Table 4.6 Forecast Internal Daily Vehicle Trips

Mode	Year 1995	2000	2005	2010
Car	2,187	3,820	8,902	21,486
Bus	3,478	5,610	12,536	31,451
Truck	6,738	10,928	24,241	55,893
Subtotal	12,403	20,358	45,679	108,830
Motorcycle	49,944	92,039	237,141	664,940
NMV	88,319	87,436	73,446	56,553

4.3.2 External Trips

Trips without a trip-end in the study area are not necessarily directly influenced by study area socioeconomic evolution, but more by developmental activities taking place in other parts of Viet Nam. Trips with one trip end within the study area, on the other hand, are likely to be influenced by both the study area macroeconomics frame and developmental activities in other parts of the nation.

The recently-completed national rail study[1], which conducted a national modal split exercise based on domestic, inter-province demand, can provide guidance in this regard. In the first instance, these data suggest that the road mode, both in terms of truck cargo and car/bus passengers, will grow increasingly dominant in future (Table 4.7).

Table 4.7 Forecast National Modal Split National Rail Study

Mode	Year 1994	2000	2005	2010
Ton Trips (000)				
Road	40,085	68,772	105,516	160,132
Rail	3,436	4,655	8,644	14,832
Inland Waterway	15,349	23,416	29,234	34,407
Total	58,870	96,843	143,394	209,371
Percent Ton Trips				
Road	68.1%	71.0%	73.6%	76.5%
Rail	5.8%	4.8%	6.0%	7.1%
Inland Waterway	26.1%	24.2%	20.4%	16.4%
Total	100.0%	100.0%	100.0%	100.0%
Person Trips (000)				
Road	181,528	370,381	639,307	1,063,573
Rail	8,807	12,417	17,041	23,120
Air	913	1,836	3,371	7,444
Total	191,248	384,634	659,719	1,094,137
Percent Person Trips				
Road	94.9%	96.3%	96.9%	97.2%
Rail	4.6%	3.2%	2.6%	2.1%
Air	0.5%	0.5%	0.5%	0.7%
Total	100.0%	100.0%	100.0%	100.0%

Source: "The Feasibility Study on the Rehabilitation and Improvement of the Railways in Viet Nam".
Data represent of inter-province, domestic demand..

[1] "The Feasibility Study on the Rehabilitation and Improvement of the Railways in Viet Nam", op. cit.

Furthermore, the growth in national road passengers is placed at roughly 11-13 percent per annum to year 2010 (Table 4.8), while road cargo (tons) growth is, over the same period, placed at some 8-10 percent (Table 4.9) by the same study. In the case of cargo forecasts, growth in tons carried somewhat lags forecast vehicle ownership growth rates. This is logical due to a number of reasons among them that a considerable portion of over-the-road trucks (particularly smaller sizes) will not necessarily be used for commercial purposes, and that some proportion of trucks in commercial use will be operated empty or only partially loaded.

It is therefore concluded that the growth in external (having at least one trip end outside the study area) domestic trips can be approximated based on findings of the "top down" analysis (refer section 4.2.2). Specifically, growth in external-external trips is correlated with forecast increases in national vehicle ownership rates, while growth in internal-external trips is approximated by an average of national vehicle ownership growth rates and growth rates previously calculated for each of the study areas four provinces (Table 4.10).

Table 4.10 Adopted Growth Rates (Percent Per Annum) External Domestic Trips

Period	Trips Between	Car	Bus	Truck	MC
1995-2000	External and	11.7	10.8	10.7	13.7
2000-2005	External Locations	13.0	12.9	12.1	16.1
2005-2010		14.3	15.7	13.6	18.4
1995-2000	Quang Tri Province and	12.7	11.8	11.7	14.8
2000-2005	External Locations	14.7	14.6	13.8	17.8
2005-2010		16.0	17.3	15.2	20.0
1995-2000	Thua Thien-Hue Province	12.3	11.4	11.4	14.4
2000-2005	and	16.2	16.1	15.2	19.3
2005-2010	External Locations	17.6	19.0	16.9	21.7
1995-2000	Quang Nam-Da Nang Province	10.4	9.5	9.5	12.5
2000-2005	and	14.3	14.2	13.4	17.4
2005-2010	External Locations	15.8	17.2	15.1	19.8
1995-2000	Quang Ngai Province and	12.2	11.4	11.3	14.3
2000-2005	External Locations	17.6	17.5	16.7	20.8
2005-2010		17.4	18.8	16.7	21.5

A further consideration is international external demand, or more specifically, future trip activity at Lao Bao (external zone 36). This forecast is directly related to the economic evolution and integration of the Greater Mekong Subregion (particularly trade between Thailand and Viet Nam), as well as type, extent and location of supporting transport infrastructure.

The Thailand-Lao PDR-Viet Nam East-West Corridor Project has, in recent years, been a subject of intense political discussions and technical reviews, the most up-to-date being a ADB-executed, French-funded *Thailand-Lao PDR-Viet Nam East-West Transport Corridor Study* which is to consider in detail the optimal configuration and sequencing of transport investments, taking into account recent developments in abutting countries and the renewed commitment to subregional cooperation. Completion of this study was scheduled for early 1996; however, at time of writing, was not yet made available. Recent discussions [1] with representatives of the ADB and JICA nevertheless confirm that Thailand, Lao PDR and Viet Nam have agreed in principle that the Highway 9 corridor represents the preferred option for

[1] Discussions conducted with ADB Division west representatives in Manila and JICA representatives in Hanoi during November, 1995.

Table 4.8 FORECAST INTER-PROVINCE PASSENGER DEMAND BY ROAD MODE
NATIONAL RAIL STUDY

ECONOMIC DEVELOPMENT REGION	NUMBER OF DAILY, INTER-PROVINCE, DOMESTIC PERSON TRIPS							
	NORTHERN MOUNTAINS	RED RIVER DELTA	NORTH COASTAL	SOUTH COASTAL	WESTERN HIGHLANDS	EASTERN NAM BO	MEKONG DELTA	TOTAL
YEAR 1994								
N. MOUNTAIN	4,096,293	15,862,990	178,679	50,622	23,347	70,707	4,698	20,287,336
RED R. DELTA	16,030,749	34,699,395	2,280,857	789,183	291,156	413,481	124,676	54,629,497
N. COASTAL	186,440	2,267,390	2,001,812	1,170,917	172,448	428,188	36,192	6,263,387
S. COASTAL	47,898	732,891	1,133,176	4,896,979	1,511,471	3,511,831	446,235	12,280,481
W.HIGHLANDS	21,658	270,511	164,608	1,512,600	68,288	1,289,610	72,597	3,399,872
E. NAM BO	64,103	380,383	395,884	3,503,086	1,260,998	37,241,995	16,296,977	59,143,426
MEKONG R. DELTA	4,240	113,221	33,985	438,403	72,226	16,265,117	8,596,330	25,523,522
TOTAL	20,451,381	54,326,781	6,189,001	12,361,790	3,399,934	59,220,929	25,577,705	181,527,521
YEAR 2000								
SED REGION	N MNTN	RED RIV	N COAST	S COAST	HIGHLND	NAM BO	MEKONG	TOTAL
N. MOUNTAIN	7,213,964	25,831,676	595,668	142,441	34,227	133,506	5,894	33,957,376
RED R. DELTA	25,939,701	59,747,436	5,385,169	1,549,603	360,694	769,065	246,271	93,997,939
N. COASTAL	614,238	5,336,493	5,558,802	3,425,544	274,279	1,000,389	93,294	16,303,039
S. COASTAL	134,780	1,494,248	3,364,664	10,070,369	2,478,957	7,018,038	783,979	25,345,035
W.HIGHLANDS	32,000	349,667	267,248	2,472,962	114,657	2,375,640	151,170	5,763,344
E. NAM BO	122,529	733,693	995,393	6,996,145	2,331,922	91,233,643	34,181,080	136,594,405
MEKONG R. DELTA	5,427	231,437	89,251	768,585	149,978	34,232,270	22,943,351	58,420,299
TOTAL	34,062,639	93,724,650	16,256,195	25,425,649	5,744,714	136,762,551	58,405,039	370,381,437
AVERAGE PERCENT GROWTH PER ANNUM FROM YEAR 1994								
	8.9%	9.5%	17.5%	12.8%	9.1%	15.0%	14.8%	12.6%
YEAR 2010								
SED REGION	N MNTN	RED RIV	N COAST	S COAST	HIGHLND	NAM BO	MEKONG	TOTAL
N. MOUNTAIN	22,187,642	66,157,807	2,406,165	478,524	147,973	305,319	10,162	91,693,592
RED R. DELTA	66,194,541	141,009,349	17,412,972	4,066,439	1,241,449	1,872,201	569,046	232,365,997
N. COASTAL	2,448,181	17,270,903	19,592,949	11,543,432	1,225,418	2,607,883	312,095	55,000,861
S. COASTAL	450,409	3,994,894	11,399,893	26,275,591	10,171,985	18,234,000	2,460,920	72,987,692
W.HIGHLANDS	137,377	1,237,716	1,203,854	10,113,265	809,278	8,519,977	606,248	22,627,715
E. NAM BO	277,961	1,811,549	2,674,878	18,194,621	8,405,464	293,236,439	89,161,473	413,762,385
MEKONG R. DELTA	9,309	539,066	299,718	2,403,266	599,558	89,445,032	81,838,761	175,134,710
TOTAL	91,705,420	232,021,284	54,990,429	73,075,138	22,601,125	414,220,851	174,958,705	1,063,572,952
AVERAGE PERCENT GROWTH PER ANNUM FROM YEAR 2000								
	10.4%	9.5%	13.0%	11.1%	14.7%	11.7%	11.6%	11.1%

ECONOMIC DEVELOPMENT REGION	PERCENT OF TOTAL TRIPS							
	NORTHERN MOUNTAINS	RED RIVER DELTA	NORTH COASTAL	SOUTH COASTAL	WESTERN HIGHLANDS	EASTERN NAM BO	MEKONG DELTA	TOTAL
YEAR 1994								
N. MOUNTAIN	2.3%	8.7%	0.1%	0.0%	0.0%	0.0%	0.0%	11.2%
RED R. DELTA	8.8%	19.1%	1.3%	0.4%	0.2%	0.2%	0.1%	30.1%
N. COASTAL	0.1%	1.2%	1.1%	0.6%	0.1%	0.2%	0.0%	3.5%
S. COASTAL	0.0%	0.4%	0.6%	2.7%	0.8%	1.9%	0.2%	6.8%
W.HIGHLANDS	0.0%	0.1%	0.1%	0.8%	0.0%	0.7%	0.0%	1.9%
E. NAM BO	0.0%	0.2%	0.2%	1.9%	0.7%	20.5%	9.0%	32.6%
MEKONG R. DELTA	0.0%	0.1%	0.0%	0.2%	0.0%	9.0%	4.7%	14.1%
TOTAL	11.3%	29.9%	3.4%	6.8%	1.9%	32.6%	14.1%	100.0%
YEAR 2000								
SED REGION								
N. MOUNTAIN	1.9%	7.0%	0.2%	0.0%	0.0%	0.0%	0.0%	9.2%
RED R. DELTA	7.0%	16.1%	1.5%	0.4%	0.1%	0.2%	0.1%	25.4%
N. COASTAL	0.2%	1.4%	1.5%	0.9%	0.1%	0.3%	0.0%	4.4%
S. COASTAL	0.0%	0.4%	0.9%	2.7%	0.7%	1.9%	0.2%	6.8%
W.HIGHLANDS	0.0%	0.1%	0.1%	0.7%	0.0%	0.6%	0.0%	1.6%
E. NAM BO	0.0%	0.2%	0.3%	1.9%	0.6%	24.6%	9.2%	36.9%
MEKONG R. DELTA	0.0%	0.1%	0.0%	0.2%	0.0%	9.2%	6.2%	15.8%
TOTAL	9.2%	25.3%	4.4%	6.9%	1.6%	36.9%	15.8%	100.0%
YEAR 2010								
SED REGION								
N. MOUNTAIN	2.1%	6.2%	0.2%	0.0%	0.0%	0.0%	0.0%	8.6%
RED R. DELTA	6.2%	13.3%	1.6%	0.4%	0.1%	0.2%	0.1%	21.8%
N. COASTAL	0.2%	1.6%	1.8%	1.1%	0.1%	0.2%	0.0%	5.2%
S. COASTAL	0.0%	0.4%	1.1%	2.5%	1.0%	1.7%	0.2%	6.9%
W.HIGHLANDS	0.0%	0.1%	0.1%	1.0%	0.1%	0.8%	0.1%	2.1%
E. NAM BO	0.0%	0.2%	0.3%	1.7%	0.8%	27.6%	8.4%	38.9%
MEKONG R. DELTA	0.0%	0.1%	0.0%	0.2%	0.1%	8.4%	7.7%	16.5%
TOTAL	8.6%	21.8%	5.2%	6.9%	2.1%	38.9%	16.5%	100.0%

Source: "The Feasibility Study on the Rehabilitation and Improvement of the Railways in Viet Nam", op. cit. Forecasts based on improved rail network.

Table 4.9 FORECAST INTER-PROVINCE CARGO DEMAND BY ROAD MODE NATIONAL RAIL STUDY

ECONOMIC DEVELOPMENT REGION	NUMBER OF DAILY INTER-PROVINCE DOMESTIC TONS							
	NORTHERN MOUNTAINS	RED RIVER DELTA	NORTH COASTAL	SOUTH COASTAL	WESTERN HIGHLANDS	EASTERN NAM BO	MEKONG DELTA	TOTAL
YEAR 1994								
N. MOUNTAIN	3,063,688	5,396,223	810,589	250,561	10,995	86,483	2,202	9,620,741
RED R. DELTA	5,470,035	2,451,137	1,015,435	288,755	85	54,139	28,825	9,308,411
N. COASTAL	783,893	1,024,160	1,049,130	553,638	28,850	94,015	10,817	3,544,503
S. COASTAL	244,811	311,453	574,225	1,767,700	600,469	675,794	145,268	4,319,720
W.HIGHLANDS	10,220	97	29,136	607,259	1,041	186,631	67,920	902,304
E. NAM BO	73,560	54,422	88,327	675,456	189,817	2,439,250	2,748,481	6,269,313
MEKONG R. DELTA	2,639	35,483	11,617	154,284	70,846	2,727,362	3,117,960	6,120,191
TOTAL	9,648,846	9,272,975	3,578,459	4,297,653	902,103	6,263,674	6,121,473	40,085,183
YEAR 2000								
SED REGION	N MNTN	RED RIV	N COAST	S COAST	HIGHLND	NAM BO	MEKONG	TOTAL
N. MOUNTAIN	4,364,753	8,314,888	1,150,415	272,536	21,760	135,449	3,260	14,263,061
RED R. DELTA	8,261,736	4,104,324	1,589,848	350,669	121	104,808	30,946	14,442,452
N. COASTAL	1,302,948	1,769,768	1,853,896	875,649	54,324	211,281	15,224	6,083,090
S. COASTAL	433,068	551,760	1,065,257	2,667,481	882,075	1,410,477	178,263	7,188,381
W.HIGHLANDS	28,246	192	59,360	902,808	2,090	449,737	98,308	1,540,741
E. NAM BO	194,639	272,773	248,971	1,464,706	474,690	6,118,530	6,294,516	15,068,825
MEKONG R. DELTA	5,292	48,522	14,568	179,158	99,803	5,797,157	4,041,506	10,186,006
TOTAL	14,590,682	15,062,227	5,982,315	6,713,007	1,534,863	14,227,439	10,662,023	68,772,556
AVERAGE PERCENT GROWTH PER ANNUM FROM YEAR 1994								
	7.1%	8.4%	8.9%	7.7%	9.3%	14.7%	9.7%	9.4%
YEAR 2010								
SED REGION	N MNTN	RED RIV	N COAST	S COAST	HIGHLND	NAM BO	MEKONG	TOTAL
N. MOUNTAIN	7,929,520	18,957,962	2,334,439	393,767	58,075	306,756	7,091	29,987,610
RED R. DELTA	16,573,139	8,454,452	3,253,765	584,711	252	280,786	45,933	29,193,038
N. COASTAL	2,934,984	3,718,323	2,795,831	1,498,502	140,550	510,889	26,620	11,625,699
S. COASTAL	934,987	1,136,785	1,874,743	3,890,517	1,779,202	2,527,918	298,265	12,442,417
W.HIGHLANDS	99,584	550	171,114	1,815,050	6,821	1,414,202	218,668	3,725,989
E. NAM BO	541,611	1,402,036	659,254	2,684,153	1,419,996	19,095,288	19,538,063	45,340,401
MEKONG R. DELTA	15,082	100,155	22,323	276,769	223,280	18,766,550	8,412,252	27,816,411
TOTAL	29,028,907	33,770,263	11,111,469	11,143,469	3,628,176	42,902,389	28,546,892	160,131,565
AVERAGE PERCENT GROWTH PER ANNUM FROM YEAR 2000								
	7.1%	8.4%	6.4%	5.2%	9.0%	11.7%	10.3%	8.8%

ECONOMIC DEVELOPMENT REGION	PERCENT OF TOTAL TONS							
	NORTHERN MOUNTAINS	RED RIVER DELTA	NORTH COASTAL	SOUTH COASTAL	WESTERN HIGHLANDS	EASTERN NAM BO	MEKONG DELTA	TOTAL
YEAR 1994								
N. MOUNTAIN	7.6%	13.5%	2.0%	0.6%	0.0%	0.2%	0.0%	24.0%
RED R. DELTA	13.6%	6.1%	2.5%	0.7%	0.0%	0.1%	0.1%	23.2%
N. COASTAL	2.0%	2.6%	2.6%	1.4%	0.1%	0.2%	0.0%	8.8%
S. COASTAL	0.6%	0.8%	1.4%	4.4%	1.5%	1.7%	0.4%	10.8%
W.HIGHLANDS	0.0%	0.0%	0.1%	1.5%	0.0%	0.5%	0.2%	2.3%
E. NAM BO	0.2%	0.1%	0.2%	1.7%	0.5%	6.1%	6.9%	15.6%
MEKONG R. DELTA	0.0%	0.1%	0.0%	0.4%	0.2%	6.8%	7.8%	15.3%
TOTAL	24.1%	23.1%	8.9%	10.7%	2.3%	15.6%	15.3%	100.0%
YEAR 2000								
SED REGION								
N. MOUNTAIN	6.3%	12.1%	1.7%	0.4%	0.0%	0.2%	0.0%	20.7%
RED R. DELTA	12.0%	6.0%	2.3%	0.5%	0.0%	0.2%	0.0%	21.0%
N. COASTAL	1.9%	2.6%	2.7%	1.3%	0.1%	0.3%	0.0%	8.8%
S. COASTAL	0.6%	0.8%	1.5%	3.9%	1.3%	2.1%	0.3%	10.5%
W.HIGHLANDS	0.0%	0.0%	0.1%	1.3%	0.0%	0.7%	0.1%	2.2%
E. NAM BO	0.3%	0.4%	0.4%	2.1%	0.7%	8.9%	9.2%	21.9%
MEKONG R. DELTA	0.0%	0.1%	0.0%	0.3%	0.1%	8.4%	5.9%	14.8%
TOTAL	21.2%	21.9%	8.7%	9.8%	2.2%	20.7%	15.5%	100.0%
YEAR 2010								
SED REGION								
N. MOUNTAIN	5.0%	11.8%	1.5%	0.2%	0.0%	0.2%	0.0%	18.7%
RED R. DELTA	10.3%	5.3%	2.0%	0.4%	0.0%	0.2%	0.0%	18.2%
N. COASTAL	1.8%	2.3%	1.7%	0.9%	0.1%	0.3%	0.0%	7.3%
S. COASTAL	0.6%	0.7%	1.2%	2.4%	1.1%	1.6%	0.2%	7.8%
W.HIGHLANDS	0.1%	0.0%	0.1%	1.1%	0.0%	0.9%	0.1%	2.3%
E. NAM BO	0.3%	0.9%	0.4%	1.7%	0.9%	11.9%	12.2%	28.3%
MEKONG R. DELTA	0.0%	0.1%	0.0%	0.2%	0.1%	11.7%	5.3%	17.4%
TOTAL	18.1%	21.1%	6.9%	7.0%	2.3%	26.8%	17.8%	100.0%

Source: "The Feasibility Study on the Rehabilitation and Improvement of the Railways in Viet Nam", op. cit. Forecasts based on improved rail network.

enhanced east-west land-based trade. This conclusion also appears to be supported by the United Nations ESCAP *Asian Highway Network* study, now in final stages of development in cooperation with the Mekong River Secretariat. Preliminary discussions[1] suggest that Highway 1 south of Dong Ha and Highway 9 in its entirety are included as Asian Highway 3. Subsequently, in-depth negotiations between Thailand and Lao PDR yielded, during May, 1996, an agreement confirming that the second Mekong River bridge (the first being in northern Thailand connecting Nong Kai with Vientiane) will link Mukdaban (Thailand) and Savannakhet (Lao PDR). Most recently[2], the ADB has given priority to the development of two commercial corridors linking the Mekong riverine nations. One is the Bangkok-Mukdahan-Savannakhet-Dong Ha-Da Nang corridor, which is defined as a backbone of a transnational road network centered on Highway 9. These developments confirm the status of the Highway 9 corridor. The current study has therefore adopted (refer *Interim Report*) as a major goal that the Highway 9 road corridor, termed the **Indochina East-West Trade Corridor**, represents a key economic catalyst for the Mekong Subregion in general, the study area in particular (Figure 4.7). This concept is also supported by on-going national planning efforts in Thailand[3] as well as other private sector oriented programs and policies[4].

