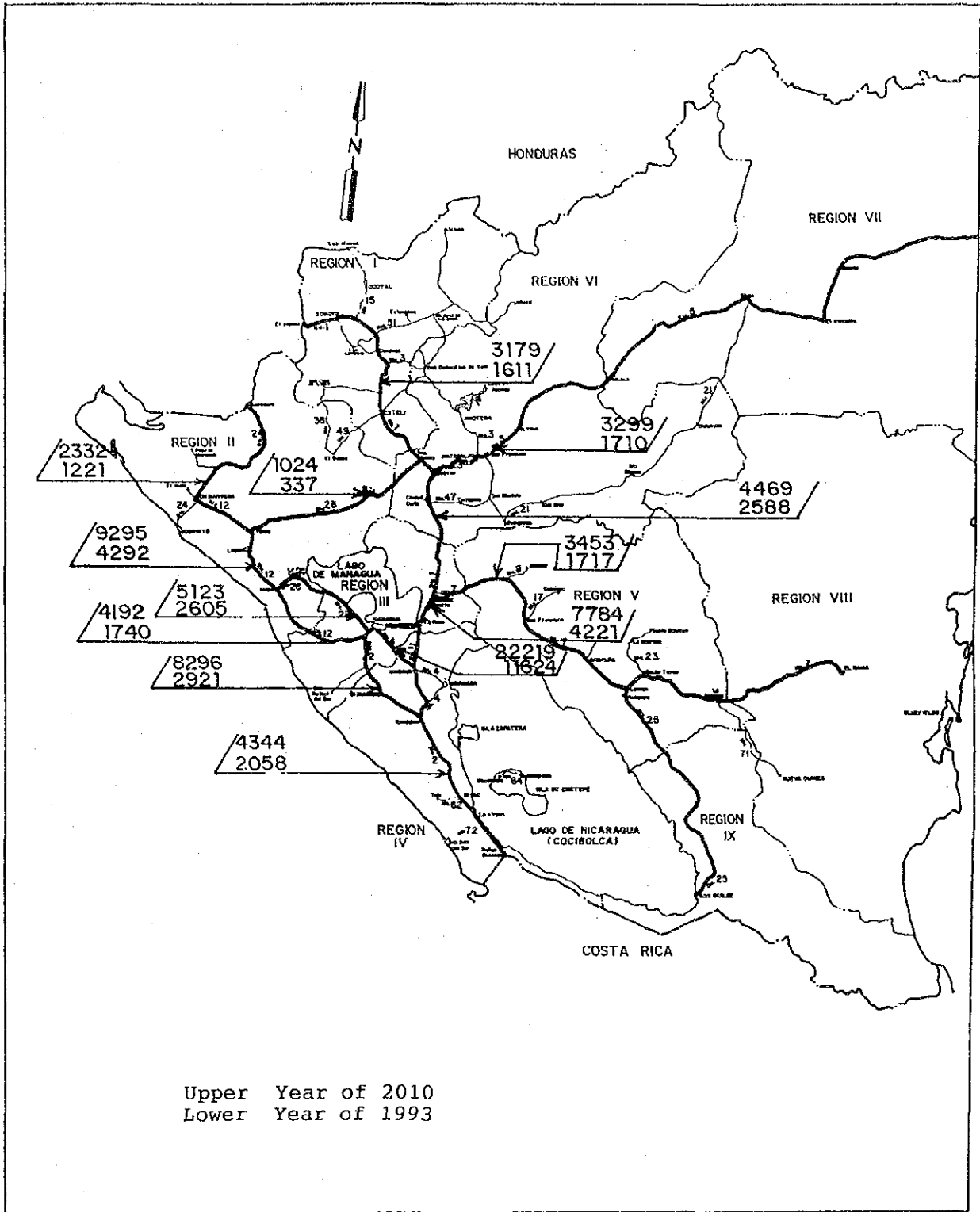


Figure 9-4 Future Traffic Volume on the Road Network

Table 9-10 Average Speed and Congestion Rate by Subnetwork

Case	Average Speed (km/hr)			Average Congestion Rate		
	1993	2000	2010	1993	2000	2010
Without Case	47.5	45.7	44.1	0.34	0.48	0.75
Sub-network-1	-	49.0	46.7	-	0.42	0.63
Sub-network-2	-	47.0	46.6	-	0.47	0.73
Sub-network-3	-	48.5	46.5	-	0.45	0.70
Sub-network-4	-	47.2	45.7	-	0.46	0.72
Sub-network-5	-	46.3	44.8	-	0.47	0.73
Sub-network-6	-	46.6	45.0	-	0.47	0.73
Sub-network-7	-	45.9	44.3	-	0.47	0.73

Table 9-11 shows the total vehicle hours by case. Since the major road network will not be altered in the future, total vehicle running kilometer will be the same in all the sub-networks. Table 9-12 shows the saving vehicle hours, which are used to evaluate projects.

Table 9-11 Total Vehicle Hours by Case

(Unit : vehicle*hours)

Case	Year	Passenger Car	Microbus	Bus	Medium-Size Truck	Heavy Truck	Others	Total
Without Case	2000	38,901	3,564	7,521	35,205	21,974	12,273	119,438
	2010	73,690	5,636	13,413	52,600	35,742	17,633	198,714
Sub-Network-1	2000	32,397	3,005	6,553	30,299	19,320	11,318	102,892
	2010	59,014	4,600	11,418	44,124	30,550	16,139	165,845
Sub-Network-2	2000	37,429	3,531	7,358	34,406	21,276	11,819	115,819
	2010	71,134	5,586	13,141	51,494	34,649	17,054	193,058
Sub-Network-3	2000	34,408	3,102	6,559	31,687	20,339	9,616	105,711
	2010	63,259	4,748	11,218	45,428	32,107	12,925	169,685
Sub-Network-4	2000	38,251	3,481	7,384	34,496	21,398	11,923	116,933
	2010	72,583	5,513	13,198	51,668	34,880	17,189	195,031
Sub-Network-5	2000	38,723	3,531	7,440	34,841	21,773	12,227	118,535
	2010	73,383	5,591	13,282	52,099	35,433	17,574	197,362
Sub-Network-6	2000	38,764	3,542	7,470	34,914	21,694	12,243	118,627
	2010	73,455	5,602	13,326	52,215	35,326	17,598	197,522
Total	2000	38,890	3,559	7,517	35,120	21,912	12,272	119,270
	2010	73,670	5,628	13,404	52,489	35,650	17,632	198,473

Table 9-12 Saving Vehicle Hours by Case

(Unit : vehicle*hours)

Case	Year	Passenger Car	Microbus	Bus	Medium-Size Truck	Heavy Truck	Others	Total
Sub-Network-1	2000	6,504	559	968	4,906	2,654	955	16,546
	2010	14,676	1,036	1,995	8,476	5,192	1,494	32,869
Sub-Network-2	2000	1,472	33	163	799	698	454	3,619
	2010	2,556	50	272	1,106	1,093	579	5,656
Sub-Network-3	2000	4,493	462	962	3,518	1,635	2,657	13,727
	2010	10,431	888	2,195	7,172	3,635	4,708	29,029
Sub-Network-4	2000	650	83	137	709	576	350	2,505
	2010	1,107	123	215	932	862	444	3,683
Sub-Network-5	2000	178	33	81	364	201	46	903
	2010	307	45	131	501	309	59	1,352
Sub-Network-6	2000	137	22	51	291	280	30	811
	2010	235	34	87	385	416	35	1,192
Total	2000	13,434	1,192	2,362	10,587	6,044	4,492	38,111
	2010	29,312	2,176	4,895	18,572	11,507	7,319	73,781

CHAPTER 10

**ROAD NETWORK
IMPROVEMENT PLAN**

CHAPTER 10 ROAD NETWORK IMPROVEMENT PLAN

10.1 GENERAL

In the Study, the major road network improvement Master Plan for the whole of Nicaragua was formulated with a target year of 2010 on the basis of a comprehensive examination of the strategies and the process of its establishment. In addition, high priority projects for the Feasibility Study were selected through technological and economic examinations.

10.2 ROAD NETWORK STRATEGIES

10.2.1 Purpose and Planning Issues

The purpose of the Master Plan is to examine the necessity of extending the road network and/or improving existing road conditions by the target year of 2010, then to select high priority projects from various viewpoints. In order to achieve this purpose, the following planning issues were analyzed and examined in the process of establishing of the Master Plan, considering current and future socio-economic circumstances as well as road conditions.

- ① Capacity of road network capacity to meet traffic demand.
- ② Determination of road functions.
- ③ Consistency with the Central American Highway in other Central American countries as a part of the international road.
- ④ Promotion of agricultural redevelopment.
- ⑤ Export and import support.
- ⑥ Traffic safety consideration.
- ⑦ Environmental consideration.
- ⑧ Recommendation of feasible projects.

10.2.2 Process of the Master Plan Formulation

The process of formulation of the Master Plan starts by defining determining the function of each road in the road network. Thereafter, the expected or desired improvement level is examined on the basis of an analysis of existing road conditions in Chapter 3, present traffic demand in Chapter 4, and future traffic projections in Chapter 9. Under this improvement level, the Master Plan is formulated for the seven sub-networks indicated in Figure 10-1, considering road design criteria, traffic safety measures and road disaster preventions. From among these seven sub-networks, objective projects in the Feasibility Study are selected by performing not only an economic evaluation but also an overall evaluation. The above process is shown in more detail in Figure 10-1.

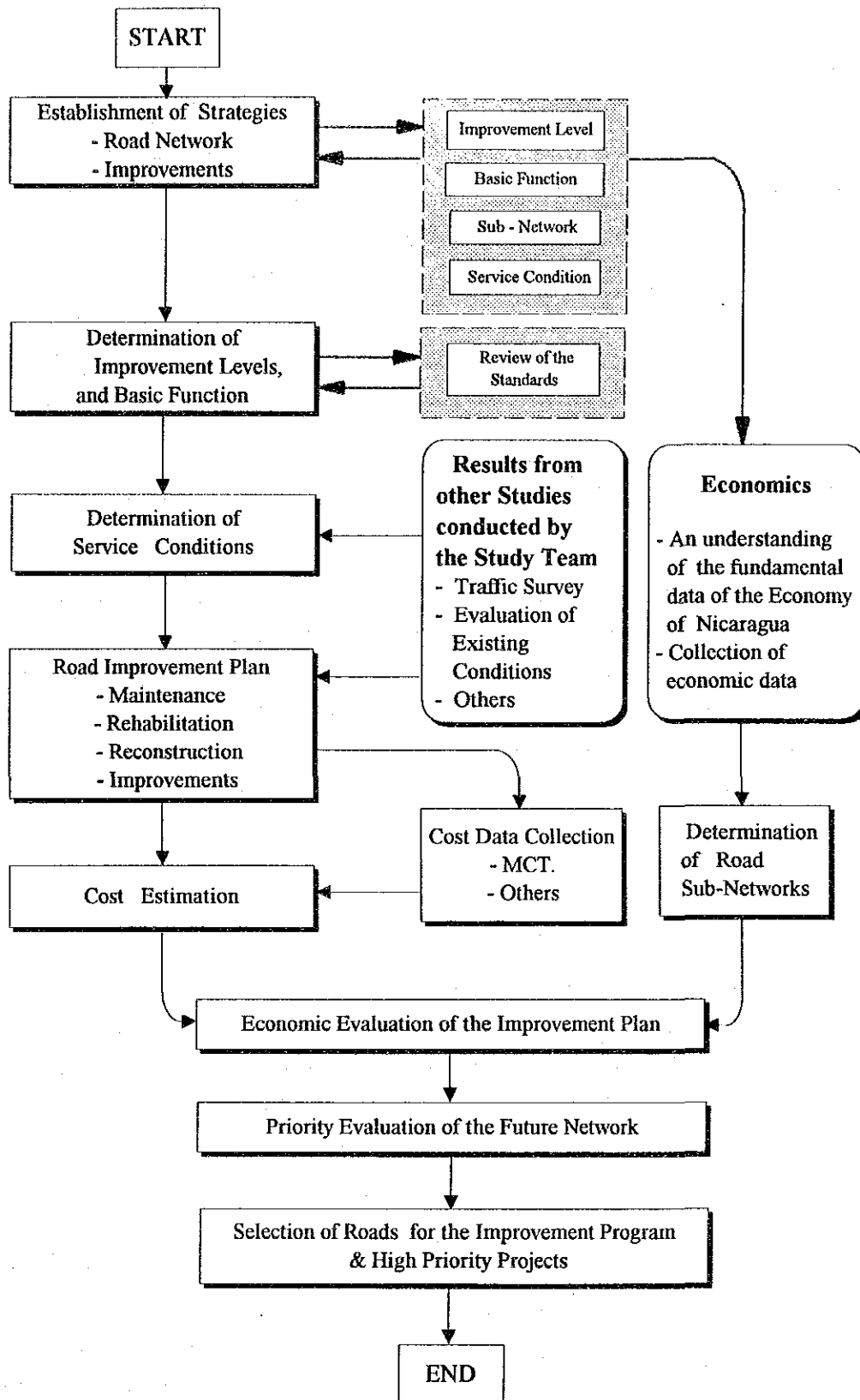


Figure 10-1 Formulation Process of the Road Network Master Plan

10.2.3 Elements of Road Functions

The basic road network is made up of many roads connecting many communities; however, some of these roads are much important than others because they are in areas of high population concentration, where there is an agglomeration of socio-economic activities, or where consumption markets are linked with production areas, access to the administrative and commercial centers, etc. At the same time, some roads are useful only for local residents. In any case, each road in the network plays a specific role according to its elements of road functions. Future road improvement should be determined only after taking the elements of the road functions into consideration. The typical elements of road functions in Nicaragua are characterized as follows:

(1) Element 1 - Connection of Communities

There are 143 municipalities, and many villages and communities in Nicaragua. These communities are connected to each other by roads, and although some of them are high standard roads, others are narrow and unpaved with some of them becoming impassable during the rainy season. Naturally, roads connecting larger communities are much more important. Among others, the roads that connect the municipalities listed in Table 10-1 will play a very important role in the future road network of Nicaragua. The hierarchical road structure is shown in Figure 10-2.

(2) Element 2 - Access to Busy Areas

Securing the access to busy areas such as commercial centers, administrative centers, industrial areas, etc. is one of the important roles that a road network plays. In Nicaragua, Managua, Masaya, León, Chinandega, Granada enjoy easy access to a wide variety of places as shown in Figure 4-11.

(3) Element 3 - Promotion of Exports and Imports

Exports and imports are of critical importance to all countries. In Nicaragua almost all consumption goods and industrial raw materials are important from abroad; therefore, exports are particularly significant. At present the Central American Highway plays an important role in this respect. In particular, the access road leading from Puerto Corinto to the various agricultural and consumption areas around the country must be improved as part of any road network plan.

Table 10-1 Principal Municipalities in Nicaragua

Municipality	Population	Municipality	Population
Region I		Region V	
Ocotal	7,875	Boaco	37,484
Somoto	29,183	Juigalpa	47,443
Estell	86,213	Camoapa	27,654
Jalapa	32,389	Santo Domingo	18,254
Telpaneca	10,269	La Libertad	5,698
Sn.Juan de Río Coco	14,021	Santo Tomás	14,013
Condega	22,120	Acoyapa	15,217
San Juan de Limay	14,258	Region VI	
Region II		Jinotega	66,034
León	165,286	Matagalpa	91,527
Chinandega	97,615	Wiwili	26,224
Corinto	22,764	San Sebastián de Yali	14,552
Puerto Morazán	11,246	El Tuma	34,342
El Sauce	27,919	San Isidro	13,846
El Viejo	65,056	Sébaco	22,223
El Jicaral	8,485	Río Blanco	36,003
Telica	21,496	Ciudad Darío	35,854
La Paz Centro	28,524	Terrabona	10,898
Region III		San Dionisio	11,481
Managua	935,520	Muy Muy	8,882
Tipitapa	72,204	Esquipulas	13,625
San Rafael del Sur	36,951	Region VII	
Region IV		Puerto Cabezas	30,739
Masaya	97,877	Rosita	12,588
Diriamba	55,720	Siuna	27,598
Granada	88,319	Waslala	22,990
Rivas	34,298	Region VIII	
Nandaime	35,134	El Rama	35,658
Tola	20,045	Bluefields	36,988
San Juan del Sur	15,889	Nueva Guinea	47,381
Moyogalpa	9,831	Region IX	
Altagracia	15,475	San Carlos	15,816

Actually, Puerto Corinto has strong connections related to existing export and import activities in Nicaragua as shown in Figures 10-3 and 10-4. These connections should be improved to promote exports and imports.

(4) Element 4 - Support of Agricultural Production

Agricultural production is especially important in Nicaragua, since the export of agricultural products has brought the most foreign currency into Nicaragua. In the government's official report (Medium-term Development Strategy 1992-1996), the redevelopment of agriculture has been strongly emphasized. Therefore, the linkage between agricultural production areas and export bases like Puerto Corinto and consumption areas like the big cities is particularly important as shown in Figures 10-3 and 10-4. The main agricultural areas are also shown in Figure 8-5.