A review of recent trade patterns between Thailand, Lao PDR and Viet Nam is of interest (Table 4.11).

Thailand exported, during 1994, some US$ 255 million to Viet Nam and US$ 293 million to Lao PDR. Imports from Viet Nam totaled US$ 39 million, and from Lao PDR US$ 70 million. In aggregate, this amounts to less than two percent of Thailand's foreign trade.

- Vietnamese exports/imports to/from Lao PDR appear, based on "official" data, negligible, but with Thailand totaled, in 1994, almost US$ 300 million. The share of national trade with Thailand aggregated to some three percent of the national total in 1992. From the Lao PDR perspective, Thailand trade dominates accounting, during 1992, for some 39 percent of all exports and 58 percent of all imports.
- Exports from Viet Nam to Thailand decreased dramatically between 1993 (US$ 85.8 million) and 1994 (US$ 39.4 million). This is largely due to changes in "wood in rough, sawn or chipped form". Year 1993 exports of this trade category totaled US$ 60.4 million, and year 1994 exports US$ 12.0 million. Still, is 1994, this remained as one of the principal export categories. Imports to Viet Nam from Thailand, on the other hand, increased sharply during the same year from US$ 117.2 million to US$ 255.2 million. Year 1994 imports were heavily supported by two trade categories: "motorcycles, parts and accessories" as well as "sugar".

The volume of "official" Thailand-Lao PDR/Viet Nam trade crossing the northeast Thailand frontier is difficult to quantify. According to a joint survey conducted by the Bank of Thailand as well as the State Bank of Lao, and released during early 1996, cross-Mekong trade at Mukdaban-Savannakhet (Highway 9) totaled some US$ 71 million, and at Nakhon Phanom-Thakhek (site of third potential Mekong River bridge) some US$ 24 million.

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[1] Discussions conducted at UN ESCAP headquarters, Bangkok, during November, 1995.

[2] Third Greater Mekong Sub-Region (GMS) Summit Conference held in Ho Chi Minh City, Viet Nam, during September, 1996.

[3] "Formulation of a Spatial Development Framework for Thailand", for UDCD/NESDB, Government of Thailand, by Norconsult International, et.al., on-going.

[4] "Forum for the Comprehensive Development of the Indo-China Private Sector Advisory Group". First annual conference, jointly sponsored by the United Nations ESCAP, Government of Japan and Government of Thailand, was held in Bangkok, Thailand during March, 1996.

Figure 4.7 Greater Mekong Sub-region and Indochina East-West Trade Corridor

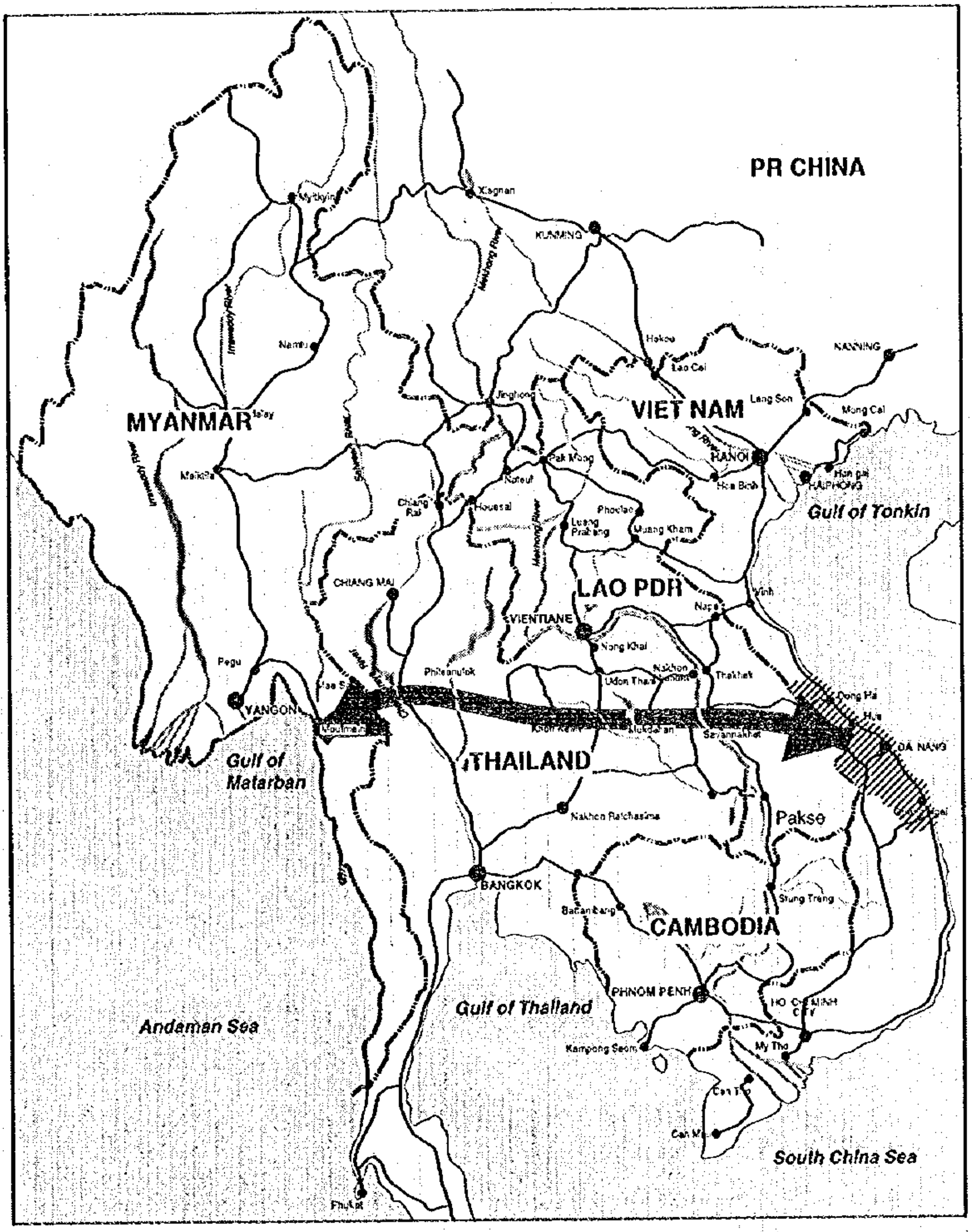

Table 4.11 HISTORIC TRADE ACTIVITY: THAILAND, VIET NAM AND LAO PDR

NATION	TRADE ACTIVITY	ORIGIN OR DESTINATION	ANNUAL TRADE (MILLION US $)											
			1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Thailand	Exports	Total	9,368.6	7,412.5	7,121.7	8,754.2	11,658.3	15,953.1	20,079.5	23,067.6	28,423.1	32,474.4	38,054.4	46,080.4
		Viet Nam	1.0	9.4	0.3	1.2	4.8	5.1	17.7	20.1	24.5	84.3	117.2	255.2
		Lao PDR	36.4	19.1	21.7	32.9	40.9	56.4	70.2	72.3	84.3	133.1	177.2	293.1
		Subtotal	37.4	28.5	22.0	34.1	45.7	61.5	87.9	92.4	108.8	217.4	294.4	548.3
		% of Total	0.4%	0.4%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.7%	0.8%	1.2%
	Imports	Total	10,287.7	10,397.0	9,243.0	9,140.2	12,994.0	20,288.5	25,771.6	33,377.2	37,589.6	40,689.2	46,833.9	54,825.4
		Viet Nam	0.4	0.6	0.5	1.6	2.7	8.3	41.4	85.3	105.7	72.9	85.8	39.4
		Lao PDR	1.1	0.9	1.0	1.2	5.4	20.4	39.7	40.3	42.7	37.3	64.0	69.5
		Subtotal	1.5	1.5	1.5	2.8	8.1	28.7	81.1	125.6	148.4	110.2	149.8	108.9
		% of Total	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.3%	0.4%	0.4%	0.3%	0.3%	0.2%
Viet Nam	Exports	Total	206.2	250.0	341.9	341.1	423.5	531.6	968.5	1,299.1	1,589.3	2,264.0	*	*
		Thailand	0.4	0.6	0.5	1.6	2.7	8.3	41.4	85.3	105.7	72.9	85.8	39.4
		Lao PDR	-	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	*	*
		Subtotal	0.4	0.7	0.6	1.7	2.8	8.4	41.6	85.5	105.9	73.1	85.8	39.4
		% of Total	0.2%	0.3%	0.2%	0.5%	0.7%	1.6%	4.3%	6.6%	6.7%	3.2%	*	*
	Imports	Total	413.1	524.8	610.3	590.3	614.6	793.8	840.8	1,041.8	1,667.0	3,356.7	*	*
		Thailand	1.0	9.4	0.3	1.2	4.8	5.1	17.7	20.1	24.5	84.3	117.2	255.2
		Lao PDR	-	-	-	-	-	-	-	-	-	-	*	*
		Subtotal	1.0	9.4	0.3	1.2	4.8	5.1	17.7	20.1	24.5	84.3	117.2	255.2
		% of Total	0.2%	1.8%	0.0%	0.2%	0.8%	0.6%	2.1%	1.9%	1.5%	2.5%	*	*
Lao PDR	Exports	Total	24.0	11.4	16.6	14.1	23.3	55.8	92.8	60.8	78.7	95.6	*	*
		Viet Nam	-	-	-	-	-	-	-	-	-	-	*	*
		Thailand	1.1	0.9	1.0	1.2	5.4	20.4	39.7	40.3	42.7	37.3	64.0	69.5
		Subtotal	1.1	0.9	1.0	1.2	5.4	20.4	39.7	40.3	42.7	37.3	64.0	69.5
		% of Total	4.6%	7.9%	6.0%	8.5%	23.2%	36.6%	42.8%	66.3%	54.3%	39.0%	*	*
	Imports	Total	80.1	40.5	54.0	60.1	79.8	102.2	126.2	131.7	151.1	229.6	*	*
		Viet Nam	-	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	*	*
		Thailand	36.4	19.1	21.7	32.9	40.9	56.4	70.2	72.3	84.3	133.1	177.2	293.1
		Subtotal	36.4	19.2	21.8	33.0	41.0	56.5	70.4	72.5	84.5	133.3	177.2	293.1
		% of Total	45.4%	47.4%	40.4%	54.9%	51.4%	55.3%	55.8%	55.0%	55.9%	58.1%	*	*

Note: (-) implies nil or negligible; (*) implies data not available.

Data sources: United Nations Economic and Social Commission for Asia and the Pacific; Government of Thailand

These data suggest that the bulk of Thailand - Viet Nam trade does not move via land, at least not at these two locations. In all likelihood, most cross-Mekong trade involves goods between Thailand and Lao PDR, and that the share of Thailand - Viet Nam land-based trade is currently very modest. For example, traffic flow data for the western-most segments of Highway 9 inside Viet Nam indicate that daily traffic has reduced from 703 vehicles per day in 1992 to 570 vpd and 438 vpd in 1993 and 1994, respectively[1]. Data collected within the framework of the current study suggest that 1995 traffic flow may have stabilized near 300-350 vpd or, if each truck carries an average of six tons, some 0.5 million tons per year. Similar conclusions were reached at completion of a Highway 9 corridor reconnaissance in the Lao PDR[2]. Land based transport activity is, at present, minimal, even though cross-Lao road facilities are available, albeit in poor condition, as are passenger and vehicle ferries across the Mekong River between Savannakhet, Lao PDR and Mukdaban, Thailand.

Thus, forecasts in Highway 9 activity must be based on perceived potential, rather than current, observed experience. A review[3] of potential land-based trade patterns between Thailand and seaports located in the study area suggests a potential growth in volume of some 8.5 percent per annum once Highway 9 infrastructure is suitably improved. However, this is contingent upon a number of externalities among them corridor travel times, competitiveness of transport hubs, shipment costs, jurisdictional formalities and political will.

One might argue that future Highway 9 traffic could increase in line with overall Thailand-Viet Nam trade. However, this is unlikely since increased value of trade does not necessarily imply increased volume of trade (example: computer chips). Furthermore, future trade shipments may continue to follow established routes, which at present apparently does not include Highway 9.

It is therefore concluded that, for modeling purposes, truck activity at Lao Bao (external zone 36) is depicted as increasing at an annual rate of 10 percent to year 2000, and 15 percent thereafter[4]. Cars and buses, of which practically none cross the border at present, will be represented by a volume equal to one-fourth of truck volume.

4.3.3 Mega-Projects

The trip generation process defined in the previous sections is sensitive to changing socioeconomic patterns exhibited within the study area. However, two major focii of transport activity are likely to evolve in future whose degree of success transcends the socioeconomic development pattern of the study area; specifically, Chan May port and Dung Quat ports. Both facilities are expected to generate a sizable number of truck trips whose impact must be superimposed onto demand growth fueled by socioeconomic evolution.

Forecasts of road-mode cargo flows are sensitive to a number of variables including import/export commodity breakdowns, progress of containerization, truck loading patterns, and integration of port functions with adjacent industrial activities, among others. Unfortunately, detailed feasibility studies for either port are not yet available; thus, estimates of demand must be derived based on available information and professional judgment.

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[1] Source: Quang Tri Province People's Committee.

[2] "Route Reconnaissance Report: Highway 9, Lao Bao-Savannakhet, Lao PDR" by Pacific consultants International, July, 1996.

[3] "Interim Report", op. cit.

[4] These rates also correspond to maximum rates employed during conduct of the "Subregional Transport Sector Study for the Greater Mekong Subregion", Asian Development Bank, October 1995.

Port demand has been estimated at:

Port	Item	Million Tons per Year		
		2000	2005	2010
Chan May	General Cargo	0	3.0	8.1
Dung Quat	General Cargo	0	3.2	5.8
	Refinery	0	12.7	25.4

Source: JICA Study Team

Each port is expected to feature a different operational orientation.

- Chan May port is largely intended to serve the Hue-Da Nang area and, to a lesser degree, international trade via the Highway 9 corridor[1]. Chan May port will also interact with the adjacent FTZ (free-trade zone), whose function will largely be the processing/assembly of goods via international import/export consignments. As a commercial port, Chan May is expected to increasingly accommodate containerized shipments.

- Dung Quat port is, on the other hand, intended as an industrial port. Viet Nam's first refinery will be located in the port; however, the import, refining and export of petroleum products will be on a national scale (via coastal shipping and pipeline). Thus, the refinery is expected to generate virtually no landside shipments via the truck mode. The abutting Dung Quat industrial estate will closely interact with the port in areas of power generation, steel processing, chemical products as well as ship maintenance, repair, scrapping and recycling. A sizable portion of port general cargo imports/exports will relate to operation of the industrial estate. Some general cargo shipments will be goods (typically in break-bulk form) to/from the immediate port interland.

It is also of interest to examine the recently-completed feasibility study for the Cai Lai deepwater seaport[2]. Forecasts indicate that the port will achieve a throughout of 2.4 million and 10.2 million annual general cargo tons by years 2000 and 2010, respectively. Containerized cargo is, for the same horizon, expected to reach 0.4 million and 4.2 million tons. A sizable portion (roughly one-half) of general cargo demand is expected to be linked with factories located in the immediate environs of the port. The remainder of cargo will be transported to/from major centers in the Red River Delta. Container activity will likely be focused on Hanoi due to the planned construction of a new inland container terminal. Current estimates suggest that the railways role in transporting cargo could reach 30 percent assuming that requisite contractual arrangements can be negotiated between railway authorities and shipping companies.

In light of these considerations, the following scenario for general cargo activity is adopted for modeling purposes.

[1] JICA Study Team forecasts (refer Interim Report) place potential demand between Vietnamese ports and Thailand at 0.83 and 1.88 million tons per annum by years 2000 and 2010, respectively.
[2] "The Feasibility Study on Cai Lan Port Construction Project in the Socialist Republic of Viet Nam", for Ministry of Transport, by Japan International Cooperation Agency, February 1995.

Item	Units	Chan May		Dung Quat	
		2005	2010	2005	2010
Interaction with adjacent industrial estates/EPZ	Percent	25	35	50	70
Shipment via alternative (non-road) modes	Percent	20	20	10	10
Containerization	Percent	20	50	0	15
Average load container truck	Tons	11.3	13.0	11.3	13.0
Average load, break-bulk truck	Tons	6.0	7.2	6.0	7.2

Conclusions are that Chan May port is expected to catalyze some 660 and 1,160 inter-zonal truck trips per day during years 2005 and 2010, respectively. Similar statistics at Dung Quat port are 750 and 580 truck trips per day. In addition, it is assumed that the ports will generate car/bus trips roughly equal in volume to 20 percent of truck trips.

4.4 TRIP DISTRIBUTION MODEL

Base-year trip distribution is constrained by three factors:

- The overall fabric of the study area is, with few exceptions, under-developed thus catalyzing modest absolute trip totals.
- Trip origin-destination relationship are, due to existing landuse and development patterns, imbalanced with remote zones generating no or few trips.
- The poor condition of the roadway network inhibits longer trips.

It is clear that, in future, these relationships will change as land uses expand/intensify, mega-projects are gradually realized, and the road network is improved. This requires that trip distribution be sensitive to changes in both developmental intensity (trip generation) and travel time. This is achieved via the application of a doubly-constrained gravity model of the form:

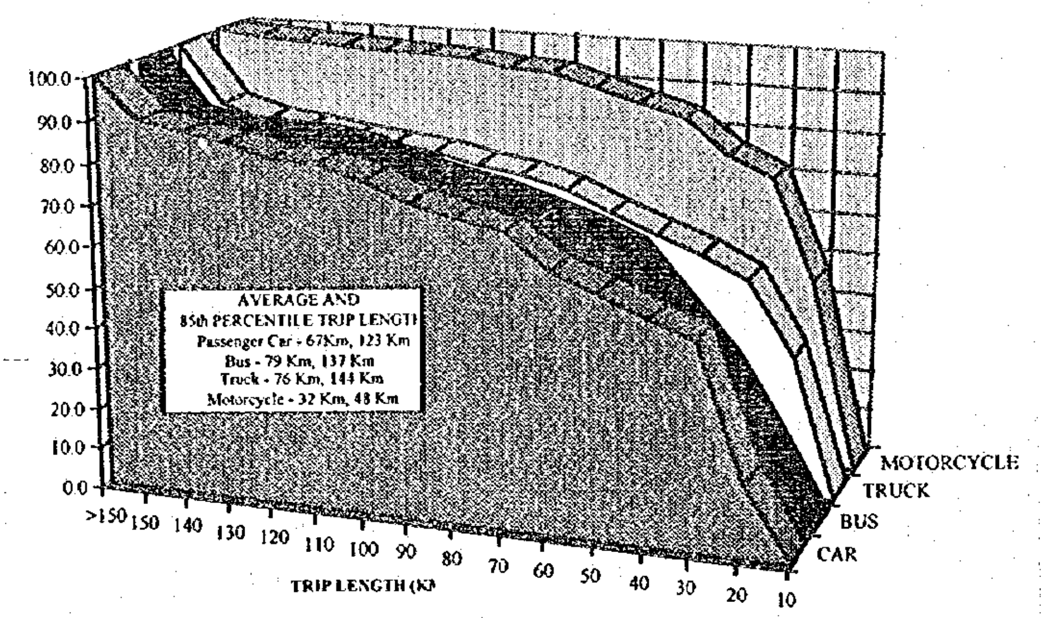
$$T_{(ij)} = \frac{P_i A_j F_{t_{(ij)}}}{\sum_{x=1}^{n} A_x F_{t_{(ix)}}}$$

where $T_{(i,j)}$ = trips produced in zone *i* and attracted to zone j
P_i = trips produced in zone *i*
A_j = trips attracted to zone j
$t_{(i,j)}$ = travel time between zone *i* and zone j
$F_{t(i,j)}$ = empirically derived travel time factor that expresses the average area-wide effect of spatial separation on trip on trip interchange between zones that are *t(i,j)* apart

Thus, within TRANPLAN, the function accepts zonal trip end productions and attractions stratified by class of trip (purpose), travel impedance factors as well as zone-to-zone travel indexes, and generates a zone-to-zone trip table using the above gravity model distribution formula.

Inter-zonal journeys by trucks and buses currently achieve highest average trip length - near 80 kilometers. Passenger cars average near 70 kilometers, and motorcycles near 30 kilometers. The 85th percentile trip length of cars, buses and trucks brackets the 130-140 kilometer range, with some 10-15 percent of trips exceeding 150 kilometers in length (Figure 4.8). These distributions underlie the travel deterrence function (F-curves), whose development was successfully achieved as part of the gravity model calibration process.

Figure 4.8 SIMULATED YEAR 1995 CUMULATIVE MODAL TRIP LENGTH PA STUDY AREA ROAD NETWORK



4.5 COMPOSITE FORECAST

Application of the trip generation models to calculate internal as well as external trips, and use of the trip distributions model, yields composite future-year demands for the study area. The number of daily trips is expected to considerably increase for motorized modes. Car, bus and truck inter-zonal are shown as increasing from 15,100 per day in year 1995 to 129,200 by year 2010. The growth in motorcycle inter-zonal trip activity is likely to be even more pronounced expanding from 52,000 per day in year 1995 to some 687,000 per day by year 2010 (Table 4.12).

A review of zonal patterns for car, bus and truck activity reveals (Figure 4.9):

- Growth is, on a relative basis, pronounced in all zones throughout the planning horizon.
- Highest absolute trip totals are typically identified with zones featuring a concentration of urban population, extensive employment opportunities and catalysts such as key industrial estates. Typical examples include zone 8 (Hue); zones 14 and 15 (Da Nang metropolitan area) and zone 27 (Quang Ngai).
- Some zones, such as zone 10 (Chan May development) and zone 25 (Dung Quat industrial complex) cannot rival the more urbanized zones in terms of absolute trip

productions; however, these zones record some of the highest relative growth rates in trip activity, particularly after the turn of the century.

It is also of interest to review, on an overview basis, changes in trip patterns throughout the study area (Table 4.13).

- Year 1995 internal interzonal trips by cars, buses and trucks are highly concentrated in that 75-85 percent never leave the province of origin. This ratio is expected to considerably reduce by year 2010; in the case of Thua Thien-Hue province, for example, 58 percent are expected to remain within the province but almost one-fourth are likely to reach Quang Nang-Da Nang province (the Hue-Da Nang urban corridor).

- Year 1995 external interzonal trips by cars, buses and trucks are dominated by "through" trips: some 40 percent of trips have neither end within the study area. While through trips are expected to retain their importance in future, the relative share is shown as reducing to near 30 percent by year 2010 due to an increasing number of trips between the study area and other parts of the nation.

- Year 1995 internal interzonal motorcycle trips are typically of modest length, with some 90 percent never leaving the province of origin. While some lengthening of trips is unavoidable in future, the intra-province focus of motorcycle trips is nevertheless likely to remain.

- Quang Nam-Da Nang province represents the major element of 1995 matrixes accounting for 38 percent of car, bus and truck trips as well as 52 percent of motorcycle trips. While the province is expected to continue generating the highest absolute number of trips among the four study area provinces, Quang Nam-Da Nang's relative role will likely decline. By year 2010, the province is shown as generating some one-fourth of car, bus and truck trips, as well as about 39 percent of motorcycle trips.

These future year (2000, 2005, 2010) trip totals therefore serve as the demand potential against which the adequacy (supply) of road systems are tested.

Table 4.12 FORECAST DAILY VEHICLE TRIP ENDS

	YEAR 2000						YEAR 2005						YEAR 2010					
ZONE (1)	CAR	BUS	TRUCK	SUBTOT	MC	NMV	CAR	BUS	TRUCK	SUBTOT	MC	NMV	CAR	BUS	TRUCK	SUBTOT	MC	NMV
1	34	23	42	99	938	1,051	69	50	86	205	2,252	889	152	118	180	450	5,786	812
2	76	163	162	401	1,182	1,571	169	361	360	890	3,142	1,329	364	854	763	1,981	8,141	1,213
3	349	108	578	1,035	5,254	3,714	763	236	1,186	2,185	12,995	3,142	1,818	636	2,710	5,164	37,303	2,869
4	33	108	47	188	752	1,994	68	230	101	399	1,883	1,688	143	532	198	873	4,638	1,541
5	129	141	194	464	2,572	1,356	254	282	369	905	5,749	1,147	511	617	712	1,840	13,347	1,047
6	95	49	132	276	298	781	201	98	257	556	670	662	434	223	508	1,165	1,552	604
7	204	232	108	544	2,253	2,563	467	538	252	1,257	5,969	2,168	1,148	1,385	608	3,141	17,043	1,979
8	641	473	1,016	2,130	9,426	6,203	1,579	1,144	2,468	5,191	26,146	5,248	3,979	3,017	6,031	13,027	76,135	4,791
9	156	253	96	505	2,819	4,878	391	619	250	1,260	8,258	4,127	1,077	1,737	709	3,523	27,342	3,768
10	66	164	74	304	1,501	1,990	212	421	505	1,138	4,651	1,684	604	1,384	1,156	3,144	18,835	1,538
11	18	90	175	283	1,069	947	40	203	377	620	2,613	801	94	517	854	1,465	7,090	732
12	39	81	177	297	448	180	85	181	367	633	1,083	152	196	446	825	1,467	2,854	139
13	21	84	171	276	549	398	45	203	377	625	1,410	337	105	507	872	1,484	3,884	308
14	134	637	1,479	2,250	13,496	5,705	329	1,497	3,583	5,409	38,747	4,827	828	3,827	8,711	13,366	115,647	4,406
15	462	1,026	2,774	4,262	20,551	8,218	992	2,129	5,279	8,400	45,620	6,952	2,203	4,995	10,472	17,670	111,742	6,348
16	73	430	403	906	2,389	5,173	148	848	729	1,725	5,106	4,377	371	2,081	1,744	4,196	14,918	3,996
17	68	218	135	421	2,403	4,182	126	399	226	751	4,672	3,539	255	837	409	1,501	10,449	3,231
18	81	188	101	370	1,590	2,156	149	337	166	652	3,030	1,824	287	674	287	1,248	6,261	1,665
19	166	184	239	589	2,430	3,544	342	368	447	1,157	5,438	2,998	726	808	867	2,401	12,973	2,737
20	162	216	101	479	2,138	2,927	315	413	214	942	4,280	2,476	643	915	360	1,918	10,202	2,261
21	5	10	19	34	327	450	8	18	31	57	617	380	16	36	53	105	1,283	347
22	35	91	121	247	1,888	2,402	69	179	223	471	4,066	2,031	157	416	478	1,051	10,767	1,854
23	28	73	122	223	378	211	53	125	197	375	722	179	100	255	332	687	1,512	162
24	31	109	190	330	577	550	52	192	304	548	1,086	465	101	388	536	1,025	2,307	424
25	184	119	258	561	1,605	3,910	594	366	1,167	2,127	5,854	3,308	1,727	1,126	3,150	6,003	24,405	3,021
26	97	156	368	621	1,589	5,490	264	435	1,009	1,708	4,989	4,645	615	1,191	2,397	4,203	14,867	4,241
27	419	161	1,183	1,763	7,831	4,118	1,176	466	3,338	4,980	25,558	3,484	2,845	1,272	8,107	12,224	75,903	3,181
28	127	150	454	731	2,145	6,455	312	373	1,101	1,786	5,853	5,461	668	895	2,309	3,872	15,026	4,987
29	33	113	526	672	2,021	4,441	82	275	1,248	1,605	5,496	3,758	176	658	2,701	3,535	14,342	3,430
30	20	84	164	268	554	398	44	202	385	631	1,472	337	99	486	810	1,395	3,774	308
31	29	90	170	289	580	398	71	225	448	744	1,641	337	152	562	938	1,652	4,376	308
32	33	75	152	260	461	419	81	185	358	624	1,220	354	171	447	754	1,372	3,134	324
33	93	407	674	1,174	943	211	223	825	1,419	2,467	2,391	179	444	1,855	2,706	5,005	6,291	163
34	19	51	94	164	86	18	48	100	220	368	206	15	93	223	403	719	530	14
35	16	18	80	114	99	11	38	35	161	234	225	9	75	76	326	477	561	8
36	25	25	110	160	50	-	55	55	215	325	100	-	135	135	430	700	-	-
37	21	32	84	137	296	247	41	64	163	268	673	209	88	145	339	572	150	191
38	108	240	567	915	498	412	221	462	1,073	1,756	1,142	348	457	998	2,111	3,566	1,681	318
TOTALS	4,330	6,872	13,540	24,742	95,986	89,672	10,176	15,139	30,659	55,974	247,025	75,866	24,057	37,274	67,856	129,187	687,051	69,266

(1) Refer Figure 1.2 for zone map.
Note: some totals may differ due to rounding and directional balancing. Demand represents daily trips crossing a zone boundary.

Figure 4.9 Forecast Study Area Demand

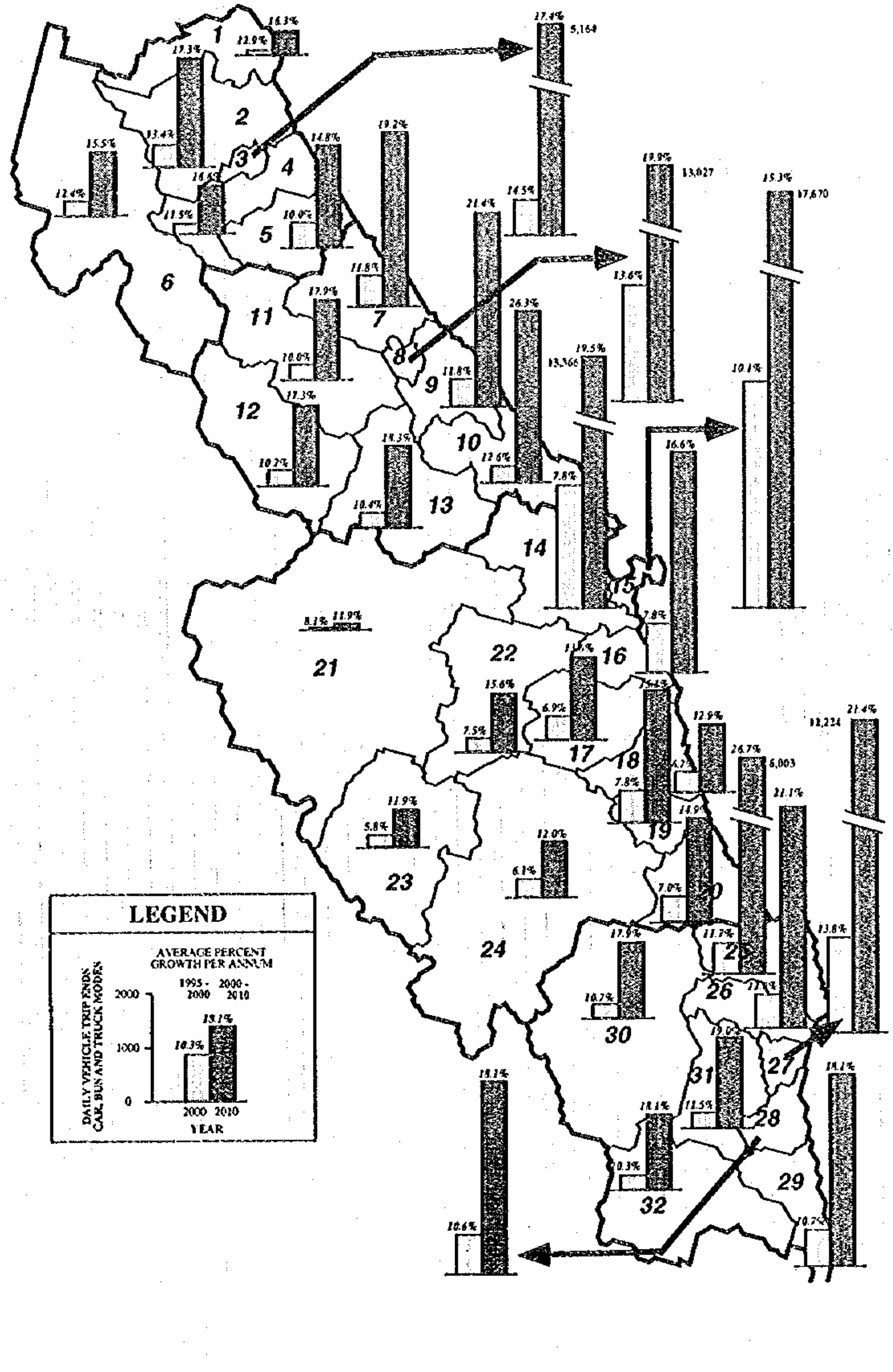


TABLE 4.13 COMPARISON OF SIMPLIFIED BASE AND FUTURE YEARS TRIP MATRIXES

YEAR 1995		NUMBER OF TRIPS: CAR, BUS AND TRUCK						PRODUCTION (ROW) PERCENTAGES						TRIP (MATRIX) PERCENTAGES					
ORIGIN/DESTN(J)		1	2	3	4	5	TOTAL	1	2	3	4	EXT	TOTAL	1	2	3	4	5	TOTAL
Quang Tri	1	1,026	92	58	5	164	1,345	76.3	6.8	4.3	0.4	12.2	100.0	6.8	0.6	0.4	0.0	1.1	8.9
Thua Thien - Hue	2	93	1,843	286	27	171	2,420	3.8	76.2	11.8	1.1	7.1	100.0	0.6	12.2	1.9	0.2	1.1	16.0
QN - Da Nang	3	60	288	5,812	117	451	6,728	0.9	4.3	86.4	1.7	6.7	100.0	0.4	1.9	38.4	0.8	3.0	44.5
Quang Ngai	4	6	30	117	2,526	250	2,929	0.2	1.0	4.0	86.2	8.5	100.0	0.0	0.2	0.8	16.7	1.7	19.4
External	5	167	167	455	248	668	1,705	9.8	9.8	26.7	14.5	39.2	100.0	1.1	1.1	3.0	1.6	4.4	11.3
TOTAL		1,352	2,420	6,728	2,923	1,704	15,127	8.9	16.0	44.5	19.3	11.3	100.0	8.9	16.0	44.5	19.3	11.3	100.0

YEAR 2010		NUMBER OF TRIPS: CAR, BUS AND TRUCK						PRODUCTION (ROW) PERCENTAGES						TRIP (MATRIX) PERCENTAGES					
ORIGIN/DESTN(J)		1	2	3	4	5	TOTAL	1	2	3	4	5	TOTAL	1	2	3	4	5	TOTAL
Quang Tri	1	6,298	3,123	790	123	1,126	11,460	55.0	27.3	6.9	1.1	9.8	100.0	4.9	2.4	0.6	0.1	0.9	8.9
Thua Thien - Hue	2	3,125	15,896	6,153	613	1,475	27,262	11.5	58.3	22.6	2.2	5.4	100.0	2.4	12.3	4.8	0.5	1.1	21.1
QN - Da Nang	3	785	6,160	31,158	4,296	2,749	45,148	1.7	13.6	69.0	9.5	6.1	100.0	0.6	4.8	24.1	3.3	2.1	35.0
Quang Ngai	4	120	615	4,294	26,949	2,274	34,252	0.4	1.8	12.5	78.7	6.6	100.0	0.1	0.5	3.3	20.9	1.8	26.5
External	5	1,148	1,438	2,780	2,265	3,406	11,037	10.4	13.0	25.2	20.5	30.9	100.0	0.9	1.1	2.2	1.8	2.6	8.5
TOTAL		11,476	27,232	45,175	34,246	11,030	129,159	8.9	21.1	35.0	26.5	8.5	100.0	8.9	21.1	35.0	26.5	8.5	100.0

YEAR 1995		NUMBER OF TRIPS: MOTORCYCLES						PRODUCTION (ROW) PERCENTAGES						TRIP (MATRIX) PERCENTAGES					
ORIGIN/DESTN(J)		1	2	3	4	5	TOTAL	1	2	3	4	5	TOTAL	1	2	3	4	5	TOTAL
Quang Tri	1	4,532	325	58	3	372	5,290	85.7	6.1	1.1	0.1	7.0	100.0	8.7	0.6	0.1	0.0	0.7	10.2
Thua Thien - Hue	2	324	8,332	212	18	56	8,942	3.6	93.2	2.4	0.2	0.6	100.0	0.6	16.0	0.4	0.0	0.1	17.2
QN - Da Nang	3	63	212	27,278	620	125	28,298	0.2	0.7	96.4	2.2	0.4	100.0	0.1	0.4	52.5	1.2	0.2	54.5
Quang Ngai	4	6	21	626	7,305	463	8,421	0.1	0.2	7.4	86.7	5.5	100.0	0.0	0.0	1.2	14.1	0.9	16.2
External	5	372	51	127	461	0	1,011	36.8	5.0	12.6	45.6	0.0	100.0	0.7	0.1	0.2	0.9	0.0	1.9
TOTAL		5,297	8,941	28,301	8,407	1,016	51,962	10.2	17.2	54.5	16.2	2.0	100.0	10.2	17.2	54.5	16.2	2.0	100.0

YEAR 2010		NUMBER OF TRIPS: MOTORCYCLES						PRODUCTION (ROW) PERCENTAGES						TRIP (MATRIX) PERCENTAGES					
ORIGIN/DESTN(J)		1	2	3	4	5	TOTAL	1	2	3	4	5	TOTAL	1	2	3	4	5	TOTAL
Quang Tri	1	58,874	7,581	311	0	4,032	70,798	83.2	10.7	0.4	0.0	5.7	100.0	8.5	1.1	0.0	0.0	0.6	10.3
Thua Thien - Hue	2	7,521	125,859	19,147	0	713	153,240	4.9	82.1	12.5	0.0	0.5	100.0	1.1	18.2	2.8	0.0	0.1	22.2
QN - Da Nang	3	307	19,040	268,164	9,294	1,234	298,039	0.1	6.4	90.0	3.1	0.4	100.0	0.0	2.8	38.9	1.3	0.2	43.2
Quang Ngai	4	0	0	9,202	140,440	6,146	155,788	0.0	0.0	5.9	90.1	3.9	100.0	0.0	0.0	1.3	20.4	0.9	22.6
External	5	4,031	646	1,256	6,128	0	12,061	33.4	5.4	10.4	50.8	0.0	100.0	0.6	0.1	0.2	0.9	0.0	1.7
TOTAL		70,733	153,126	298,080	155,862	12,125	689,926	10.3	22.2	43.2	22.6	1.8	100.0	10.3	22.2	43.2	22.6	1.8	100.0

Note: some totals may differ due to rounding and directional balancing. Demand represents daily trips crossing a zone boundary.