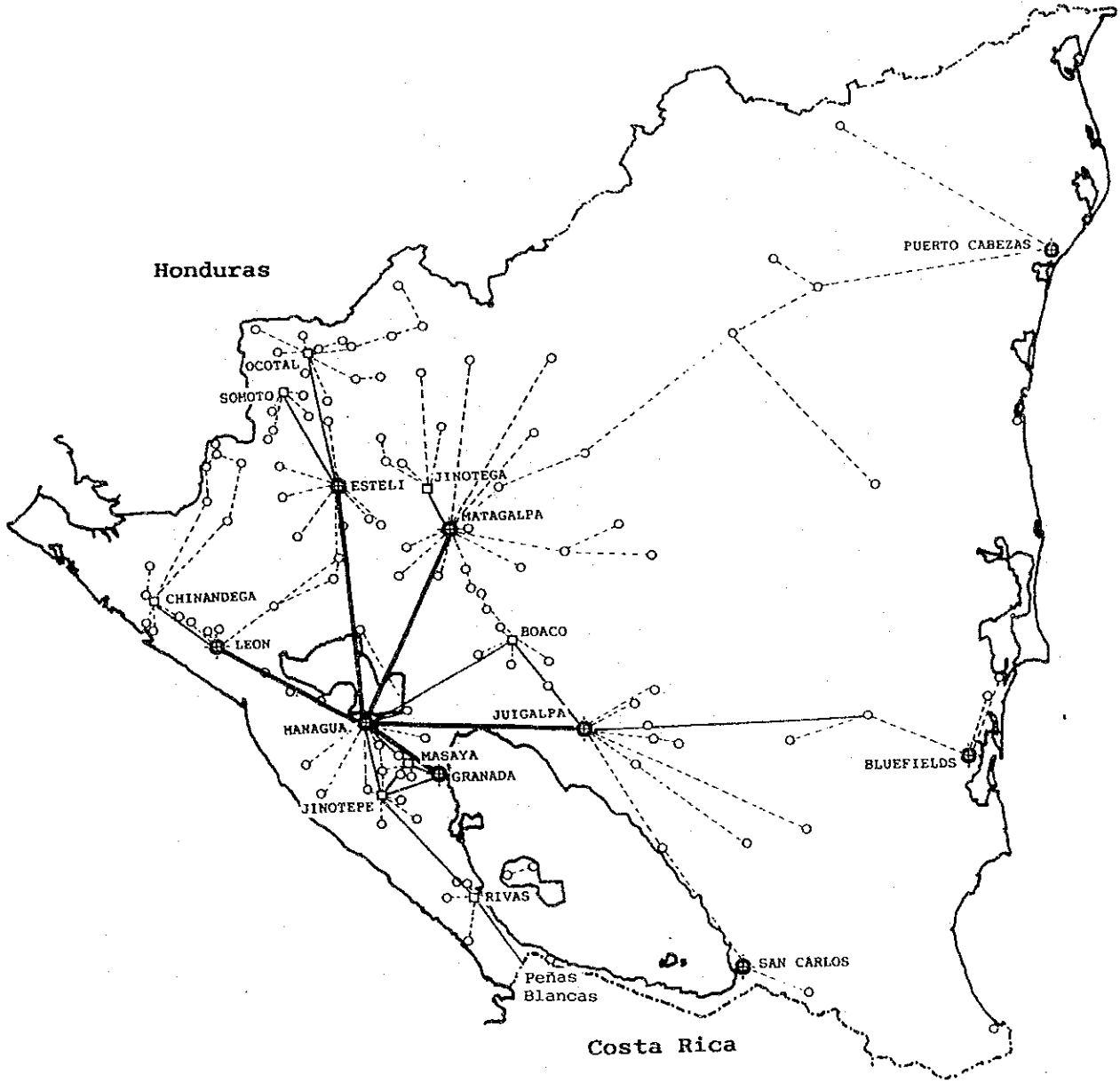


Figure 10-2 Hierarchical Road Structure

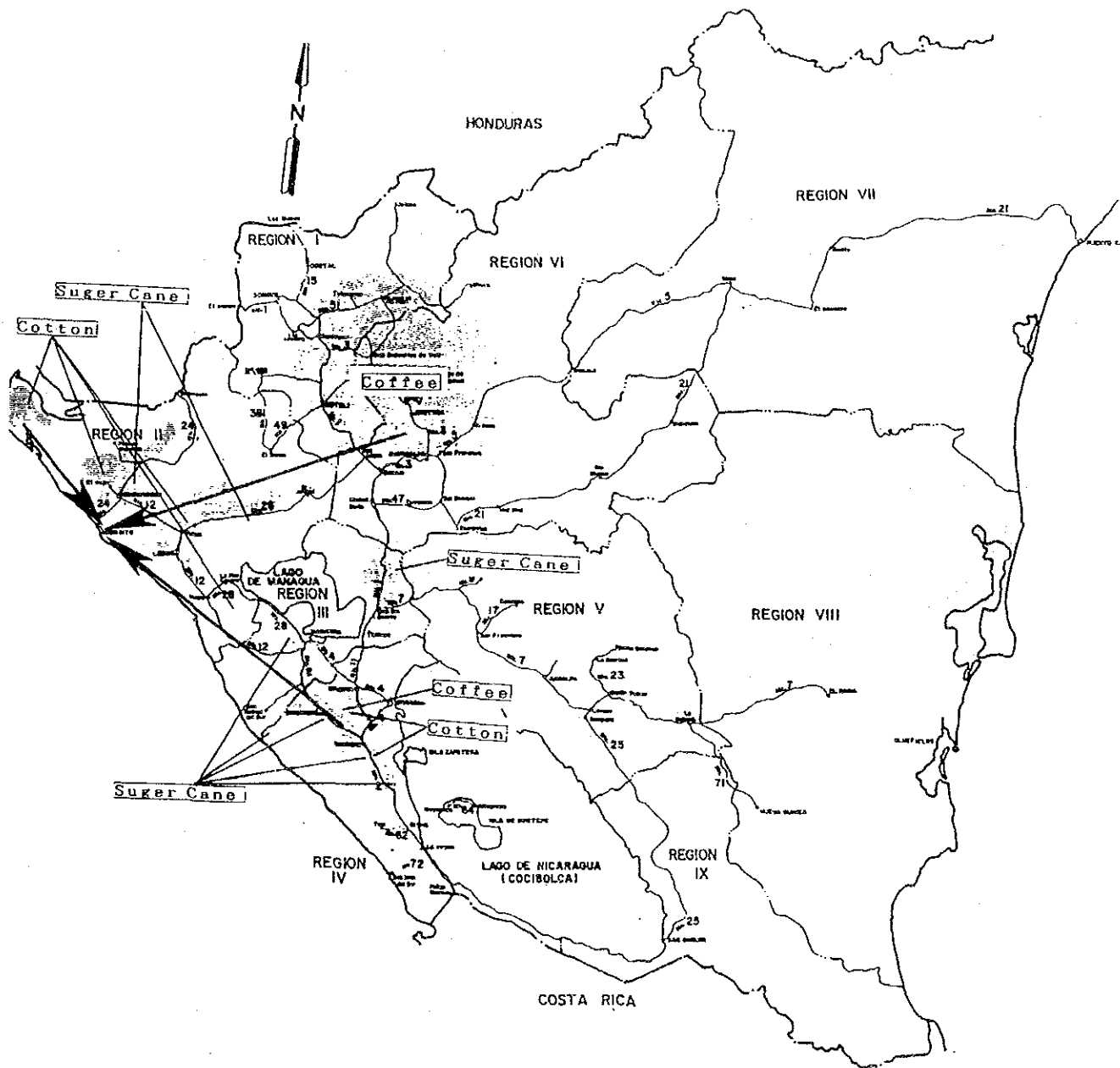


Figure 10-3 Movement of Main Export Goods

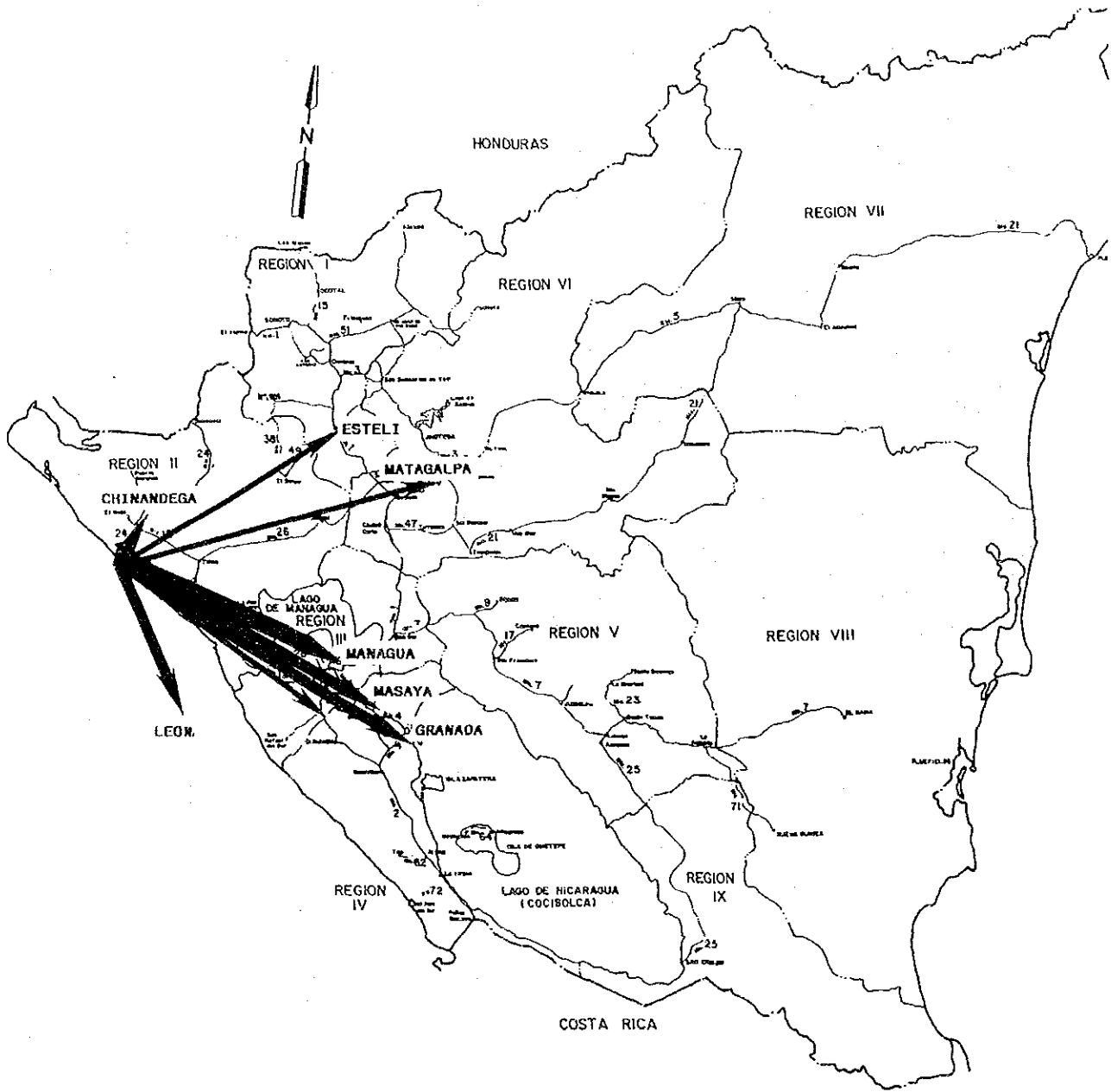


Figure 10-4 Movement of Main Import Goods

(5) Element 5 - Role of International Transportation

The Central American Highways in Nicaragua accommodate international through-traffic linking the country to Costa Rica, Guatemala, the United States, etc. Since international traffic flow is expected to increase more and more in the future as economic activities with the above countries pick up, the role of these highways will become increasingly important. In addition, tolls can be collected from international traffic, thereby bringing even more foreign currency into the country.

The above-mentioned examination identified the following routes to be the most important in the network after considering the above-mentioned elements of road functions:

- ① Managua - Masaya - Nandaimé - Rivas - Peñas Blancas
- ② Managua - León - Chinandega - Guasaule
- ③ Managua - San Benito - Estelí - El Espino
- ④ San Benito - Boaco - Juigalpa - El Rama - Bluefields
- ⑤ Matagalpa - El Tuma - Puerto Cabezas
- ⑥ León - Larreynaga - San Isidro - Estelí

The principal road network is summarized in Figure 10-5. Below, this principal network is extensively analyzed.

10.2.4 Strategies for Formulation of Master Plan

the following three improvement strategies, that is, desired road classification, ranking of road function, and service conditions were introduced for the purpose of achieving the objectives of the Study, .

(1) Desired Road Classification

On the basis of the above elements of road functions, major roads are classified into eight categories, T.P.-I, T.P.-II, T.S.-I, T.S.-II, C.P.-I, C.P.-II, C.S., C.V. (from higher to lower grade) after considering the following.

- Existing road conditions
- Future traffic volume
- Design speed

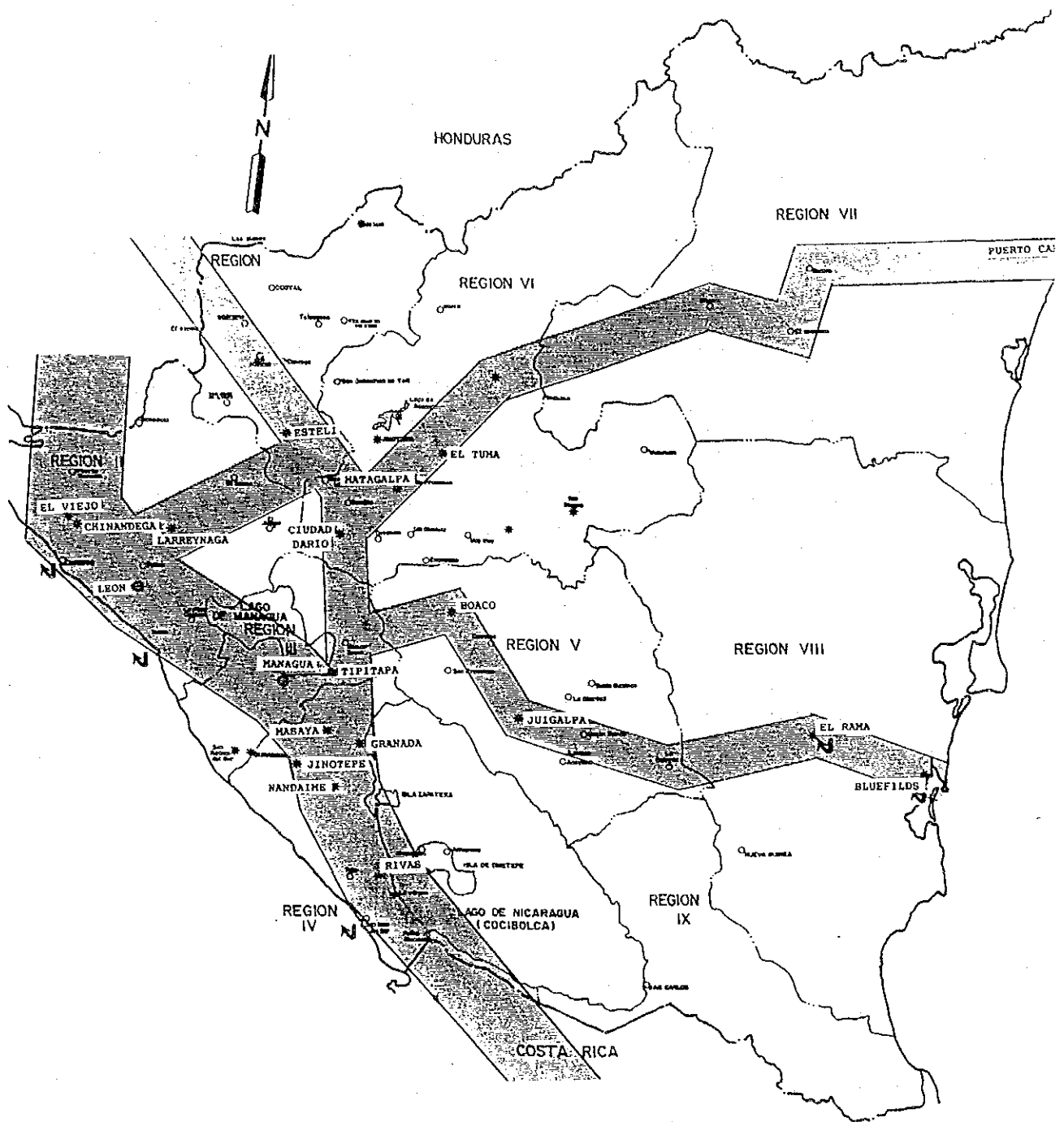


Figure 10-5 Principal Road Network Based on Road Function

The contents of these eight categories are shown in Table 10-2. Design speed of roads classified in highest category, T.P.-I, is set as 100 km/h on flat terrain.

Table 10-2 Desired Road Classification

Classification	Description	Urban Towns and Population	Traffic Flow ADT (veh./day)	Traveling Distance	Design Speed (km/h)			Remarks
					Flat	Hilly	Mountainous	
T.P.-I	Troncal	More than 100,000	More than 5,000	Long Distance	100	80	60	
T.P.-II	Principal	50,000-100,000	1,500-5,000		80	60	40	National 2a
T.S.-I	Troncal	25,000-50,000	500-1,500	Medium Distance	80	60	40	
T.S.-II	Secundaria	10,000-25,000			60	50	30	Departmental
C.P.-I	Colectora	5,000-10,000	250-500	Short Distance	50	40	30	1a
C.P.-II	Principal				50	40	30	Departmental
C.S.	Colectora Secundaria	1,000-5000	100-250	Relatively Short Distance	50	40	30	2a
C.V.	Camino Vecinales	Less than 1,000	Less than 100	Very Short Distance	40	30	20	

To determine the number of traffic lanes, the standard design volume must be predetermined. In the Study the traffic volume listed in Table 10-3 was applied as the standard design volume, after considering road classification and topographical conditions on the basis of the "Highway Capacity Manual", "A Policy on Geometric Design of Highways and Street, AASHTO" and the "Road Structure Ordinance" (Japan). For regional roads with less than the above standard design volume, two traffic lanes are provided except climbing lane, turning lane, and speed change lane. Roads other than regional roads are designed to have more than four lanes.

Table 10-3 Standard Design Traffic Volume

(Unit : veh/day)

Classification	Topography	Standard Design Volume
T.P.-I	Flat Area	12,000
	Mountainous Area	8,000
T.P.-II	Flat Area	11,000
	Mountainous Area	7,000
T.S.-II	Flat Area	11,000
	Mountainous Area	7,000
C.P.-I	Flat Area	7,000
	Mountainous Area	5,000
C.P.-II	Flat Area	7,000
	Mountainous Area	5,000
C.S.	Flat Area	6,000
	Mountainous Area	4,000
C.V.	Flat Area	5,000
	Mountainous Area	3,000
T.P.-I	Flat Area	4,000
	Mountainous Area	2,000

Typical cross sections for the above-mentioned standard design criteria are shown in Figure 10-6.

(2) Ranking of Roads by Function

A functional examination was conducted on all major roads on the basis of the elements of road functions shown in the following table.

Table 10-4 Elements of Road Functions

Road Type	Element of Road Function				
	1	2	3	4	5
North-South Trunk Road	#	#	#	#	#
East-West Trunk Road	#	#	#	#	
Road Linking among more than 50,000 of Population	#		#		
Roads other than the Above	#				

Note Element 1 : Connecting communities
 Element 2 : Access to areas where activities are concentrated
 Element 3 : Promotion of exports and imports
 Element 4 : Support of agricultural production
 Element 5 : Role of international transportation

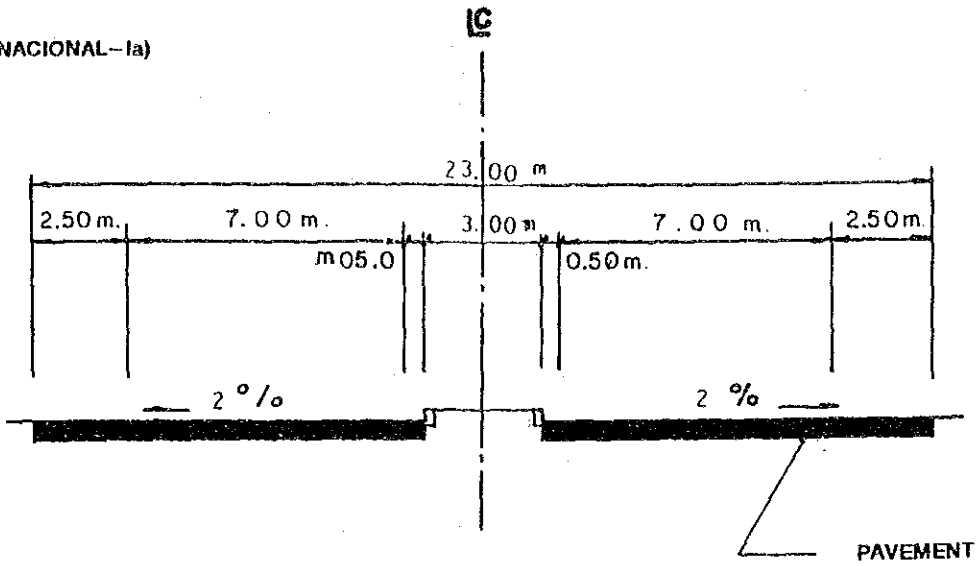
According to the examination results shown in the table above, the major roads can be ranked as follows:

- Rank a : North - South trunk road
- Rank b : East - West trunk road
- Rank c : Access roads to ports and other areas where activities are concentrated
- Rank d : Roads other than the above

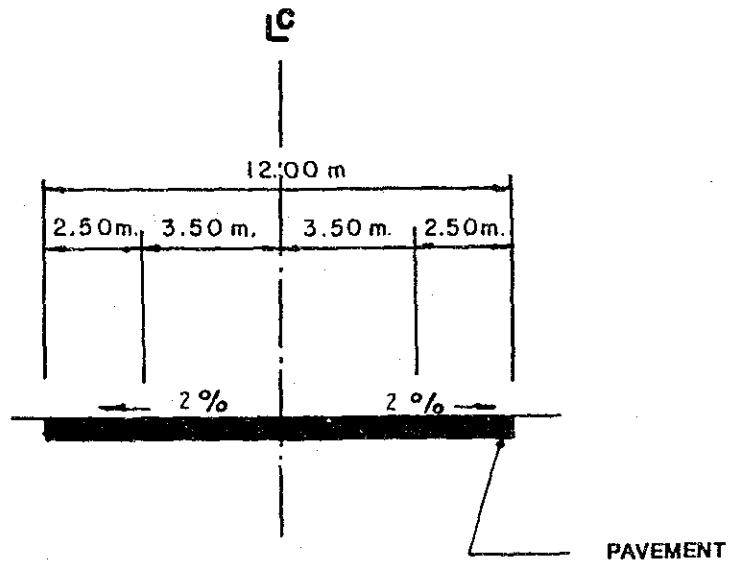
(3) Service Conditions

For road users service conditions (comfort and convenience) are very important factors that must be considered when improving road quality. Service conditions often deteriorate when the physical conditions of road surfaces worsen, i.e., cracking, faulting, raveling, etc. The service conditions of each road section were inspected and evaluated by the JICA Study Team and MCT's engineers using five ranks (Perfect Road, Good Road, Fair Road, Bad Road, and Impassable Road) as indicated in Table 10-5. In its evaluation, the JICA Study Team followed modified AASHTO criteria. (For a better understanding of those service conditions, see Appendix 10-1)

TP-1a (NACIONAL-1a)



TP-1 (NACIONAL-1a)



TP-11

Ts-1 (NACIONAL-2a)