CHAPTER 5

SUFFICIENCY ANALYSIS AND STRATEGY FORMULATION

CHAPTER 5 SUFFICIENCY ANALYSIS AND STRATEGY FORMULATION

A sufficiency review, that is, the ability of the road system to absorb forecast demand, is achieved by "assigning" vehicle trip matrixes onto alternative road networks which feature varying types of infrastructure improvements. Comparative findings include absolute volume, volume to capacity ratios and performance indicators such as pcu (passenger car unit) kilometers of travel, pcu hours of travel and average operating speed. Identified deficiencies subsequently serve as the basis upon which a preferred road improvement program is founded.

5.1 ASSIGNMENT PROCESS AND TOLL ANALOGY

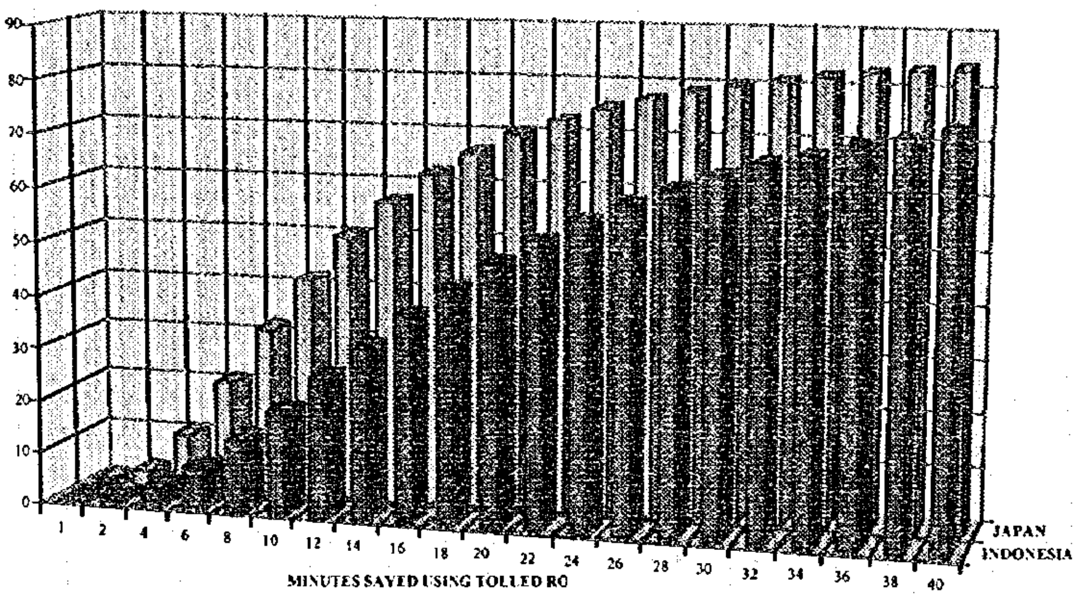
The purpose of the trip assignment process is to replicate the amount of traffic on the road system. Thus, the content of trip matrixes (daily pcu trips) is "loaded" onto the roadway network where trip origin-destination patterns are permitted to interact with embedded network parameters (distance, time, speed, capacity and other user-specified criteria).

Since route choice, travel time and congestion impacts are important considerations relative to study area road operation, an equilibrium assignment algorithm is considered appropriate. Equilibrium, in the context of transportation assignments, occurs when no trip can be made by an alternative path without increasing the total travel time of all trips in the network. Equilibrium assignment consists of an iterative series of traffic assignments with an adjustment of link capacity/speed reflecting congestion encountered in each associated iteration. The load from each assignment after the first iteration is combined with the previous load in such a way as to minimize the impedance of each trip and thus reducing the number of iterations to find the equilibrium loads. Equilibrium assignment is multipath because the final loads are a linear combination of loadings from each iteration. These loads may be assigned to different paths because of the time adjustments after each iteration.

The cost of road infrastructure improvements is considerable, and will thus necessitate the application of innovative financing strategies, to include the possible participation of the private sector in BOT (build, operate, transfer) or similar schemes. In the latter case, toll applications are likely and provision for testing this eventuality must be incorporated into the assignment process.

In a direct sense, tolled roads will "compete" with non-tolled (free) roads. Thus, the ability to simulate diversion between tolled and non-tolled facilities, in addition to routing algorithms of the equilibrium assignment process, is both desirable and achievable via the capabilities of TRANPLAN. Toll diversion relationships (the propensity of drivers to incur out-of-pocket costs in exchange for operating benefits) are not established in Viet Nam, thus, findings from overseas work must be employed. Diversion relationships have extensively been calibrated in Japan; a toll diversion relationship for inter-urban tollroads was also previously developed by Pacific Consultants International via roadside interviews of motorists near Jakarta and Surabaya, Indonesia, traveling in corridors featuring competing tolled and non-tolled roads. These relationships rely on the most significant diversion-choice variables, namely, toll cost and time savings. Findings suggest that, for equivalent toll payment and time savings, diversion to tolled roads is more pronounced in Japan than in Indonesia (Figure 5.1). This is not surprising given the differential in unit national incomes.

Figure 5.1 COMPARISON OF INTER-URBAN TOLL DIVERSION I JAPAN AND INDONESIA



In the absence of local data, it is surmised that Vietnamese diversion patterns will more closely mirror Indonesian rather than Japanese patterns. The adopted empirical Vietnamese toll diversion relationship, adjusted to the modal mix on study area roads, is therefore:

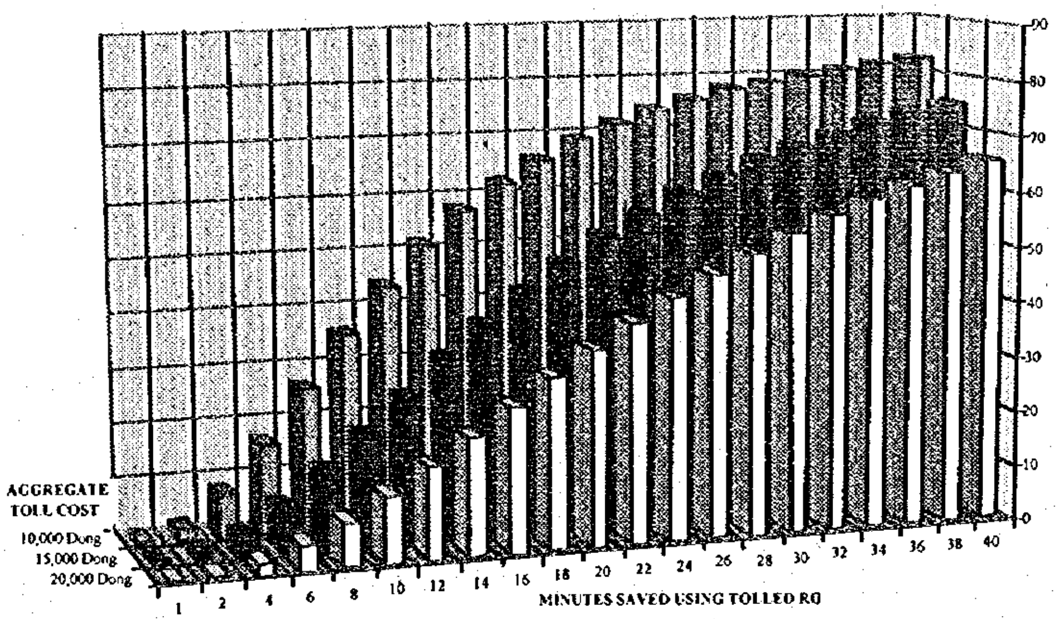
$$P = \frac{K}{1.0 + (a * \frac{C}{T})^{b}}$$

Where

P	=	proportion of trips using the tolled road
K	=	upper diversion threshold (90 percent)
$\frac{C}{T}$	=	ratio of toll cost to travel time difference (non-toll routing minus tollroad routing)
a	=	0.0095
b	=	2.0789

Diversion to the tolled route is sensitive to out-of-pocket cost and time savings. For example, at a time savings of 20 minutes, some two-thirds of motorists would, based on the adopted analogy, divert to the tolled road if toll cost aggregated to 10,000 VD. However, only about one-third would divert if the toll were increased to 20,000 VD (Figure 5.2).

Figure 5.2 EMPIRICAL VIETNAMESE TOLL DIVERSION RELATIC



5.2 PERFORMANCE OF THE BASE-YEAR NETWORK

As an initial step in the sufficiency analysis, year 1995 trip matrixes were assigned onto the year 1995 simulated network. This process replicates existing conditions, and permits a quantitative assessment of operations. Key conclusions and observations are:

- The dominant role of Highway 1 is unmistakable within the study area. Heaviest volumes are found near Da Nang (22,000 pcu per day) and south of Da Nang (10,000 pcu per day). The Hai Van pass constriction is obvious with a daily volume of 4,100 pcu. Demand on roads other than Highway 1 is minor, with the exception of Highway 9 which reaches some 2,100 pcu west of Dong Ha (Figure 5.3).

- A review of road sufficiency reveals that, by and large, link volume to capacity ratios fall within acceptable ranges. The exception is in vicinity of Da Nang and, to a lesser degree, Hue where inter-zonal demand approaches assignment capacity. This argues for a timely implementation of urban bypasses at major cities.

- On a study area-wide basis, trucks contribute 44 percent of expended pcu kilometers, two-wheeled vehicles near one-third of total pcu kilometers, and buses some 21 percent of pcu kilometers. The contribution of cars is minor. Higher-order roads, as suggested in Figure 5.3, absorb a disproportionate share of pcu kilometers. For example, ASG 4 and 5 (two-lane roads wider than 6.2 meters), constitute only 29 percent of the network, yet accommodate 77 percent of pcu kilometers. The average loading on these two road classes is some 6,500 two-way pcu per day (Table 5.1).

Figure 5.3 Simulated Year 1995 Traffic Pattern Study Area Road Network

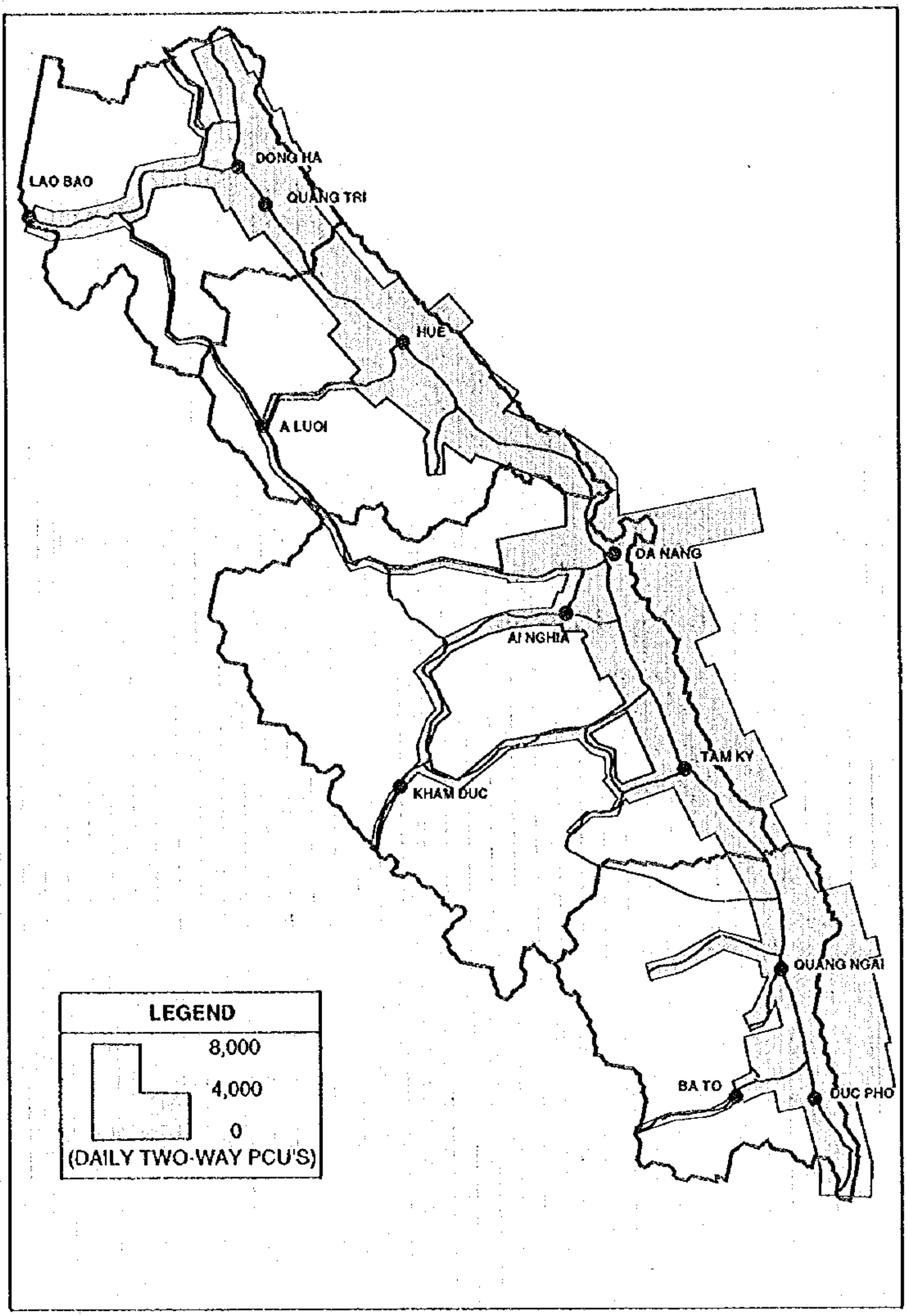
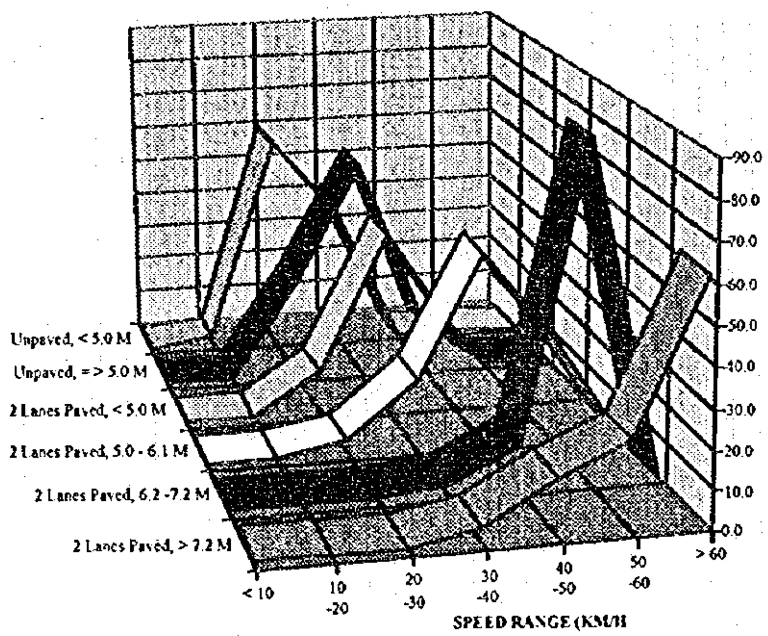


Table 5.1 Performance Indicators Under Present Demand Condition Base Year (1995) Road Network

ASG Code	Road Type	Length (km)	Pcu km (000)	Pcu hr (00)	Speed (Km/Hr)	Pcu km per km
4	Two Lane Paved (width > 7.2 m)	252.9	1725.5	321.8	54	6822
5	Two Lane Paved (width 6.2 - 7.2 m)	161.1	988.2	189.8	52	6134
6	Two Lane Paved (width 5.0 - 6.1 m)	410.0	472.3	116.1	41	1151
7	Two Lane Paved (width < 5.0 m)	99.3	37.9	10.9	35	381
8	Two Lane Unpaved (width = > 5.0 m)	358.6	216.6	68.8	31	604
9	Two Lane Unpaved (width < 5.0 m)	137.5	69.2	26.0	27	503
	TOTAL	1419.4	3509.7	733.4	48	2472

- The average operating speed of all road classes is a modest 48 km/hour. Not surprisingly, the speed distribution decreases as road quality worsens. For example, the largest expenditure of pcu kilometers for an ASG 5 road (two paved lanes, width 6.2 - 7.2 meters) is in the 50-60 km/hr range. For an ASG 9 road (two unpaved lanes, width less than five meters), on the other hand, the 20-30 km/hr range absorbs the highest number of pcu kilometers (Figure 5.4).

Figure 5.4 SYNTHESIZED 1995 OPERATING SPEED PR

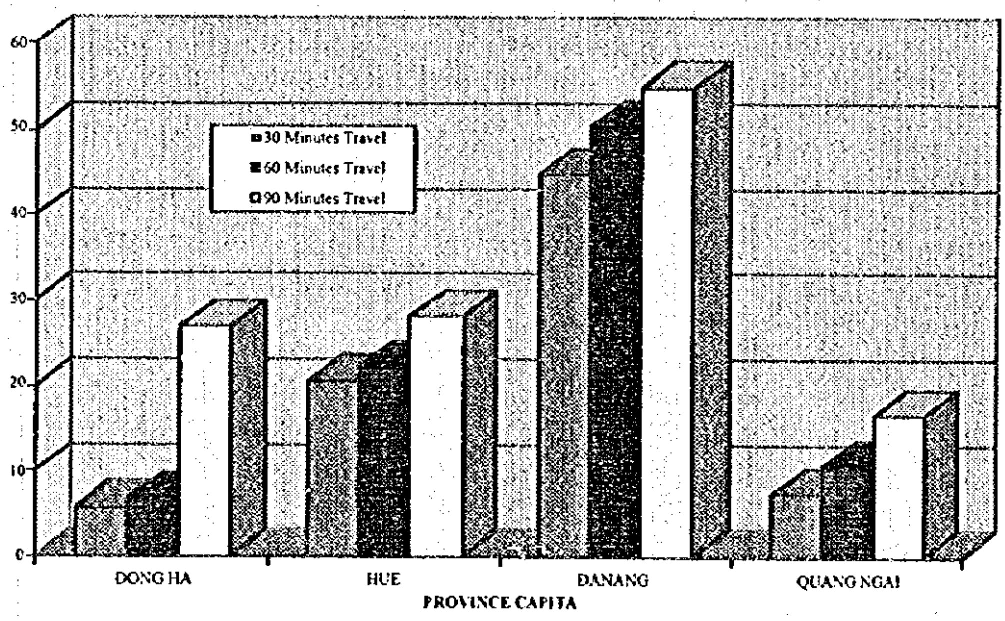


It is also of interest to examine travel isochrones for province capitals, particularly 90 minutes which approximates the time required for the average inter-zonal trip (Figure 5.5).

- Dong Ha and Hue are the only two capitals with overlapping 90 minute isochrones. Hue and Da Nang are not mutually reachable, largely due to reduced trip speed associated with the Hai Van pass crossing.
- Both Dong Ha and Quang Ngai can reach adjacent provinces (i.e. cross the study area boundary) within the 90 minute isochrone.
- Hinterland penetration is limited due to poor road condition, and, in the case of Hue, the Highway 49 ferry. Only Highway 9 (direction Lao Bao) and Highway 14B (direction Giang) offer reasonable hinterland penetration.

Da Nang is also strategically sited in that some 35 percent of the study areas population resides within 90 minutes travel time. Urban population accessibility is even more pronounced: 55 percent of study area urban population reside within 90 minutes travel time of Da Nang, as opposed to 28 percent for Hue, 27 percent for Dong Ha and 17 percent for Quang Ngai (Figure 5.6).