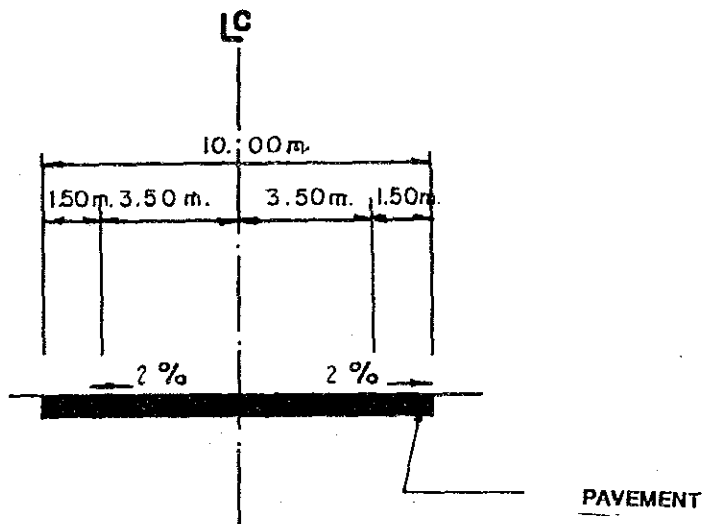
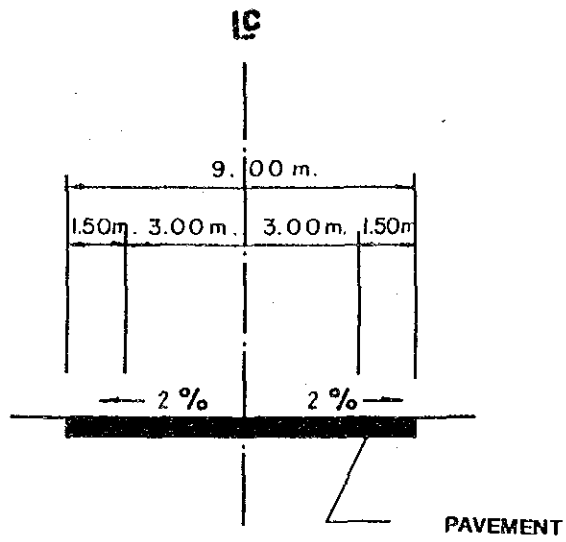
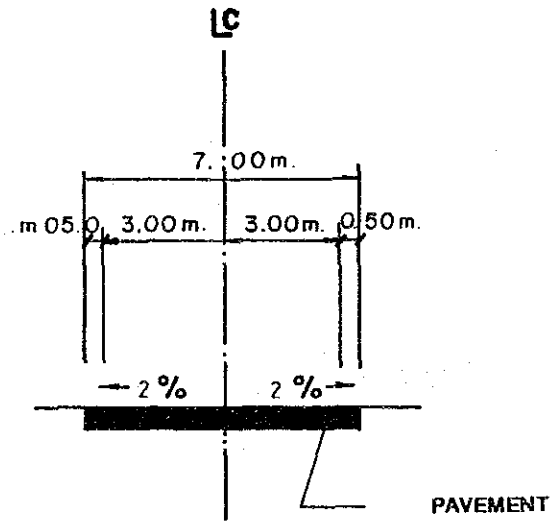


Figure 10-6 Proposed Typical Cross Section (1)

Ts-II
CP-I (DEPARTAMENTAL-1a)



CP-II
CS (DEPARTAMENTAL-2a)



CV

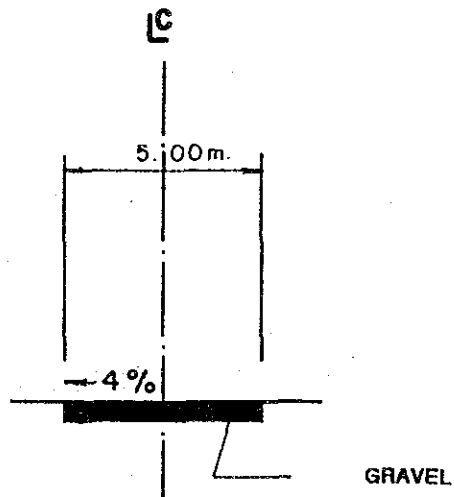


Figure 10-6 Proposed Typical Cross Section (2)

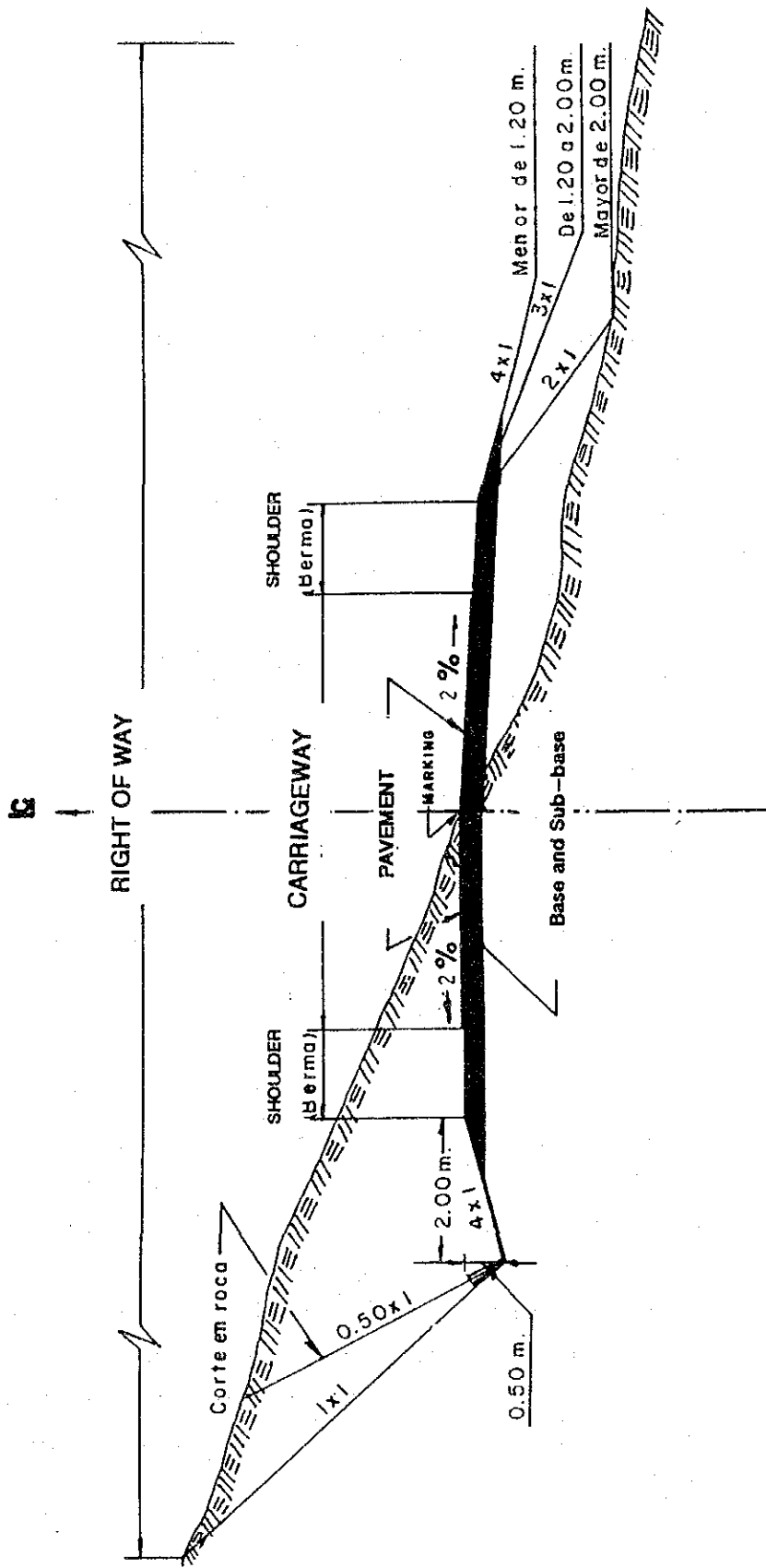


Figure 10-6 Proposed Typical Cross Section (3)

Table 10-5 Ranking of Service Conditions

Rank	Definition	Description
I	Perfect road (Initial condition)	<ul style="list-style-type: none"> - Initial conditions. - Traffic condition performs according to designed traffic volume. - Effective roadway width is appropriate for the existing traffic demand. - Actual conditions (including structural conditions) were evaluated with a rank of E or D by the JICA Study Team. - Routine maintenance work conducted by a maintenance workshop was sufficient.
II	Good road	<ul style="list-style-type: none"> - Initial condition is last, however the service condition is still good. - Traffic condition is still optimal , but traffic congestion are observed during peak hours. - Effective roadway width is adequate to meet traffic demand. - Actual conditions (including structural conditions) were given a D or C rank by the JICA Study Team. - Periodic maintenance work by a maintenance workshop is required.
III	Fair road (Terminal condition zone)	<ul style="list-style-type: none"> - Service conditions are near to their terminal limit, and the minimum performance period is near to the end. - Traffic conditions are considerably affected and congestion is very frequent. - Effective roadway width is too narrow to handle traffic congestion, and pavement or shoulders deteriorate as a result. - Actual conditions (including structural conditions) were given a C or B rank by the JICA Study Team. - Periodic maintenance work is not sufficient, hence special maintenance or partial rehabilitation by a maintenance workshop is required.
IV	Bad road	<ul style="list-style-type: none"> - Service conditions are below the terminal limit, the maximum performance period is near to end. - Traffic volume has decreased because of road capacity features.. - Effective roadway width is too narrow to handle traffic, and pavement of shoulders deteriorate as a result. - Actual conditions (including structural conditions) were given a B or A rank by the JICA Study Team. - Rehabilitation work is required.
V	Impassable road	<ul style="list-style-type: none"> - The whole basic road functions are last. - The maximum performance period is last. - Reconstruction is required.