Figure 5.6 SIMULATED YEAR 1995 PROVINCE CAPITAL ACCESSI URBAN POPULATION WITHIN STUDY AREA

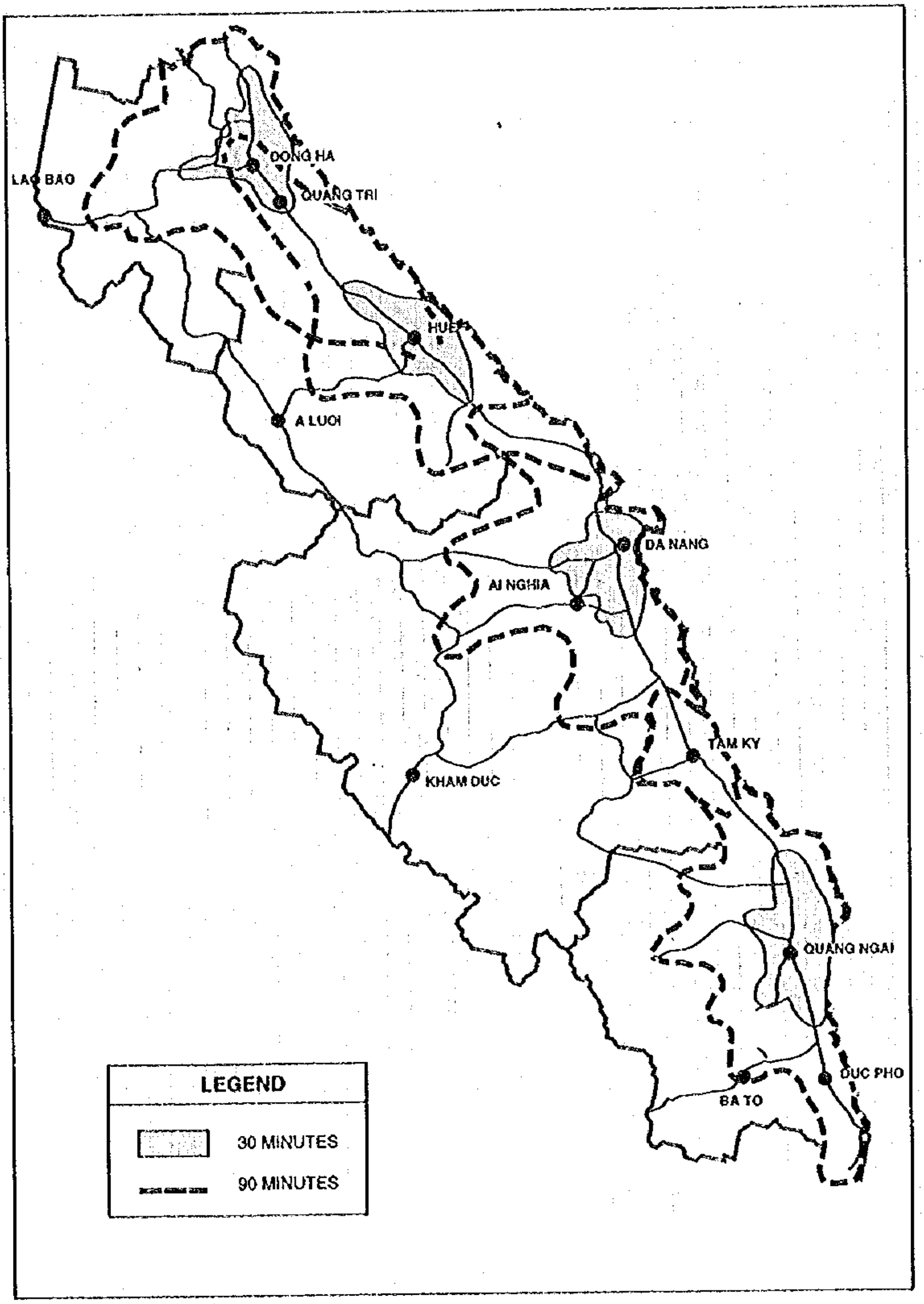


5.3 PERFORMANCE OF THE COMMITTED NETWORK

The second analysis consists of the assignment of 1995, 2000, 2005 and 2010 trip matrixes onto the existing network upgraded by committed improvements. These include, as described in Section 3.2, Highway 1 and Highway 9 upgraded in line with on-going IBRD and ADB projects. These will, in essence, improve both facilities to what is essentially an MOT Class III standard (two lanes, 7.2 meters width plus bicycle lanes in flat terrain; 7.0 meters width and no bicycle lanes in hilly terrain). It is also assumed that improved feeder roads for Dung Quat port will be available at commencement of port operation in year 2005.

The initial assessment is the composite performance of the study area road network (Table 5.2).

Figure 5.5 Simulated Year 1995 Travel Isochrones Trips Originating from Province Capitals



- Pcu kilometers of travel are expected to increase rapidly from some 2.8 million under 1995 conditions to 5.5 million, 12.1 million and 29.5 million under 2000, 2005 and 2010 demand conditions, respectively. This is a doubling over the 1995-2000 period, and a more than five-fold increase over the subsequent decade to year 2010.

- The simulation indicate that pcu hours of travel will increase at a much faster pace than pcu kilometers of travel thus resulting in a steady decrease in average operating speed. For 1995 demand conditions average network operating speed is shown as 45 km/hr. However, this degrades rapidly to 39, 20 and nine kilometers per hour for year 2000, 2005 and 2010 demand conditions.

- The anticipated degradation in performance of the committed network is also reflected in the unit load (pcu kilometers of travel per road kilometer) and volume to capacity ratio. Under year 2005 conditions, select road segments have failed, but, under year 2010 demand conditions, the entire network has essentially failed.

- The importance of higher-order roads (ASG 4 and 5) is confirmed during all assignment phases. While representing only some 30 percent of the road network, two-lane roads wider them 6.2 meters attract on the order of 80 percent of expended pcu kilometers.

The pre-eminent road facility is, under present and future demand conditions, Highway 1. This facility absorbs the vast majority of pcu kilometers expended in the study area, and achieves, by far, highest unit loadings (Table 5.3).

Table 5.3 Highway Loading Indicators Under Present and Future Demand Conditions Existing Road Network With Committed Improvements

Item[1]	Highway Number						
	1	9	14	14B	24	49	PH[2]
Year 1995							
Total pcu kilometer (000)	2,245.4	122.4	109.7	72.7	62.4	36.2	*
Pcu km per Road Kilometer	5,524	1,466	362	1,155	902	591	598
Year 2000							
Total pcu kilometer (000)	4,535.8	171.7	162.0	149.9	103.1	87.1	*
Pcu km per Road Kilometer	11,158	2,056	534	2,382	1,492	1,422	738
Year 2005							
Total pcu kilometer (000)	9,761.0	342.7	468.1	280.1	239.8	214.7	*
Pcu km per Road Kilometer	24,012	4,104	1,543	4,453	3,470	3,508	1,784
Year 2010							
Total pcu kilometer (000)	20,502.3	1,048.4	2,664.5	634.5	508.5	584.9	*
Pcu km per Road Kilometer	50,436	12,556	8,782	10,088	7,359	9,558	4,435

(1) Passenger car unit (pcu) kilometers expended by interzonal car, bus, truck and motorcycle trips.
(2) Average utilization of all province highways in network.

The indicated years 2005 and 2010 Highway 1 unit loadings suggest that additional capacity beyond that envisaged by the on-going IBRD and ADB projects is required. This observation is even more relevant when again noting at this point that modeling demand consists of interzonal trips, and does not include short intra-zonal journeys such as those, for example, made entirely within Da Nang city.

A more detailed review of the Highway 1 corridor within the study area is therefore desirable (Figure 5.7).

Table 5.1 NETWORK PERFORMANCE INDICATORS UNDER PRESENT AND FUTURE DEMAND CONDITIONS
EXISTING ROAD NETWORK WITH COMMITTED IMPROVEMENTS

			YEAR 1995 ASSIGNMENT (1)														
ASG CODE (2)	ROAD TYPE	ROAD WIDTH	LENGTH (KM)	PCU KM (000)	PCU HR (00)	SPEED (KM/H)	V/C RATIO	PCU KM PER KM	PERCENT LENGTH	PERCENT PCU KM	PERCENT PCU HR	PCU KM BY MODE (%) CAR	BUS	TRUCK	MCYCLE	TOTAL
4	Two Lane Paved	> 7.2 Meters	259.7	1471.4	302.5	49	0.25	5665	18.3	51.4	47.8	5.8	28.2	51.1	14.9	100.0
5	Two Lane Paved	6.2 - 7.2 Meters	171.6	810.5	170.8	47	0.23	4723	12.1	28.3	27.0	4.3	23.9	57.8	14.0	100.0
6	Two Lane Paved	5.0 - 6.1 Meters	392.8	319.5	75.8	42	0.05	813	27.7	11.2	12.0	4.6	19.8	59.9	15.7	100.0
7	Two Lane Paved	< 5.0 Meters	99.3	30.6	8.9	34	0.03	308	7.0	1.1	1.4	4.2	20.6	54.2	20.9	100.0
8	Two Lane Unpaved	=> 5.0 Meters	358.6	175.3	54.9	32	0.04	498	25.3	6.1	8.7	3.8	25.1	56.2	15.0	100.0
9	Two Lane Unpaved	< 5.0 Meters	137.5	56.4	20.6	27	0.05	410	9.7	2.0	3.3	3.6	21.0	59.9	15.6	100.0
	TOTAL		1419.5	2863.7	633.5	45	0.12	2017	100.0	100.0	100.0	5.1	25.6	54.5	14.8	100.0
			YEAR 2000 ASSIGNMENT (1)														
ASG CODE (2)	ROAD TYPE		LENGTH (KM)	PCU KM (000)	PCU HR (00)	SPEED (KM/H)	V/C RATIO	PCU KM PER KM	PERCENT LENGTH	PERCENT PCU KM	PERCENT PCU HR	PCU KM BY MODE (%) CAR	BUS	TRUCK	MCYCLE	TOTAL
4	Two Lane Paved	> 7.2 Meters	259.7	3078.8	808.6	38	0.52	11855	18.3	56.1	57.4	4.8	24.1	56.1	15.0	100.0
5	Two Lane Paved	6.2 - 7.2 Meters	171.6	1509.2	337.3	45	0.43	8794	12.1	27.5	23.9	4.5	22.9	58.0	14.5	100.0
6	Two Lane Paved	5.0 - 6.1 Meters	392.8	506.8	128.9	39	0.08	1290	27.7	9.2	9.1	4.6	21.5	56.1	17.7	100.0
7	Two Lane Paved	< 5.0 Meters	99.3	51.8	16.3	32	0.05	521	7.0	0.9	1.2	4.1	21.6	57.3	17.0	100.0
8	Two Lane Unpaved	=> 5.0 Meters	358.6	255.9	85.0	30	0.05	713	25.3	4.7	6.0	3.9	24.3	54.2	17.6	100.0
9	Two Lane Unpaved	< 5.0 Meters	137.5	81.6	33.2	25	0.07	593	9.7	1.5	2.4	3.3	22.0	59.4	15.3	100.0
	TOTAL		1419.5	5494.1	1409.3	39	0.23	3863	100.0	100.0	100.0	4.7	23.5	56.6	15.2	100.0
			YEAR 2005 ASSIGNMENT (1)														
ASG CODE (2)	ROAD TYPE		LENGTH (KM)	PCU KM (000)	PCU HR (00)	SPEED (KM/H)	V/C RATIO	PCU KM PER KM	PERCENT LENGTH	PERCENT PCU KM	PERCENT PCU HR	PCU KM BY MODE (%) CAR	BUS	TRUCK	MCYCLE	TOTAL
4	Two Lane Paved	> 7.2 Meters	259.7	6596.0	3138.8	21	1.12	25398	18.0	54.3	52.7	4.5	22.9	55.4	17.2	100.0
5	Two Lane Paved	6.2 - 7.2 Meters	192.8	3452.6	1989.5	17	0.89	17907	13.4	28.4	33.4	4.6	20.8	56.3	18.2	99.9
6	Two Lane Paved	5.0 - 6.1 Meters	392.8	1123.3	356.8	31	0.18	2859	27.3	9.3	6.0	4.8	23.6	54.0	17.6	100.0
7	Two Lane Paved	< 5.0 Meters	99.3	159.4	68.2	23	0.14	1605	6.9	1.3	1.4	3.7	30.2	52.5	13.6	100.0
8	Two Lane Unpaved	=> 5.0 Meters	358.6	588.8	241.5	24	0.12	1641	24.9	4.9	4.1	4.1	23.6	53.4	18.9	100.0
9	Two Lane Unpaved	< 5.0 Meters	137.5	220.1	162.7	14	0.18	1600	9.5	1.8	2.7	3.7	23.5	56.0	14.8	100.0
	TOTAL		1440.7	12140.2	5957.5	20	0.51	8426	100.0	100.0	100.0	4.5	22.6	55.4	17.5	100.0
			YEAR 2010 ASSIGNMENT (1)														
ASG CODE (2)	ROAD TYPE		LENGTH (KM)	PCU KM (000)	PCU HR (00)	SPEED (KM/H)	V/C RATIO	PCU KM PER KM	PERCENT LENGTH	PERCENT PCU KM	PERCENT PCU HR	PCU KM BY MODE (%) CAR	BUS	TRUCK	MCYCLE	TOTAL
4	Two Lane Paved	> 7.2 Meters	259.7	13807.8	17234.8	8	2.34	53168	18.0	46.8	51.6	4.6	22.2	49.0	24.2	100.0
5	Two Lane Paved	6.2 - 7.2 Meters	192.8	7513.0	9098.9	8	1.93	38967	13.4	25.4	27.2	4.7	20.7	51.0	23.7	100.1
6	Two Lane Paved	5.0 - 6.1 Meters	392.8	3903.3	2786.3	14	0.61	9937	27.3	13.2	8.3	4.0	27.3	56.1	12.6	100.0
7	Two Lane Paved	< 5.0 Meters	99.3	987.6	1170.0	8	0.89	9945	6.9	3.3	3.5	3.0	31.4	58.8	6.8	100.0
8	Two Lane Unpaved	=> 5.0 Meters	358.6	2486.2	1820.8	14	0.52	6933	24.9	8.4	5.4	3.5	25.9	56.4	14.2	100.0
9	Two Lane Unpaved	< 5.0 Meters	137.5	830.0	1299.4	6	0.68	6036	9.5	2.8	3.9	3.2	28.2	56.8	11.9	100.1
	TOTAL		1440.7	29527.9	33410.2	9	1.24	20495	100.0	100.0	100.0	4.4	23.3	51.6	20.7	100.0
			RATIO YEAR 2000 TO YEAR 1995														
ASG CODE (2)	ROAD TYPE		LENGTH (KM)	PCU KM (000)	PCU HR (00)	SPEED (KM/H)	V/C RATIO	PCU KM PER KM	RATIO TO AVERAGE LENGTH	RATIO TO AVERAGE PCU KM	RATIO TO AVERAGE PCU HR	PCU KM BY MODE (%) CAR	BUS	TRUCK	MCYCLE	TOTAL
4	Two Lane Paved	> 7.2 Meters	1.00	2.09	2.67	0.78	2.08	2.09	1.00	1.09	1.26	0.83	0.85	1.10	1.01	*
5	Two Lane Paved	6.2 - 7.2 Meters	1.00	1.86	1.97	0.96	1.87	1.86	1.00	0.97	0.89	1.05	0.96	1.00	1.04	*
6	Two Lane Paved	5.0 - 6.1 Meters	1.00	1.59	1.70	0.93	1.60	1.59	1.00	0.83	0.77	1.04	1.09	0.94	1.13	*
7	Two Lane Paved	< 5.0 Meters	1.00	1.69	1.83	0.94	1.67	1.69	1.00	0.88	0.82	0.98	1.05	1.06	0.81	*
8	Two Lane Unpaved	=> 5.0 Meters	1.00	1.46	1.55	0.94	1.25	1.46	1.00	0.76	0.70	1.03	0.97	0.96	1.17	*
9	Two Lane Unpaved	< 5.0 Meters	1.00	1.45	1.61	0.93	1.40	1.45	1.00	0.76	0.73	0.92	1.05	0.99	0.98	*
	TOTAL		1.00	1.92	2.22	0.87	1.92	1.92	1.00	1.00	1.00	0.92	0.92	1.04	1.03	*
			RATIO YEAR 2010 TO YEAR 2000														
ASG CODE (2)	ROAD TYPE		LENGTH (KM)	PCU KM (000)	PCU HR (00)	SPEED (KM/H)	V/C RATIO	PCU KM PER KM	RATIO TO AVERAGE LENGTH	RATIO TO AVERAGE PCU KM	RATIO TO AVERAGE PCU HR	PCU KM BY MODE (%) CAR	BUS	TRUCK	MCYCLE	TOTAL
4	Two Lane Paved	> 7.2 Meters	1.00	4.48	21.31	0.21	4.50	4.48	0.99	0.83	0.90	0.96	0.92	0.87	1.61	*
5	Two Lane Paved	6.2 - 7.2 Meters	1.12	4.98	26.98	0.18	4.49	4.43	1.11	0.93	1.13	1.04	0.90	0.88	1.63	*
6	Two Lane Paved	5.0 - 6.1 Meters	1.00	7.70	21.62	0.36	7.63	7.70	0.99	1.43	0.91	0.83	1.27	1.00	0.71	*
7	Two Lane Paved	< 5.0 Meters	1.00	19.07	71.78	0.25	17.80	19.09	0.99	3.54	3.03	0.73	1.45	1.03	0.40	*
8	Two Lane Unpaved	=> 5.0 Meters	1.00	9.72	21.42	0.47	10.40	9.72	0.99	1.81	0.90	0.90	1.07	1.04	0.81	*
9	Two Lane Unpaved	< 5.0 Meters	1.00	10.17	39.14	0.24	9.71	10.18	0.99	1.83	1.65	0.97	1.28	0.96	0.78	*
	TOTAL		1.01	5.38	23.71	0.23	5.39	5.31	1.00	1.00	1.00	0.94	0.99	0.91	1.36	*

(1) Derived from assignment of 1995, 2000, 2005 and 2010 trip matrices to existing network with committed improvements. These include a reconstructed Highways 1 and 9 to Class III standard, and improved Dung Quat access road after port opening in year 2005. "Speed" refers to average system-wide simulated operating speed. "V/C Ratio" refers to average system wide ratio of loaded inter-zonal volume to assignment capacity.

(2) TRANPLAN designation to identify links to which a common capacity restraint function is applied.

- Under year 1995 demand conditions, Highway 1 generally operates at an acceptable level of service. Only in vicinity of Da Nang does demand approach practical (assignment) capacity.

- The Da Nang area segment of Highway 1 has reached its maximum capacity under year 2000 demand conditions. In other words, congested operation with interrupted flow and frequent delays will be the norm.

- Under year 2005 conditions, the entire Hue-Da Nang segment of Highway 1 has exceeded its practical capacity, and almost reached maximum capacity. Demand in vicinity of Hue city and Da Nang city exceeds maximum capacity. This suggests that as maximum capacity is reached, some proportion of trips will be suppressed or diverted to other modes. In either case, the continued economic expansion of the Hue and Da Nang areas is jeopardized due to a shortfall in road infrastructure. Capacity shortfalls are also noted in vicinity of Quang Ngai. This is largely catalyzed by the Dung Quat industrial complex, and underscores the importance of providing an adequate distributor road system for Dung Quat port and industrial complex once associated facilities come "on line".

- Year 2010 demand, which is not shown in Figure 5.7, far exceeds Highway 1 capacity along virtually all segments. Widespread infrastructure upgrading will be required by that time period.

The temporal degradation of Highway 1 sufficiency is also observable in simulated operating speed. Under 1995 demand conditions, average speed hovers near 50 km/h, and most pcu kilometers of travel are expanded at a speed of greater than 50 km/h. However, under year 2010 demand conditions, average operating speed has declined to 14 km/h, with most pcu kilometer of travel expended at speeds of below 10 km/h (Figure 5.8). The year 2010 average speed is very similar to that experienced during existing peak hour conditions in Bangkok, Thailand.

5.4 ROAD IMPROVEMENT: A STRATEGIC OVERVIEW

The foregoing analyses have confirmed that, from a capacity point of view, upgrading of select road links within the study area is in order. However, it should not be inferred that capacity considerations are the only criteria; indeed the Master Plan framework[1] accepts that social and economic issues are important catalysts for road transport improvements. In response, a road improvement strategy for the study area was, in a hierarchical manner, defined. While each hierarchy is discussed separately in subsequent paragraphs, it should not be inferred that any set of improvements can be conceived in isolation. Instead, roads must be viewed as an inter-related system, whose focus must be closely coordinated with study area land uses and/or major development projects.

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1 Refer "Interim Report", op. cit, for detailed discussion of formulated framework and underlying sectorial investigations.