10.2.5 Determination of Road Improvement Level

On the basis of the above three strategies, the road improvement level required for each section of the road network were determined, after considering distance, the populations of municipalities linked to each other, the traffic volume basic function, and the service level. The results are shown in the schematic diagrams of Figure 10-7 and in the map of Appendix 10-2. The highest road design criteria (T.P.-1) is applied to Central American Highways, and in particular, a criteria of four-lane road is applied for the Managua-Masaya section. These determination results are indicated in the tables shown in Appendix 10-3 and in the diagrams shown in Appendix 10-4. According to the established road improvement requirements for each section of road as mentioned above, 20 bridges must be replaced or reconstructed. (Refer to Appendix 10-5)

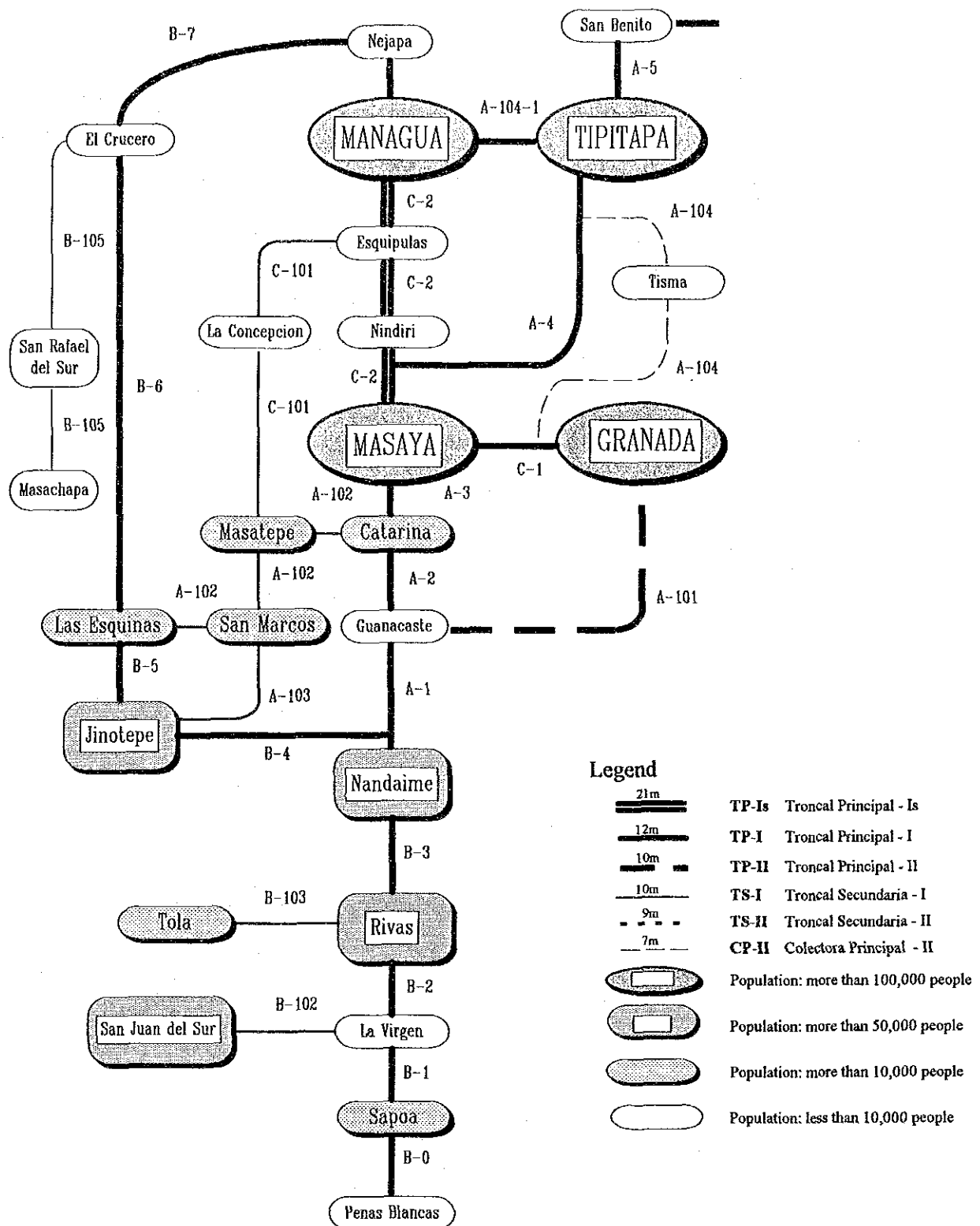


Figure 10-7 Future Road Network Charts - Improvement Levels - (1)

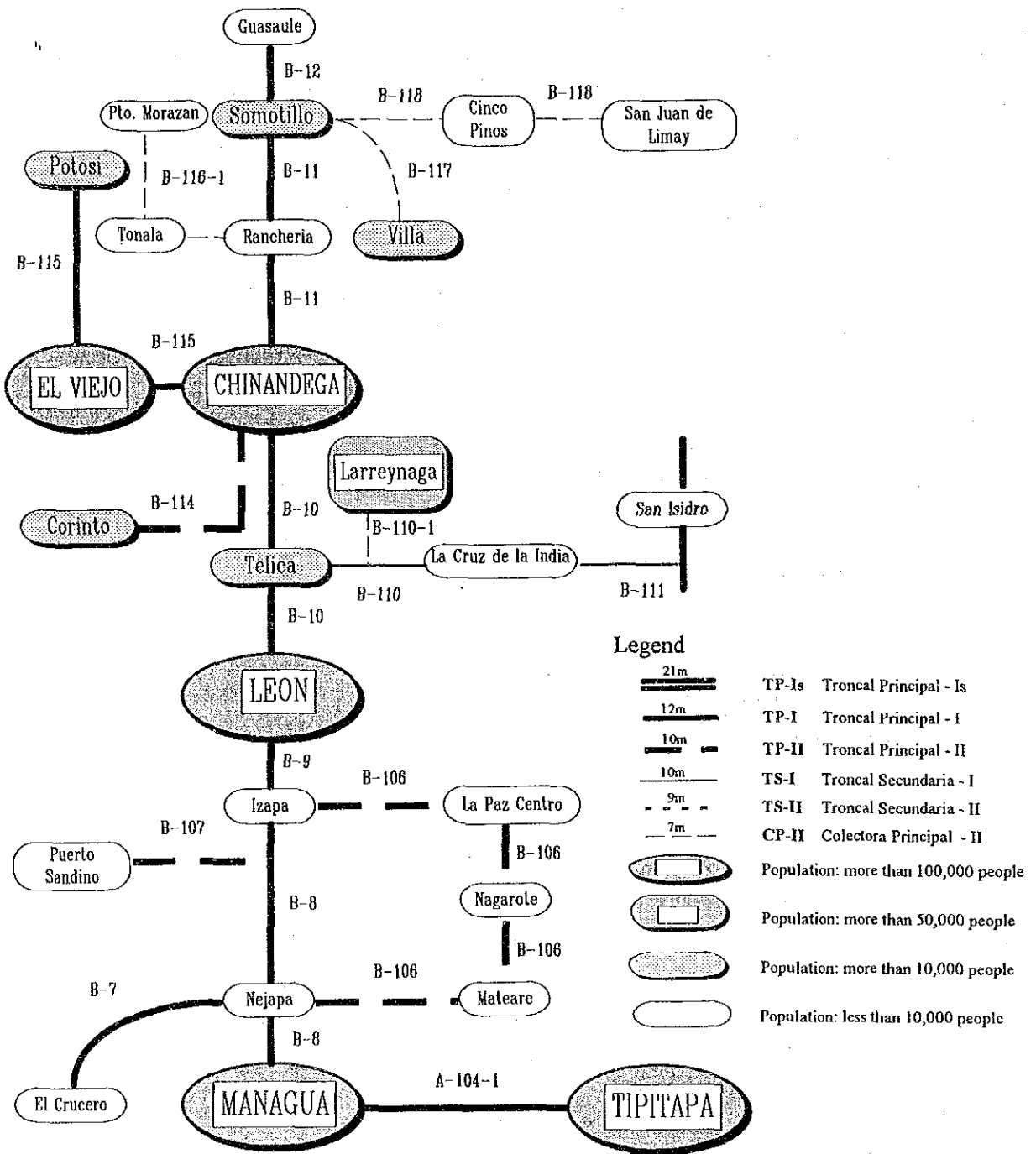


Figure 10-7 Future Road Network Charts - Improvement Levels - (2)

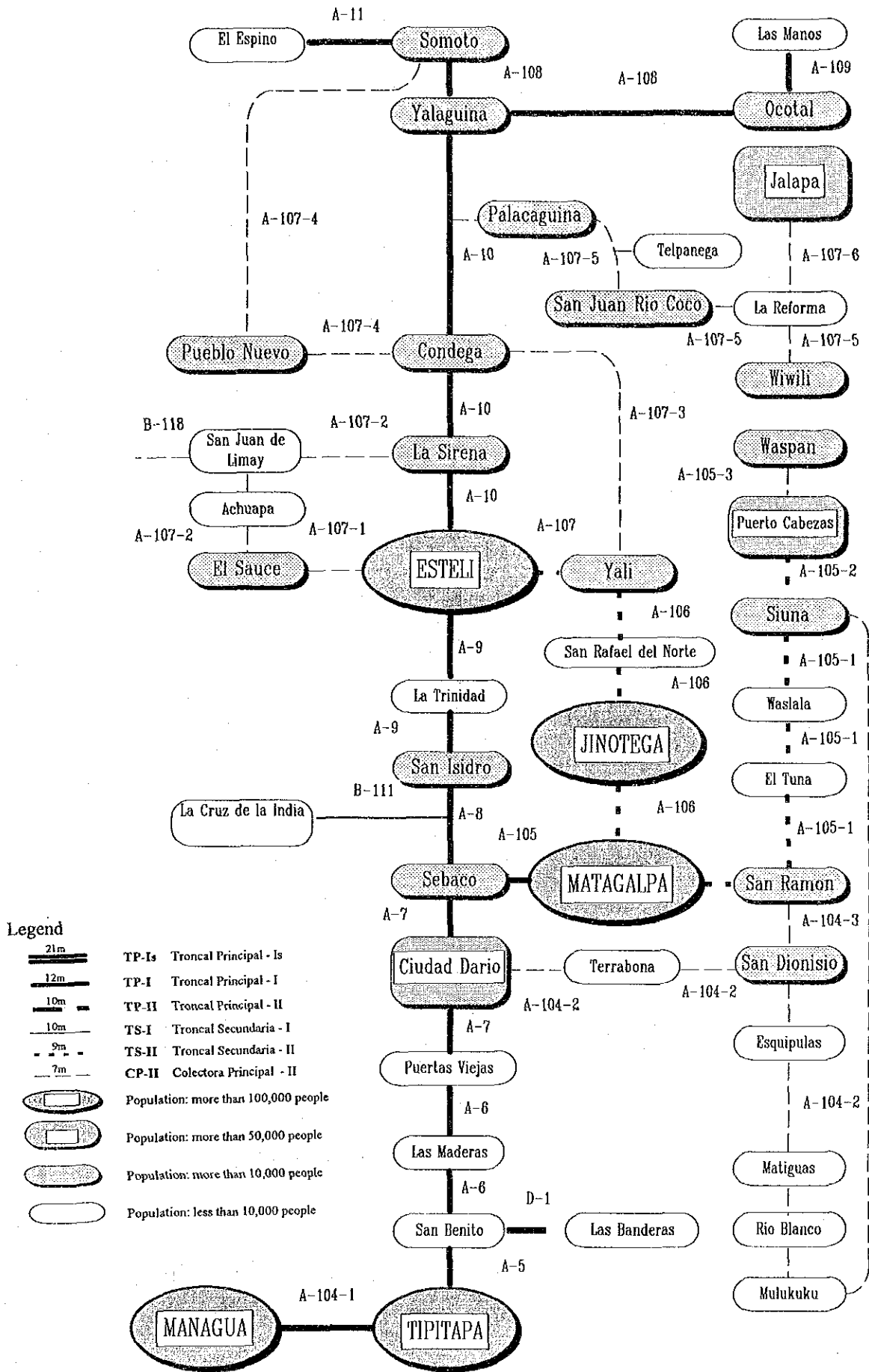


Figure 10-7 Future Road Network Charts - Improvement Levels - (3)

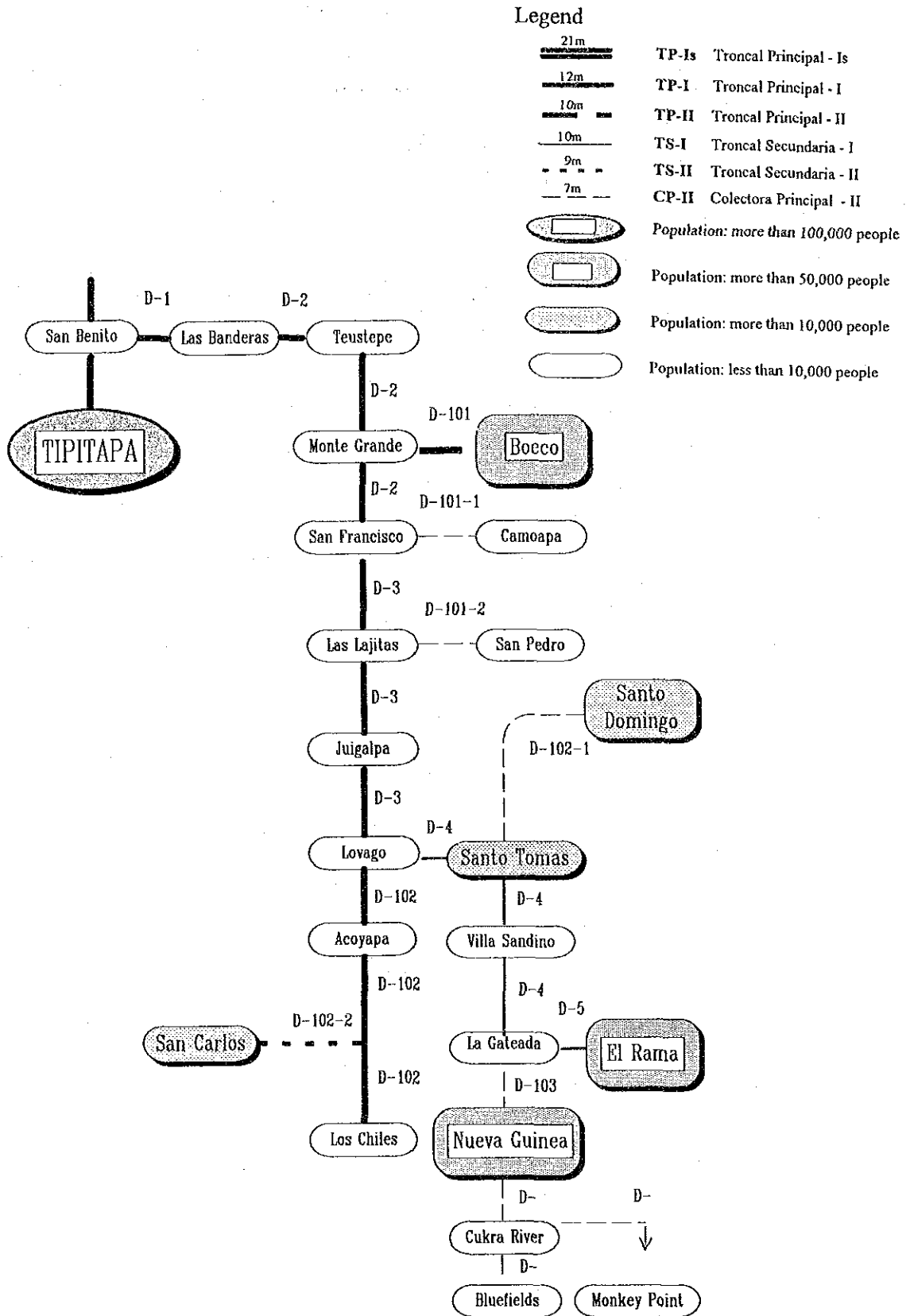


Figure 10-7 Future Road Network Charts - Improvement Levels - (4)

10.3 ROAD NETWORK EVALUATION

In the above sections, road network improvement levels were proposed, however, it is unlikely that all projects based on these improvement level will be implemented at the same time within two or three years, considering the financial situation in Nicaragua. Therefore, each project must be prioritized. In the Study, the road network was evaluated by introducing the concept of a "sub-network", since the road characteristics in Nicaragua vary depending on the regional environment including socio-economic activities, natural conditions, etc. The national road network is divided into the following seven sub-networks as shown in Table 10-6 and Figure 10-8.

Table 10-6 List of Sub-networks

Sub-network	Major Municipalities
Sub-network-1	Managua
Sub-network-2	Rivas
Sub-network-3	León, Chinandega
Sub-network-4	Esteli, Matagalpa, Jinotega
Sub-network-5	Telica, Sébaco
Sub-network-6	San Benito, El Rama
Sub-network-7	Matagalpa, Puerto Cabezas

The following analyses are based on this sub-network.

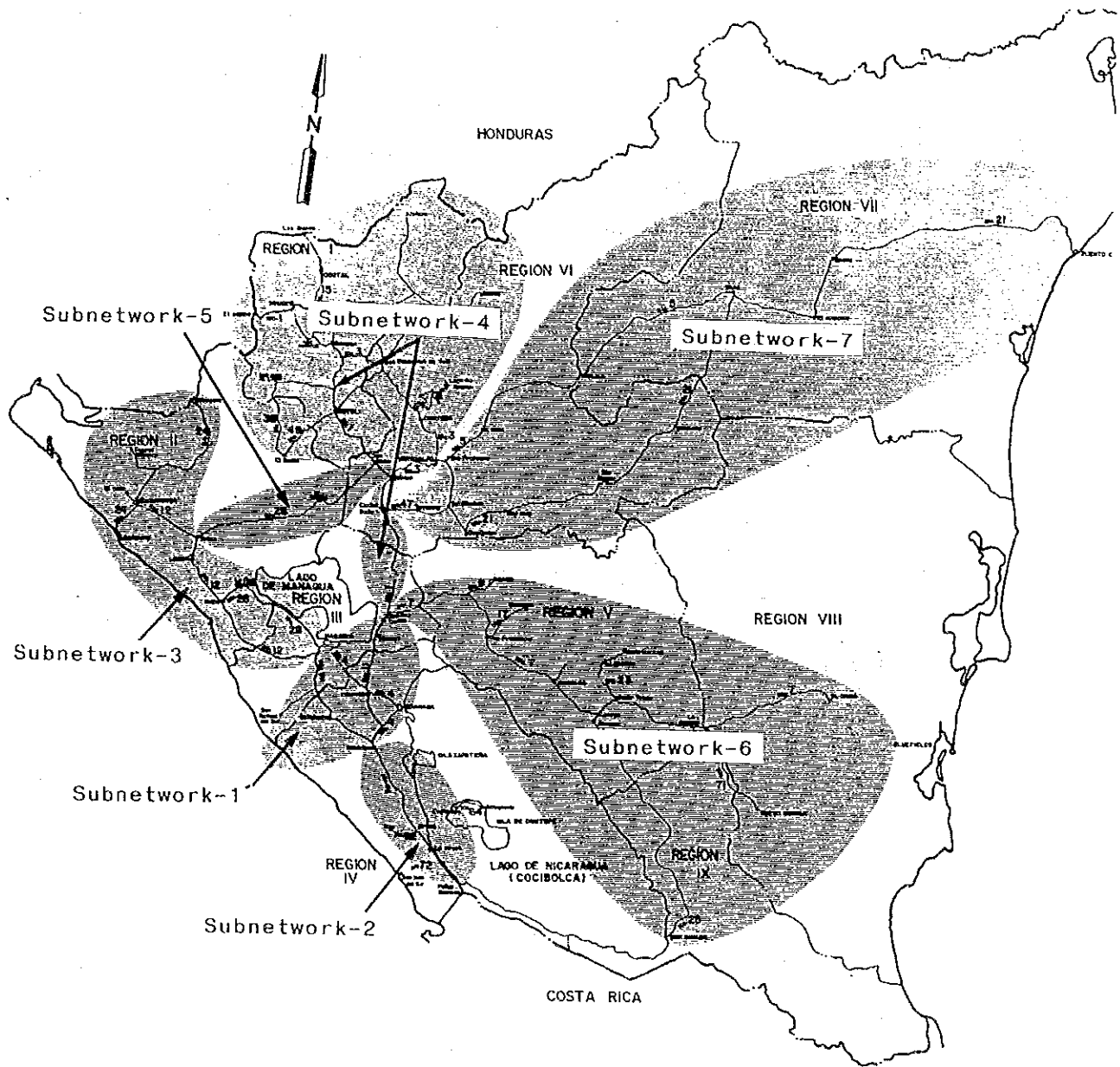


Figure 10-8 Sub-network Map

10.4 COST ESTIMATION

Cost was estimated on the basis of the improvement plan established in the previous section. The actual unit price for road construction/maintenance used in the MCT (July 1993) was applied to this cost estimation. All costs is expressed in terms of Córdobas.

Indirect costs were calculated as 33% of direct costs. Engineering fees were estimated as 10% of the total of direct costs and indirect costs.

Total costs for all sub-networks projects are estimated to be about 2,947 million Córdobas. The costs of sub-network projects are summarized in Table 10-7, while a cost breakdown by each road section is attached as Appendix 10-4. In addition, the costs involved reconstructing bridges are also shown in Appendix 10-5.