Figure 5.7 Highway No. 1 Sufficiency under Present and Future Demand Scenarios

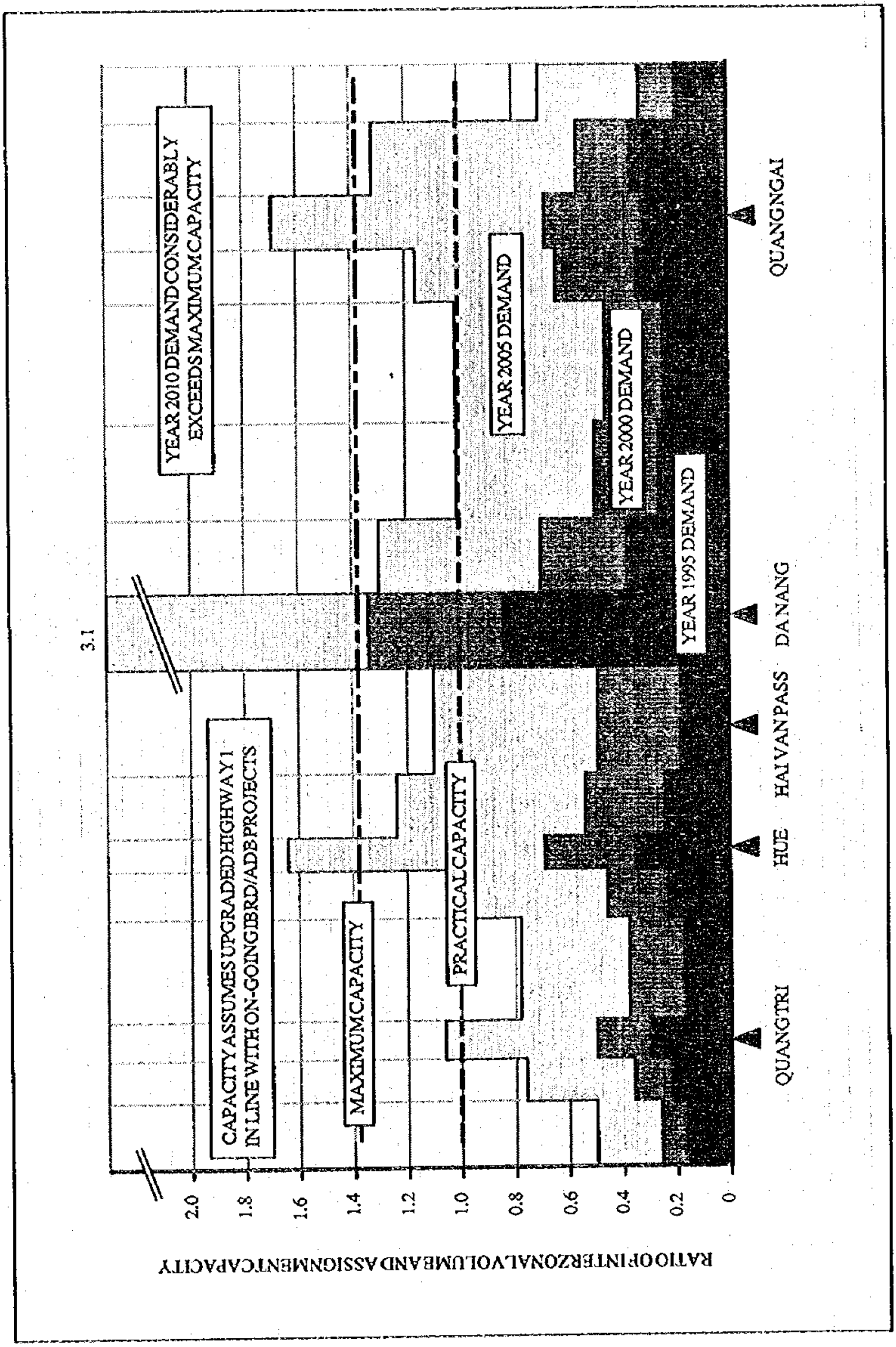
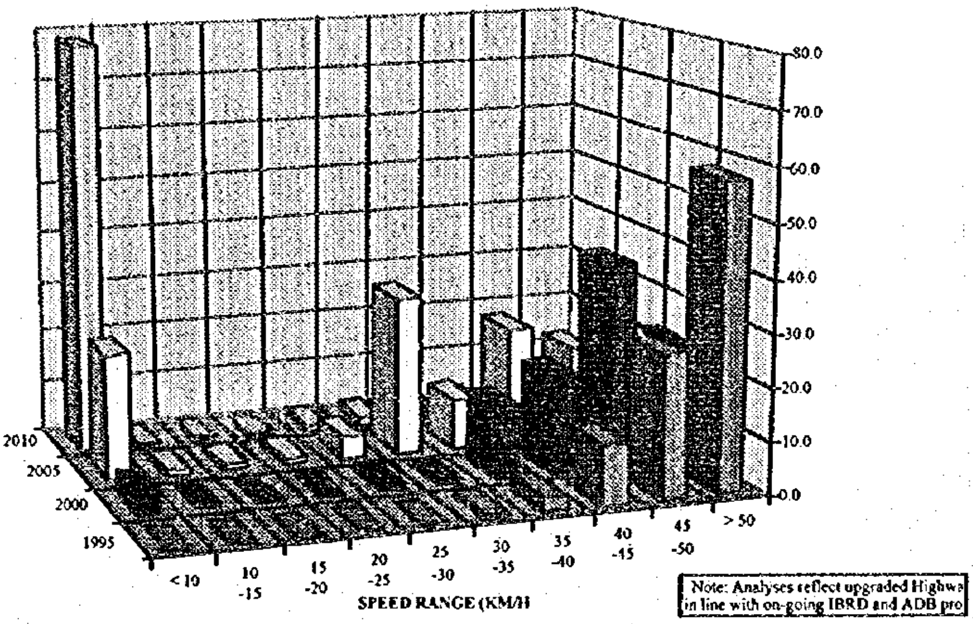


Figure 5.8 OPERATING SPEED OF IMPROVED HIGHWAY 1 UNDER PRESENT AND DEMAND SCENARIOS



5.4.1. The North-South Spine

Highways 1 and 9 are unique to the study area in that they represent critical road facilities of both national and international importance. Highway 9 has been extensively studied, and will most likely evolve as the principal (but not only) east-west road corridor linking Thailand, Lao PDR and Viet Nam. The subregional implications of Highway 9 are profound vis-à-vis the study area. Pertinent strategic issues can, on a general basis, be summarized as:

- The physical and operational improvement of the Highway 9 corridor between Dong Ha and the Lao PDR border. It is be expected that improvement to high-order two lane road status (TEDI Class III) will adequately upgrade road capacity for the foreseeable future. Thus, an institutional framework to enhance cross-border flow must concurrently be derived if international vehicular flows are to truly benefit from physical road improvements.

- The hinterland distribution opportunities for international traffic using the Highway 9 corridor must be developed to an acceptable standard. This principally includes the Highway 1 corridor between Dong Ha and selected ports and/or major regional cities such as Hue and Da Nang. Upgrading of Highway 14 could also prove beneficial for distribution of cross-border cargo flows.

The Highway 1 improvement currently visualized under IBRD and ADB highway improvement programs should fulfill near to mid-term future needs. However, demand forecasts clearly confirm that a two-lane road, even in "top condition", cannot forever meet the needs of a rapidly-expanding area. This is particularly so given the urban scenarios conceived for Dong Ha, Hue, Da Nang and Quang Ngai; the evolution of the Hue - Da Nang urban corridor; the advent of planned mega-projects such as Dung Quat port, and a continuing growth in north-south trade fueled by a rapidly expanding national economy.

The challenge is therefore the development of an integrated and cascading strategy which effectively combines several key elements.

- An "immediate-action" program centered on low-cost, but highly effective, actions loosely termed Transportation System Management (TSM). This would include optimized utilization of existing road infrastructure via installation of traffic signals, road safety devices, truck weighing stations, improved signage and markings, public education, driver training as well as honest and on-going enforcement.

- Upgrading to acceptable two-lane section in line with IBRD and ADB recommendations, with separation of non-motorized vehicles from the larger and faster-moving motorized traffic stream being a key objective. At this stage, the implementation of urban bypasses should also be pursued, particularly for Hue and Da Nang.

- As capacity approaches saturation levels, more cost-intensive solutions must be implemented along Highway 1, likely in a staged manner with high-volume segments receiving top priority. Demand forecasts suggest that the Hue - Da Nang urban corridor should considered as a priority candidate in this regard.

Upgrading the Hue - Da Nang corridor implies the provision of additional traffic lanes. Multi-lane status can be achieved in a number of ways:

- Widening Highway 1 along the existing alignment. This course of action could, however, be problematic due to the intense roadside development already existing along virtually the entire extent of Highway 1.

- Constructing a new arterial road along a new alignment possibly several kilometers west of Highway 1. While this offers undeniable advantages from a road-building point of view, care is required since socio-economic impacts, such as potential loss of arable land, will result.

- Major geographic constraints, particularly Hai Van pass, must be addressed. A recently completed pre-feasibility study evaluates alternative improvement options for a Hai Van pass crossing, including the construction of tunnel sections.[1]

Preliminary plans have been developed by Government for a motorway which will, in the very long-term future, link Hanoi and HCMC. In the study area, a preliminary alignment some 3-10 kilometers west of Highway 1 is potentially indicated. The Master Plan Team supports the long-range concept of this project, and recommends that high-order, access-controlled facilities (with or without tolls) should only be considered if clearly warranted on demand grounds and supported by robust socio-economic evaluations. Nevertheless, if construction of an arterial along a new alignment is considered between Hue and Da Nang, careful reviews are required to ensure that such plans do not conflict with longer-term motorway goals. Indeed, with proper planning and design, a new arterial on new alignment could represent a "first-step" element of an ultimate motorway mosaic.

5.4.2 The Highlands Corridor

Highway 14 forms an important north-south corridor within the study area. The physical role is apparent in that the highlands corridor could potentially offer an attractive route of travel vis-à-vis Highway 1. Highway 14, due to its junction with Highway 9 in Quang Tri province, also offers potential as a distributor facility for road traffic to/from Lao PDR and Thailand.

In addition to transport utility, upgrading of the highlands corridor could catalyze a vast improvement in standard of living for people residing within the corridor. The highland area, road access to which has always been problematic, is under developed. Full realization of economic and developmental potential is thus stunted, and regional wealth correspondingly

[1] "Pre-Feasibility Study of Hai Van Pass Tunnel of Highway No. 1", by Express Highway Research Foundation of Japan, for IBRD and Ministry of Transport, Government of Viet Nam, March, 1996 (Draft Final Report).

low. Societal benefits would occur not duly due to enhanced access to centers of activity within the study area, but also to Kon Tum province (and beyond) in the south. The Government of Viet Nam has committed to an upgrading of Highway 14 using its own funds.

5.4.3 East-West Linkages

Successful functioning of the twin north-south routes (Highway 1 and Highway 14) absolutely requires that adequate east-west distribution be available. Highways 9, 14B, 24 and 49 fulfill several essential roles in this regard:

- Provide direct linkage between Highway 1 and Highway 14, both being north-south corridors of flow within the study area.
- Link major regional towns such as A Luoi, A Nghia, Thanh My and Ba To with major urban centers and higher-order road facilities.
- Connect intermediate communes and serve in a collector capacity for intermediate district/commune roads.
- Offer connections with neighboring Lao PDR. Some crossings, such as Highway 9, represent major international gateways. Others, such as Highways 24 and 49, offer possibilities for more localized cross-border contact.

Efforts should focus on improving one east-west link in each province: Highway 9 in Quang Tri province (already included for consideration in the previously defined "North-South Spine"), Highway 49 in Thua Thien-Hue province, Highway 14B in Quang Nam-Da Nang province and Highway 24 in Quang Ngai province. Upgrading should likely be to Class III standard, that is, seven meter pavement in flat terrain and six meter paved surface in rolling/mountainous terrain.

5.4.4 Local Roads

The fourth road hierarchy is the essential connection between villages as well as communes and larger settlements as well as higher-order road systems. The district and commune road system is extensive. Together these facilities account for almost 9,700 kilometers, or about 80 percent of the total study area road network. The importance of roads at the commune/district level is undeniable in that they:

- Enhance agricultural productivity and is associated with the development of off-farm income opportunities and greater participation in the market economy;
- Affect labor mobility, which is significantly related to economic status;
- Associate with the existence of permanent markets, enterprises, as well as economic diversification; and,
- Contribute positively toward crop and livestock output, crop area and yield as well as fertilizer demand.

Yet, paradoxically, the condition of rural roads in the study area is poor, even by the standards of the Vietnamese road system. Of the total district and commune network, fully 80 percent are earth surfaced. The system includes some 1,900 bridges (extending over 23.4 kilometers) of which some 1,000 bridges are limited in carrying capacity to 5 tons, and a further 720 bridges to a capacity of between five and 10 tons.

Discussions with representatives of provincial Peoples Committees confirms that the surface condition of district and commune roads is poor and that, during the rainy season, the majority of district and commune roads remain effectively closed due to wash-outs and flooding. The problem of market access is expressed even more poignantly by representatives of District

Peoples Committees, who indicate that many commune residents must walk from three to five days in order to reach a market for either selling produce or purchasing supplies.

The problem of poor commune road access (or no access at all) is typically associated with mountainous regions of the study area, and justifiably so. Indeed, these precincts have been officially labeled by DSI representatives as being "difficult to develop", largely as a result of inadequate road access. However, similar analogies are also appropriate in coastal areas, particularly Thua Thien-Hue province which possesses a large lagoon system. There, lack of adequate all-weather road access has stymied full exploitation of the fishing and fishery industry potential.

Two broad goals seem realistic in this regard:

- All district capitals should be accessible during all seasons via all-weather roads which permit the passage of cars, buses and trucks.
- All commune centers should, in principle, enjoy road access during all times of the year. However, practically speaking, this goal will be difficult to attain in the near-term future. A more modest acceptable objective might therefore be that road access is guaranteed during all seasons by at least two-wheeled vehicles.

Due to the immensity of the task, and differing local concerns, it is essential that any improvement program be defined via a local participation process. Only in this manner can enhancements, be they improvement, maintenance or project-specific endeavors such as bridge replacement, truly reflect the needs and aspirations of local residents. Likewise, responsibility for carrying out, and subsequently maintaining, rural road improvements should be the responsibility of the commune and district, with, at early stages, advice and training provided by provincial (or higher) authorities.

To facilitate local road strategies, improvements are integrated and coordinated with the Rural Community Development Program Sector of the current study.

5.5 PROJECT FORMULATION

Components of the road strategy discussed in the previous section are already being achieved in a variety of ways:

- Upgrading of Highway 1 and probably Highway 9 will proceed under auspices of the IBRD and/or the ADB.
- Highway 14 is already being upgraded under sponsorship of, and funding by, the Government of Viet Nam.
- Road infrastructure to support Dung Quat port and industrial zone is integrated with the planning of industrial and ports specialists associated with the current study.
- Upgrading of commune and district roads is linked with realization of the current study's Integrated Rural Development Program.

Thus, key remaining issues are the upgrading of east-west linkages (Highways 14B, 24 and 49) as well as the provision of enhanced road capacity in the Hue-Da Nang corridor. These two projects therefore emerge as the focus of subsequent demand forecasting processes as well as economic feasibility reviews.

5.5.1 THE HUE-DA NANG HIGHWAY

Demand forecasts confirm that enhanced road capacity between Hue and Da Nang emerges as a priority project.

1) Improvement Philosophy

The alignment and extent of a new Hue-Da Nang Highway (HDH) will be governed by several opportunities and constraints:

- The road should be operational by (preferable prior to) year 2005, and should extend from just north of the Hue metropolitan area to a point south of the Da Nang metropolitan area. The HDH will therefore be capable of absorbing longer-distance "through" trips as well as shorter journeys which view the Hue Bypass and Da Nang Bypass as attractive options.

- The location of the Hai Van pass tunnel sections are largely fixed[1]. Thus, HDH segments to the north and south of the Hai Van tunnels must be linked with the designated tunnel portals. Furthermore, it is understood that the Hai Van tunnels will initially feature a two-way, two-lane cross-section. Therefore, based on system continuity considerations and findings of the modeling process, it is proposed that the initial (year 2005) HDH carriageway also consist of two lanes.

- The HDH alignment should be convenient to existing and planned major urban concentrations, activity precincts and significant generators of road-based activity. Concurrently, the alignment must be sensitive to the study areas environmental, social and cultural fabric.

- It is likely, due to the high implementation cost of the HDH, that the participation of the private sector in BOT (build, operate, transfer) or similar schemes will be sought. This, in turn, strongly implies that users of the HDH will be subject to toll levies. HDH alignment and configuration must consequently support this eventuality.

Highway 1 within the study area (and other parts of the nation) is an arterial without any form of access control. It is used by pedestrians and all conceivable forms of vehicles ranging from animal-drawn carts and bicycles to the fastest cars and largest commercial vehicles. Highway 1 must accommodate all forms of trips ranging from the very short to extremely long. Roadside development is intense with the net result being extensive ribbon (strip) development along virtually the entire extent of Highway 1, with each activity having almost unlimited freedom of movement onto/off of Highway 1. Consequently, Highway 1 is, not surprisingly, unable to cope with this mix of functions and uses; operations and safety have been seriously degraded in recent years, and will continue to worsen in future as traffic increases and ribbon development intensifies. It is felt that on-going IBRD and ADB-sponsored projects will provide respite from these concerns only in the near-term future; however, more pronounced longer-term solutions are needed.

The Government has developed preliminary plans for a motorway which will eventually link Hanoi and HCMC. It is highly unlikely that a multi-lane motorway-class facility will be required in the study area within the current study's planning horizon. However, key preliminary actions, particularly right-of-way acquisition, should proceed at the earliest opportunity.

The HDH strategy has, in response, been adapted to avoid operational problems similar to those encountered on Highway 1, and integrate longer-term motorway plans (Figure 5.9):

- The initial (year 2005) concept calls for the provision of a high-order two-way, two-lane carriageway. However, it is strongly urged that about 50 meters of right-of-way be acquired.

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[1] "Pre-feasibility Study of Hai Van Pass Tunnel of Highway No. 1", op. cit.

- Strict zoning controls must be instituted (and rigorously enforced) which prohibit any form of access from abutting properties into the right-of-way. If necessary, fencing should be installed to prevent access. The importance of this action cannot be over-emphasized as it is the only effective measure to prevent the chaos which now exists along Highway 1.
- Instead, a frontage road (or Highway 1) will provide direct access to properties abutting the HDH right-of-way. Only at suitable distances (say every 5-10 kilometers) should high-order HDH intersections (either grade separated or signal controlled) be provided.
- In future, as the motorway (or a multi-lane arterial) concept reaches maturity, adequate right-of-way is available for constructing a paralleling carriageway. Furthermore, existing intersections can readily be upgrade to full interchanges.

Requisite actions will be technically difficult and politically unpopular, however, must be achieved if the study areas long-term movement of goods as well as persons is to be achieved in an efficient and cost-effective manner.

2) Alignment Options

The HDH corridor was, for analytical purposes, subdivided into four main sections: Hue Bypass, Lan Co/Chan May, Hai Van pass, and Da Nang bypass. Within each of these four sections, a series of alternatives were designated (Figure 5.10). A further option, that is, upgrading Highway 1 to multi-lane status (sections HB3, LC1 and DB1; refer Figure 5.10) was included.

The alternatives were reviewed with representatives of the Ministry of Planning, the Ministry of Transport and People's Committee's. In addition, highway construction/costing specialists were dispatched to conduct field reviews appropriate to the pre-feasibility level of detail. A ranking process was subsequently completed which subjectively compares the relative merits of each alternative in each section with competing alternatives. A three-level scale was adopted:

+ implies that the alternative is superior to other options and/or is likely to catalyze superior benefits.

o implies that the alternative is neutral when compared to other alternatives, and/or exhibits no pronounced benefits/disbenefits.

\- implies that the alternative is inferior to other options and/or is likely to catalyze disbenefits.

Evaluations were conducted to assess likely economic, social/cultural, environmental and road system ramifications (Table 5.4).