Table 10-7 Cost Estimation of Projects by Sub-Network

(Unit : 1,000 Córdobas in July 1993)

Sub-network	Major Cities	Estimated Cost		
		Road Project	Bridge Project	Total
1	Managua/Masaya	354,979	10,500	365,479
2	Rivas	93,615	56,700	150,315
3	León/Chinandega	503,298	50,000	553,298
4	Esteli/Jinotega	481,280	118,000	599,280
5	Telica/Sébaco/Matagalpa	132,982	0	132,982
6	Boaco/El Rama	615,801	22,000	637,801
7	Matagalpa/Puerto Cabezas	507,496	0	507,496
Total		2,689,451	257,200	2,946,651*

Note - * : Equivalent to US\$ 479,130 based on 6.15 Córdobas/US\$

10.5 ECONOMIC EVALUATION OF THE IMPROVEMENT PLAN

As described in the previous section, each sub-network consists of several projects. An economic evaluation is conducted for each sub-network, rather than for each project, in order to prioritize these sub-network projects by comparing costs and benefits. It should be mentioned that the results of this economic evaluation are part of the comprehensive evaluation of the sub-network improvement plan as described below.

10.5.1 Evaluation Method

Each sub-network improvement plan produces the benefits derived from improving road service within its sub-network. On the other hand, implementing the project is costly. The costs involved are estimated through the engineering study presented in section 10.4.

Benefits are estimated by comparing "With Case" and "Without Case" as described below.

- With Case : Some project will be implemented in each sub-network.
- Without Case : No project will be implemented in the future.

This analysis assumes that the improvement plan will be implemented starting in 1996, and will be completed in 1999. Therefore, the total cost of each sub-network improvement plan is spread out over the 4 years of its implementation period.

On the other hand, it is assumed that no benefit will be derived until the year 2000, just after the road improvement project is completed. Although theoretically benefits will continue to be realized until end of the project life, this analysis estimates that benefits will continue to be derived until 2020,

Various types of benefits will result from the implementation of the road improvement plan; however, only the following two types of benefits are assumed in this analysis.

- Saving of vehicle operating costs
- Saving of travel time cost

10.5.2 Project Costs

The project costs of each sub-network are estimated in section 10.4, and the results are summarized as follows. (Table 10-8)

Table 10-8 Summary of Project Cost by Sub-network

(Unit : 1000 Córdoba)

Sub-network	1	2	3	4	5	6	7	Total
Road Projects	354,979	93,615	503,298	481,280	132,982	615,801	507,496	2,689,451
Bridge Projects	10,500	56,700	50,000	118,000	0	22,000	0	257,200
Financial Cost	365,479	150,315	553,298	599,280	132,982	637,801	507,496	2,946,651
(in US\$ 1000)*	(59,427)	(24,441)	(89,967)	(97,444)	(21,623)	(103,707)	(82,520)	(479,130)
Economic Cost**	310,657	127,768	470,303	509,388	113,034	542,131	431,372	2,504,653

Note : * - US\$ 1 = 6.15 Córdoba

** - Economic Cost = Financial Cost - Tax (15%)

During an economic evaluation, costs estimated at the market price in the previous section should be converted into basic economic costs by eliminating their tax portions. The tax rate for project costs is assumed to be 15% considering the prevailing tax rate in Nicaragua.

10.5.3 Economic Benefit

(1) Saving of Vehicle Operating Cost

In the Study, no general "Road Network Alternative" is proposed. Therefore, the total vehicle-km under "With Case" is the same as that under "Without Case", as mentioned in Chapter 9. Therefore, the vehicle operating costs saved on the basis of total vehicle-km can be ignored. However, completing road improvements may be able to increase vehicle velocity much faster than in the case that of "Without Case" because roads will be widened, and geometric alignments and right-of-way will be improved.

In accordance with the analysis of the future traffic volume presented in Chapter 9, the average vehicle running speed throughout Nicaragua following implementation of improvements in each sub-network is estimated to be shown in Table 10-9.

Table 10-9 Average Vehicle Running Speed

(Unit : km/h)

Case	2000	2010
Without Case	45.69	44.12
Sub-network-1	49.02	46.73
Sub-network-2	46.99	45.61
Sub-network-3	48.51	46.49
Sub-network-4	47.22	45.69
Sub-network-5	46.30	44.75
Sub-network-6	46.56	44.99
Sub-network-7	45.90	44.33

Note : Sub-network-N indicates the implementation of an improvement plan in each sub-network

Generally, the consumption of the fuel per km decreases as the vehicle running speed increases up to around 80 km/h. This means that even if the vehicle-km is same in "Without Case" and "With Case", there will be a reduction of vehicle operating costs. Therefore, the vehicle operating costs saved per year can be estimated. The results of this calculation for the years 2000 and 2010 are shown in Table 10-10. Vehicle operation costs saved from 2001 to 2009 are proportionally distributed with vehicle operation costs saved from 2000 to 2010, and then from 2010 to 2020, it is assumed to be same as that of 2010.

Table 10-10 Saving of Vehicle Operation Costs
(Unit : 1,000 Córdoba/year)

Case	2000	2010
Without Case	0	0
Sub-network-1	27,449	31,682
Sub-network-2	10,716	18,086
Sub-network-3	23,245	28,768
Sub-network-4	12,611	19,057
Sub-network-5	5,028	7,647
Sub-network-6	7,171	10,560
Sub-network-7	1,731	2,549

(2) Saving of Travel Time Cost

Improving roads will save on travel time cost as described in Chapter 9.2. In this analysis, the benefits of saving on travel time cost is estimated on the basis of the value of time in Nicaragua.

Time value is assessed in terms of the hourly productivity of vehicle users. In the Study, the GDP is applied to value time. The GDP of Nicaragua, as described in Chapter 8, was 8,426.6 million Córdoba in 1992, which is 18,192.4 million Córdoba in 1980 price. At the same time, employment in 1992 was estimated at 1,255,000 by the SPP-DGNV and MITRAB of Nicaragua. Therefore, labor productivity can be estimated to be 6,714 Córdoba/year, which equals 3.07 Córdoba per hour assuming that the average worker works 2,184 hours per year.

The average number of passengers including drivers and the purpose of their trip were obtained by the traffic survey conducted in the Study. A time value was given only to trips related to economic activities, such as "business", "going to work" and "returning home".

Tables 10-11 and 10-12 summarize the travel time that will be saved throughout the country in 2000 and 2010 as a result of implementing the improvement plan for each sub-net-

work, the average number of passengers per vehicle, and purpose of trips related to economic activities.

Table 10-11 Saving of Travel Time

(Unit: hours/year)

Sub-network	2000	2010
Sub-network-1	25,799,437	51,605,539
Sub-network-2	4,969,565	7,918,107
Sub-network-3	22,352,961	48,460,567
Sub-network-4	3,895,111	5,858,397
Sub-network-5	1,680,664	2,588,291
Sub-network-6	1,350,511	2,095,797
Sub-network-7	25,859,530	4,557,834

Table 10-12 Average Number of Passengers per Vehicle and Trips Related to Economic Activities

Vehicle Type	Average Number of Passengers	Trips Related to Economic Activities
Passenger Car	3.2	0.751
Micro Bus	16.3	0.735
Large Bus	44.4	0.574
Pick-up	3.0	0.784
Medium-size Truck	4.4	0.857
Large Truck	2.5	0.896

A value 3.07 Córdoba per working hour, as calculated in the previous paragraph, was applied to calculate the value of the travel time cost saved.

The travel time cost saved from 2001 to 2009 is proportionally distributed with the travel time cost saved in 2000 and 2010 and after 2010 to 2020, it is assumed to be same as that of 2010. The total travel time cost saved throughout the country as a result of implementing the improvement plan for each sub-network through the year 2020 is shown in Table 10-13.

Table 10-13 Saving of Travel Time Cost

(Unit : 1,000 Córdoba)

Sub-network	Saved Cost
Sub-network-1	3,073,066
Sub-network-2	490,472
Sub-network-3	2,891,159
Sub-network-4	364,544
Sub-network-5	164,976
Sub-network-6	131,205
Sub-network-7	21,581

10.5.4 Economic Evaluation Results

The following three indicators are applied to evaluate the improvement plan in each sub-network.

- IRR : (Internal Rate of Return)
- NPV : (Net Present Value)
- B/C : (Cost-Benefit Ratio)

In order to obtain the value of NPV and B/C, a discount rate of 12% is adopted considering the interest rates of major international funds. The results of the economic evaluation using three indicators in implementing of improvement plans in each sub-network are summarized in Table 10-14.

Table 10-14 Summary of IRR, NPV and B/C

Sub-network	IRR (%)	NPV (1,000 Córdoba)	B/C	Project Costs (Financial) (1,000 Córdoba)
Sub-network-1	28.1	507,596	3.03	365,479
Sub-network-2	25.7	106,192	2.61	150,315
Sub-network-3	19.1	300,371	1.76	553,298
Sub-network-4	2.5	-249,428	0.38	599,280
Sub-network-5	8.7	-23,150	0.74	132,982
Sub-network-6	-	-346,450	0.17	637,801
Sub-network-7	-	-317,808	0.04	507,496

Note : Discount rate = 12% for NPV, B/C

An economic evaluation shows that the improvement plan for Sub-network-1, which is within Masaya Metropolitan Area, has the highest value for the above three indicators of all the sub-networks. At the same time, economic analysis indicates that the improvement plans for Sub-networks-6 and -7 are not viable.

10.6 PRIORITY EVALUATION OF THE FUTURE ROAD NETWORK

10.6.1 Priority Analysis Weighting

(1) Weights of Sub-network

After considering various parameters, such as traffic volume, population of each sub-network area, cost estimation results and topographical, geological and economic characteristics of sub-network areas, weights were assigned to each sub-network as shown in Table 10-15.

These weight were assigned for the following reasons.

- Sub-network-1 gets the highest weight since this sub-network covers the metropolitan area of Managua. In addition, this area has shown abrupt development in recent years, and is expected to continue developing at the same pace in the future.
- Sub-networks-6 and 7 get the lowest weight, because they are developing at the slowest pace.
- Other sub-networks get half the weight of sub-network-1 because of the size of their populations, economic activities, etc. relative to sub-network-1.

Table 10-15 Weights of the Sub-networks

Sub-network	Weight
Sub-network-1	30
Sub-network-2	15
Sub-network-3	15
Sub-network-4	15
Sub-network-5	15
Sub-network-6	5
Sub-network-7	5
Total	100

(2) Weights of Road Classifications, Road Functions and Service Conditions within Each Sub-network

As mentioned before, the level of road improvements was determined on the basis of three factors, "Road Classification", "Road Function", and "Service Conditions". Road function is considered to be the most important factor affecting the future road improvement strategy. Furthermore, the service conditions are considered to be the least important factor because routine maintenance work will be able to secure satisfactory service conditions. The intensive discussion resulted in the following weights to these factors as shown in Table 10-16.