Figure 5.9 Corridor Development Strategy for Hue-Da Nang Inter-city Highway

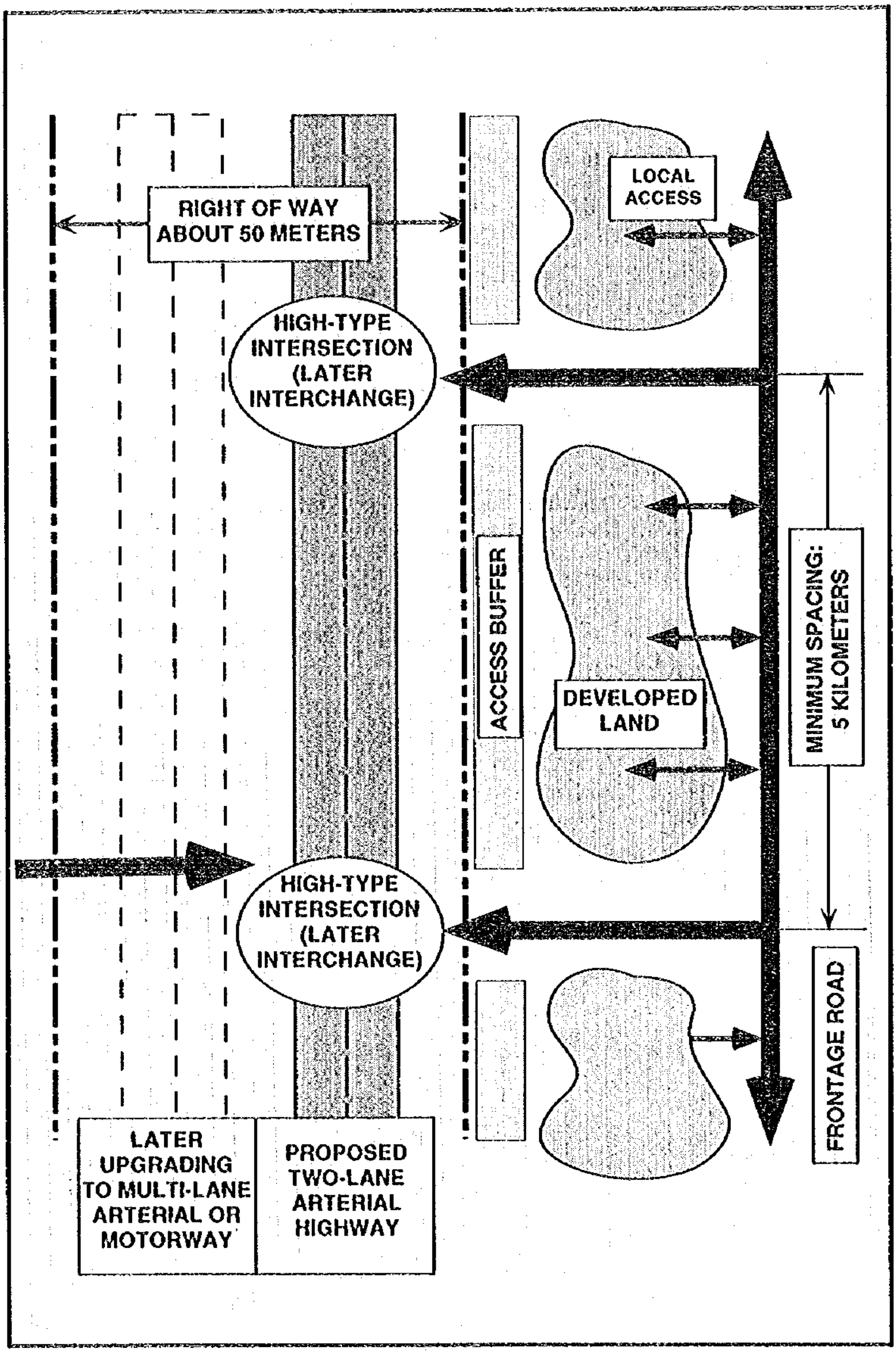

Figure 5.10 Alternative Alignments for Hue-Da Nang Inter-city Highway

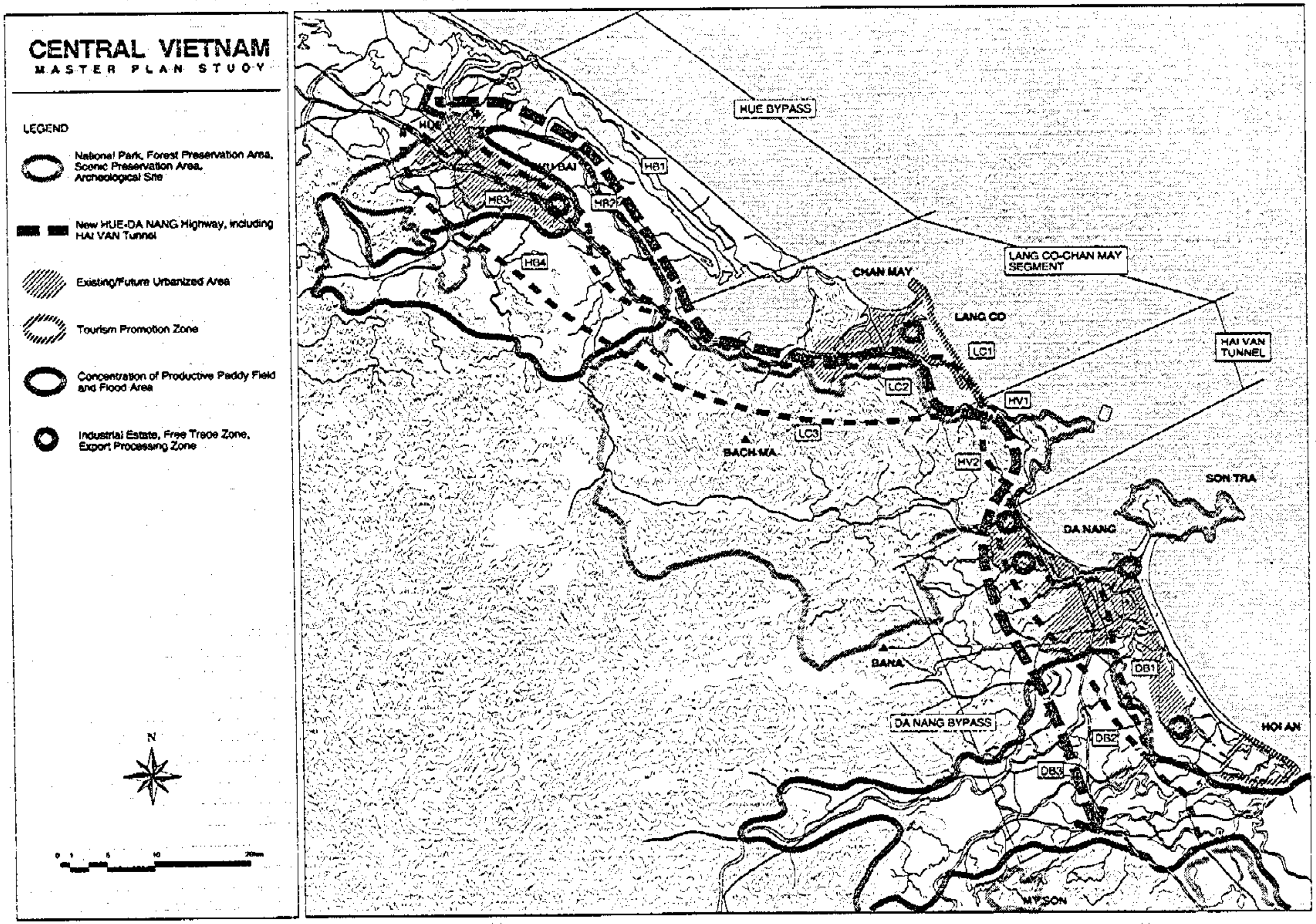

Table 5.4 Subjective Comparison Process Hue-Da Nang Highway Alternative Alignments

SECTOR	PARAMETER	HUE BYPASS				LAN CO			HAI VAN		DANANG BYPASS		
		HB1	HB2	HB3	HB4	LC1	LC2	LC3	HV1	HV2	DB1	DB2	DB3
Economic	Pady Acquisition	+	-	+	-	o	o	o	o	o	+	-	-
	Construction Cost	-	-	+	-	o	o/+	-	+	-	+	-	-
	Land Acquisition	+	-	-	+	-	+	+	o	o	-	-	+
	Development (1)	o	o	o	-	o	+	-	o	o	-	+	+
Social and Cultural	Community Disruption	+	+	-	-	-	o	+	o	o	-	-	+
	Preserve Cultural Assets	+	+	o	-	o	o	o	o	o	o	o	o
	Health and Safety	o	o	-	o	-	o	o	o	o	-	o	o
	Pollution, Noise, Vibration	o	o	-	o	-	o	+	+	-	-	-	+
Natural Environment	Flora and Fauna	o	o	o	-	+	+	-	o	o	o	o	o
	Erosion and Flooding	+	-	+	-	+	+	-	-	+	+	-	-
	Landscape (2)	+	+	-	-	o	o	-	o	o	o	o	o
Road System	Corridor Extension (3)	o	o	o	+	o	o	o	o	o	-	-	+
	Operating Profile (4)	+	-	-	+	-	+	+	o	o	-	o	+
	Accident Potential	+	+	-	+	-	+	+	o	o	-	o	+
	Conversion to Tollroad	+	+	-	+	-	+	+	o	o	-	+	+

(1) Enhanced access to new production centers, inducement to development and integration/strengthening of the economy.
(2) Impacts upon scenic areas, national parks and forest areas.
(3) Alignment compatible with potential inland extension in future north and south of the study area.
(4) Vehicle speed and safety as well as carriageway capacity.
Note: Refer Figure 5.10 for illustration of HDH segments.

Principal conclusions are:

- While upgrading existing Highway 1 to multi-lane status (sections HB3, LC1 and DB1) is technically possible, it is judged impractical due to right-of-way constraints as well as very high costs and extensive community disruptions catalyzed by an extensive right-of-way acquisition/road widening process. Furthermore, an upgraded Highway 1 cannot be operated as a toll road, nor does it offer opportunities for eventual incorporation into a motorway scheme (other than as a paralleling or feeder road). Thus, realization of the HDH along a new alignment is strongly preferred.
- Alignment HB1 is the preferred alternative for the Hue Bypass. It can be built on largely unused land (sand formation), does not intrude into paddy area (unlike alternatives HB2 and HB4) and totally avoids the Hue scenic as well as cultural preservation area (unlike alternative HB4). Furthermore, the coastal lagoon area is underutilized from a developmental (agricultural, fishery) point of view; alternative HB1 remedies this problem.
- Alternative LC2 is preferred along the Lang Co-Chan May segment since it offers good access for the Chan May complex at reasonable construction cost. Alternative LC3, on the other hand, would disrupt Bach Ma National Park and the abutting forest preservation areas. Construction costs for alignment LC3 would also be extremely high due to mountainous terrain.
- The lengths of the Hai Van pass alternatives are similar - on the order of 14 kilometers. Alternative HV1 requires three tunnels (1.8, 2.5 and 1.6 kilometers in length) as well as six bridges totaling 900 meters in length. Alternative HV2 consists of a single tunnel of 5.0 kilometers length, and two bridges totaling 850 meters in length. Construction cost of alternative HV2 is some 10 percent higher

than alternative HV1, and, due to the single-tunnel length, would require a complex ventilation system as well as an evacuation tunnel. Alternative HV1 is, for these reasons, the preferred choice[1].

- Alternative DB3 is the preferred Da Nang Bypass option. Its western location provides excellent accessibility for planned industrial estates northwest of Da Nang, completely avoids the existing/future metropolitan area and is optimally located for future extension direction Dung Quat/Quang Ngai. Improved east-west feeder roads link alternative DB3 with major tourist attractions such as the Cham Towers at My Son (Province Highway 610) and Hoi An town (Province Highway 609).

Segments HB1, LC2, HV1 and DB3 (refer Figure 5.10) therefore reflect the HDH alignment which is embedded in the modeling process.

3) Toll Structure

The HDH is, for simulation purposes, treated as tolled road. Since tollroads are rare in Viet Nam, several assumptions regarding HDH operation are required for the modeling process.

- The toll levy is distance-proportional (i.e. the total amount of the toll charge varies with distance traveled on the HDH) and is administered via a closed system. That is, a coded, magnetic card (similar in appearance to a credit card) is issued to each motorist upon entry to the HDH. This card contains a variety of computer-generated information, the more important being type of vehicle and entry point. The card is surrendered at the exit point, at which time the amount due is automatically calculated and toll is paid by the motorist. All toll booths at which the "take card" and "pay toll" transactions are completed are located astride entry/exit lanes; no disruption to mainline HDH traffic is required.

- Toll will likely be assessed according to three vehicle classes

    * Type I, being small vehicles such as cars, vans, utility vehicles, small buses and pick-up trucks.

    * Type II, being medium and large buses as well as light and medium trucks (two or three axles).

    * Type III, being trucks of more than three axles.

- It is expected that real (excluding inflation) toll prices will increase by some 6-7 percent per annum, on average, but will actually only be changed every three or so years. The constant GDP per capita of the study area is forecast to grow by some 10 percent per annum on average over the next 15 years. This suggests, when compared to likely increases in constant toll rates, that motorists perception of out-of-pocket toll payments will deflate on average by about 3-4 percent per annum.

- Motorcycles and NMV's are not permitted to use the HDH. Furthermore, it is likely that only longer-distance (inter-province or express) buses are candidates for diversion to the HDH, as most other buses would continue to provide local service along Highway 1.

- Vehicle mix on the tollroad (car, long-distance bus, truck) is guided by evolution of future-year trip matrixes. Average pcu's per vehicle for the HDH is estimated at 2.0 and 2.1 in years 2005 and 2010, respectively (it is assumed the HDH will be open in its entirety by year 2005).

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[1] Refer "Prefeasibility Study of Hai Van Pass Tunnel of Highway No. 1", op.cit, for further technical discussion regarding these issues.

Since the toll diversion process (refer Section 5.1) is sensitive to both time saved and toll payment, it is necessary to define a unit toll structure. No firm toll policy exists at present in Viet Nam; a realistic approach which relies on savings in vehicle operating cost catalyzed by improved quality of the HDH can therefore be used to define a range of reasonable tolls. Due to higher speed as well as capacity (and more moderate Hai Van pass horizontal and vertical alignment) vehicle operating cost on the HDH will be lower than on Highway 1[1]. It is reasonable that some 60-80 percent of these savings can be recouped in the form of tolls[2].

To ascertain a preliminary benefit, a series of assignments were performed using future demand levels and networks. Diversion analogies were applied to estimate potential HDH usage. Financial (that is, actual out-of-pocket costs) vehicle operating costs (refer chapter 6) were then calculated for operation under both HDH and Highway 1 conditions. Adopted guidelines are:

- VOC savings include distance and time based vehicle operating cost, but exclude the value of passenger time.
- The analysis consecutively focuses only on the vehicle sub-population which uses the HDH. No benefits are included which might accrue to non-HDH motorists (principally local buses and motorcycles) due to diversion of other vehicles to the HDH, nor is any "generated" traffic assumed.
- It is again conservatively assumed that road surface condition (IRI) will be comparable between the HDH and the IBRD/ADB-improved Highway 1. Thus, VOC savings are catalyzed only by differences in operating speed as well as, in the case of the Hai Van pass segment, horizontal and vertical alignments.

Findings suggest that, for the composite HDH corridor, VOC savings (difference between HDH and Highway 1 VOC) average some six US cents per kilometer, although variation exists among vehicle types and toll classes.

NET FINANCIAL VOC SAVINGS (US CENTS PER KILOMETER) (1)					
VEHICLE TYPE		VEHICLE CLASS		TOLL CLASS	
Car	10.4	Car	10.4	Type I	6.6
Bus (2)	5.9	Bus (2)	5.9	Type II	5.3
Pick-up Truck	4.7	Truck	5.3	Type III	8.3
Medium Truck	5.2				
Heavy Truck	8.3				
Average	6.1	Average	6.1	Average	6.1

(1) In 1996 constant terms. Calculations exclude passenger time value and reflect weighted conditions
for the entire HDH corridor.
(2) Inter-province and/or express operation.

In comparison, composite unit toll rates applied on the five elements of the Java (Indonesia) tollway network varies from 6.1 to 9.8 cents per kilometer. This is quite similar to findings of the study area VOC savings review.

Therefore, to reflect a reasonable range of modeling opportunities, the likely toll rate of 5.0 cents/km is supplemented by unit rates of 7.5 and 10.0 constant 1996 US cents per kilometer per typical vehicle.

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[1] Refer Chapter 6 for a more complete discussion of vehicle operating cost.
[2] For example, PT Jasa Marga, the national tollroad authority of the Government of Indonesia, has adopted a policy that unit tolls should, on average, recover 70 percent of VOC benefits catalyzed by the presence of the tollroad.

5.5.2 East-West Highways

Successful functioning of the twin north-south routes (Highway 1 and Highway 14) absolutely requires that adequate east-west linkages be available. This role is filled by Highways 9, 14B, 24 and 49.

These four east-west roads currently feature differing characteristics.

- Highway 9 (Quang Tri province), as previously discussed, already represents a key road with national/international implications.
- Highway 49 (Thua Thien-Hue province) links Hue city with A Luoi town. A ferry crossing is required some 10 kilometers west of Hue at the Huong River. Highway 49 is typically a five meter earth/gravel road, although paved sections (4.5-5 meters) are provided at mountain passes. The eastern half of Highway 49 can generally be termed as lying in flat terrain, the western half in rolling and mountainous terrain. Surface conditions of the earth/gravel sections is poor, while paved sections are typically in good condition. A recently constructed earth-surface spur west of Highway 14 near the Quang Tri province boundary extends Highway 49 almost to the Lao PDR border.
- Highway 14B (Quang Nam-Da Nang province) links Da Nang with A Nghia and, at the Highway 14 junction, Than My. Highway 14B is generally in good condition and features a 5.5 meter paved width, wider in vicinity of Danang. Unfortunately, extensive damage caused by heavily loaded trucks can effectively close the road to all but the largest vehicles, such as in vicinity of the Vu Gia River bridge during field inspections in January, 1996.
- Highway 24 (Quang Ngai province) provides important access to Ba To town and, via the Ba Vi pass, Kon Tum and points beyond. Highway 24 suffered severe damage during the 1995 floods and, as a result, was closed west of Ba To for reconstruction during most of 1996. East of Ba To, the road typically features a width of 5.5 meters and gravel surface, although passes are asphalted. Terrain is generally rolling or mountainous. Recent road improvements east of Ba To ensure reasonable surface quality for graveled conditions. The Mot, in cooperation with provincial People's Committee's, is now pursuing the upgrading of Highway 24 between Highway 1 and Kon Tum. The recent improvement east of Ba To town (5.5 meter gravel surface, asphalted passes), as well as (mid-1996) reconstruction west of Ba To in Quang Ngai province, are elements of this effort.

The east-west linkages fulfill several essential roles in the overall road transport scheme:

- Provide direct linkage between Highway 1 and Highway 14, both being north-south corridors of flow within the study area.
- Link major regional towns such as A Luoi, A Nghia, Thanh My and Ba To with major urban centers and higher-order road facilities.
- Connect intermediate communes and serve in a collector capacity for intermediate district/commune roads.
- Offer connections with neighboring Lao PDR. Crossings associated with Highway 49 and Highway 24, for example, offer possibilities for localized cross-border contact.

It is recommended that Highways 14B, 24 and 49 be upgraded to high-order two-lane status (Class III per Ministry of Transport criteria). This implies a paved seven meter width (plus flanking non-motorized vehicle lanes) in flat terrain and six meter width in rolling/mountainous terrain. All bridges must be of suitable load-bearing capacity. The extent of the improvement within the study area is as follows: Highway 14B - length of 83 kilometers; 22 bridges totaling

8.1 kilometers in length; Highway 24 - length of 65 kilometers; 32 bridges totaling 6.2 kilometers in length; and Highway 49 - length of 70 kilometers; 26 bridges totaling 6.1 kilometers in length.

These improvements can readily be achieved; however, Highway 14B near Da Nang requires additional capacity enhancement. Transport demand along Highway 14B between the HDH and Da Nang city is expected to be intense. Thus, expansion to multi-lane status between the HDH and Highway 1 will likely be required during the post-2005 period. This is consistent with on-going improvements: Highway 14B between Highway 1 and the Da Nang Tourism Park (east of Highway 1) is currently being upgraded to multi-lane status. Highway 14B north of that point and along the western edge of the Da Nang Tourism Park has already been improved to a high-order, multi-lane urban arterial. In addition, as part of the current studies Tourism Sector Improvement Plan, it is also proposed that a new multi-lane road be constructed along the southern edge of the Da Nang Tourism Park to include a new bridge over the Han River. This new road would therefore link Highway 14B (and, inter-alia, Highway 1) with Province Highway 603 bypassing the existing (and congested) Han River road/rail bridges.

The upgrading of Highway 49 near Hue also requires special consideration. At present Highway 49 immediately west of Highway 1 meanders for about 10 kilometers through an area studded with scenic and cultural attractions before reaching the Huong River ferry. This segment of Highway 49 is also flanked by moderate to high intensity urban development. The upgrading of this road segment to Class III status is undesirable from developmental as well as cultural perspectives, and technically difficult.

It is instead proposed that a Highway 49 bypass be constructed between the Huong River and Highway 1. This new alignment, which includes bridges over the Ta Trach and Huu Trach Rivers, could largely follow an existing local road corridor. Direct access to the HDH would also be available via a link with, and improved cross-section of, Province Highway 3 (which could conceivably be incorporated as a part of Highway 49) (Figure 5.11).

5.5.3 The Southern Precinct

Demanded forecasts have confirmed that the advent of Dung Quat port, Dung Quat industrial estate and Van Tuong township, as well as continued growth of the Quang Ngai urban area, requires commensurate upgrading of the road network. It is, from a modeling perspective, assumed that the Dung Quat complex (Phase I) will be operational by year 2005; however, the status of on-going (October, 1996) negotiations between the Government of Viet Nam and potential foreign participants is far from settled. Questions persist as to actual opening date, scale of development, and staged implementation schedules.

It is therefore difficult to associate supporting road infrastructure with a specific time frame; instead, must be linked with actual progress of Dung Quat construction. Once Phase I is realized (whether year 2005 or not) a series of roads must be constructed east of Highway 1 which link Dung Quat/Van Tuong with Highway 1 and Quang Ngai, to include a major new crossings of the Tra Khuc River (Figure 5.12). However, if the Dung Quat complex intensifies at a pace currently foreseen by the Government, and catalyzes a large commensurate increase in urban population as well as workforce, additional road improvements are needed. This would include a southward extension of the HDH to a point south of the Quang Ngai urban area, as far as Province Highway 627 or, depending on available funding, Highway 24. Province Highways 622, 625, 627 and 628 must concurrently be upgraded to link with Highway 1, and a new east-west connection must be constructed for Dung Quat port near the northern border of Quang Ngai province (refer Figure 5.12).

Figure 5.11 Improvement Strategy for Highway No. 49 Corridor

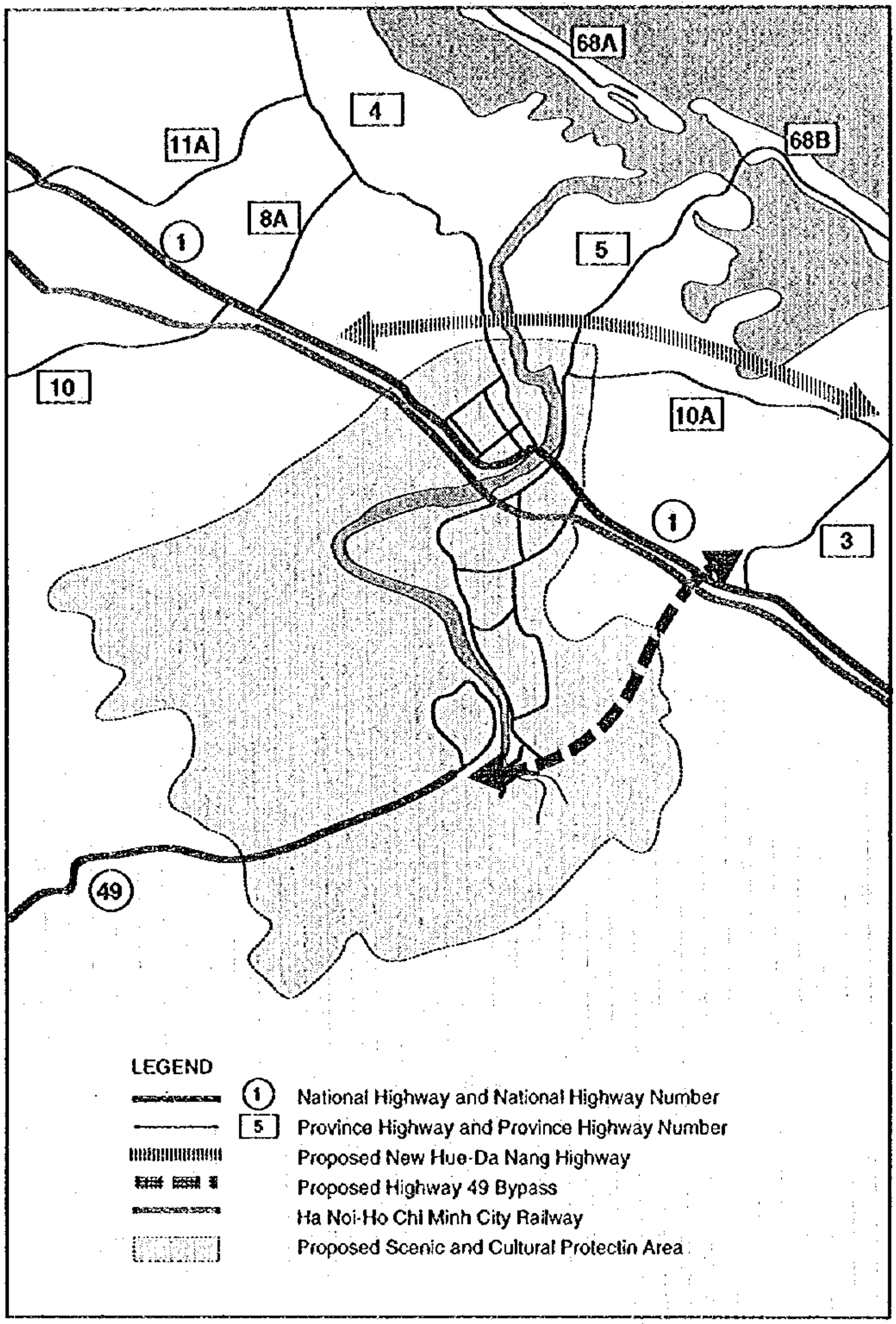
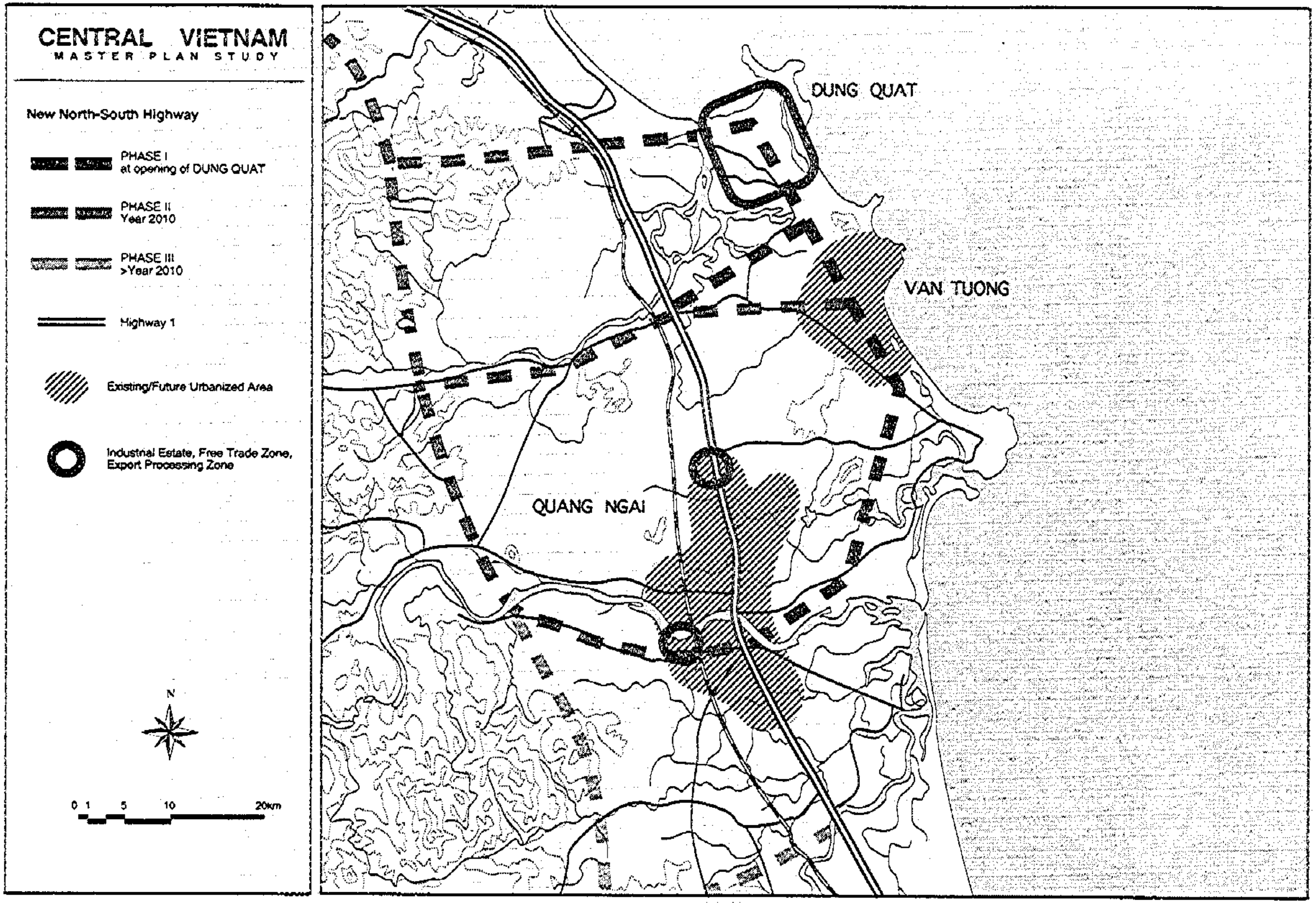


Figure 5.12 Improvement Strategy for Southern Precinct



5.6 STRATEGY FINALIZATION AND STAGING

A final series of assignments were undertaken during which future demand (years 2000, 2005 and 2010) was loaded onto an improved future network. This network builds upon the "existing plus committed" network (which encompasses Highway 1 and Highway 9 upgraded in accordance with on-going IBRD/ADB projects, plus enhanced access roads for the Dung Quat/Van Tuong complex) by including:

- The HDH with embedded toll structures featuring composite unit toll rates of 5, 7.5 and 10 constant 1996 cents per kilometer;
- Upgraded access/feeder roads linking the HDH with Highway 1, to include four lanes along Highway 14B between the HDH and Highway 1;
- Highways 14B, 24 and 49 upgraded to Class III standard; and,
- Highway 14 upgraded to a minimum of Class IV standard.

The "future" network totals some 1,590 kilometers in length, or an increase of about 12 percent over the "existing plus committed" network. More importantly, these increases are recorded in the important higher-order road categories (Table 5.5).

Table 5.5 Comparison of Improved Networks Content

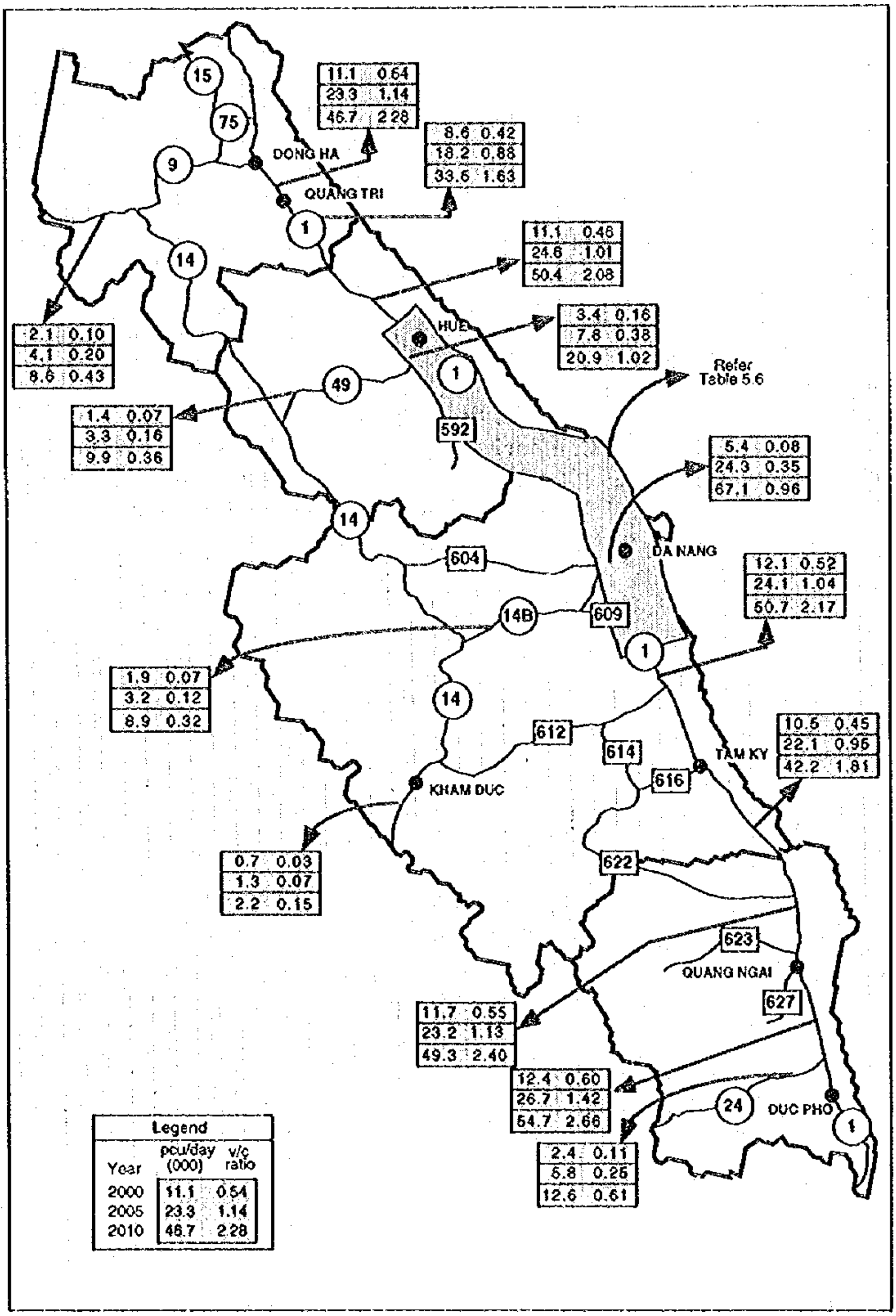
ROAD TYPE	ROAD WIDTH	LENGTH (KM) E + C[1]	FUTURE[2]	PERCENT CHANGE
Multi-lane paved	14 meters	0	21.2	*
Two lane paved	> 7.2 meters	259.7	397.8	53.2
Two lane paved	6.2 - 7.2 meters	171.6	283.8	65.4
Two lane paved	5.0 - 6.1 meters	392.8	530.8	35.1
Two lane paved	< 5.0 meters	99.3	23.2	- 76.6
Two lane unpaved	=> 5.0 meters	358.6	266.9	- 25.6
Two lane unpaved	< 5.0 meters	137.5	62.9	- 54.3
TOTAL		1419.5	1586.6	11.8

[1] Existing (1996) network plus committed improvements.
[2] Integrates HDH system plus upgraded Highways 14, 14B, 24 and 49.

A review of assignment findings reveals several distinct patterns (Figure 5.13):

- East-west highways, to wit Class III Highways 14B, 24 and 49, are expected to operate at acceptable levels for the foreseeable future. Four-laning Highway 14B between the HDH and Highway 1 is justified in light of heavy future demand along this important axis.
- Highway 1 outside of the Hue-Da Nang corridor is expected to operate at an acceptable level of service under year 2000 demand conditions. However, some segments are likely to approach their assignment capacity under year 2005 demand conditions, and virtually the entire highway will have failed (exceeded maximum capacity) under year 2010 demand conditions. This clearly confirms that on-going Highway 1 improvement projects under sponsorship of the IBRD and ADB will benefit near to mid-term Highway 1 operation. However, in the long-term (year 2010) more radical solutions are needed.

Figure 5.13 Forecast Demand for Study Area Road Network



Similar conclusions emerge in the higher-volume Hue-Da Nang corridor (Table 5.6):

- Under year 2000 demand conditions, Highway 1 still operates at an acceptable level of service. However, the subsection paralleling the HDH Da Nang Bypass segment is shown as approaching its assignment capacity. This is not surprising given the rapid socio-economic growth expected of Da Nang, and underscores the desirability of conducting a detailed, comprehensive urban transportation study for the Da Nang metropolitan are at the earliest opportune time.
- The HDH, which is slated for opening by year 2005, is shown as operating at acceptable levels of service under all toll scenarios. However, the Da Nang Bypass subsection of Highway 1 is expected to exceed assignment, and approach maximum, capacity.
- Under year 2010 demand conditions, the HDH has exceeded assignment capacity, and is approaching maximum capacity. Highway 1 is shown as having failed completely.

Table 5.6 FORECAST DEMAND: HUE-DANANG HIGHWAY CORRIDOR

YEAR	FACILITY	CORRIDOR SUB-SECTION	USE ACCORDING TO HDH TOLL STUCTURE (CENTS PER KM)					
			5.0		7.5		10.0	
			PCU(1)	V/C (2)	PCU(1)	V/C (2)	PCU(1)	V/C (2)
2000 (3)	Highway 1	Hue Bypass	13,100	0.57	13,100	0.57	13,100	0.57
		Lang Co	11,700	0.51	11,700	0.51	11,700	0.51
		Hai Van	11,500	0.47	11,500	0.47	11,500	0.47
		Danang Bypass	20,500	0.92	20,500	0.92	20,500	0.92
2005	Highway 1	Hue Bypass	16,000	0.70	17,000	0.74	17,900	0.78
		Lang Co	8,900	0.39	10,100	0.44	11,200	0.49
		Hai Van	7,700	0.32	9,000	0.37	10,100	0.42
		Danang Bypass	25,800	1.16	26,300	1.18	26,800	1.21
	HDH	Hue Bypass	14,800	0.43	13,700	0.40	12,700	0.37
		Lang Co	18,900	0.56	17,600	0.52	16,300	0.48
		Hai Van	19,200	0.62	17,800	0.58	16,600	0.54
		Danang Bypass	20,300	0.60	19,700	0.58	19,000	0.56
2010	Highway 1	Hue Bypass	35,000	1.53	35,400	1.55	35,800	1.57
		Lang Co	23,200	1.01	23,800	1.04	23,800	1.04
		Hai Van	21,100	0.87	21,700	0.90	21,600	0.89
		Danang Bypass	54,300	2.41	54,500	2.46	54,400	2.45
	HDH	Hue Bypass	36,200	1.06	35,700	1.05	35,300	1.04
		Lang Co	40,500	1.19	39,700	1.17	39,600	1.17
		Hai Van	40,000	1.30	39,200	1.27	39,300	1.28
		Danang Bypass	44,400	1.31	44,100	1.30	43,600	1.28

(1) Unconstrained demand (pcu/km/day) derived from assignment process. Average aggregate unit toll of 5, 7.5 and 10 cents per vehicle applie toll diversion model. Modes include cars, buses, trucks and motorcycles for Highway 1, and cars, long-distance buses and trucks for HDH.

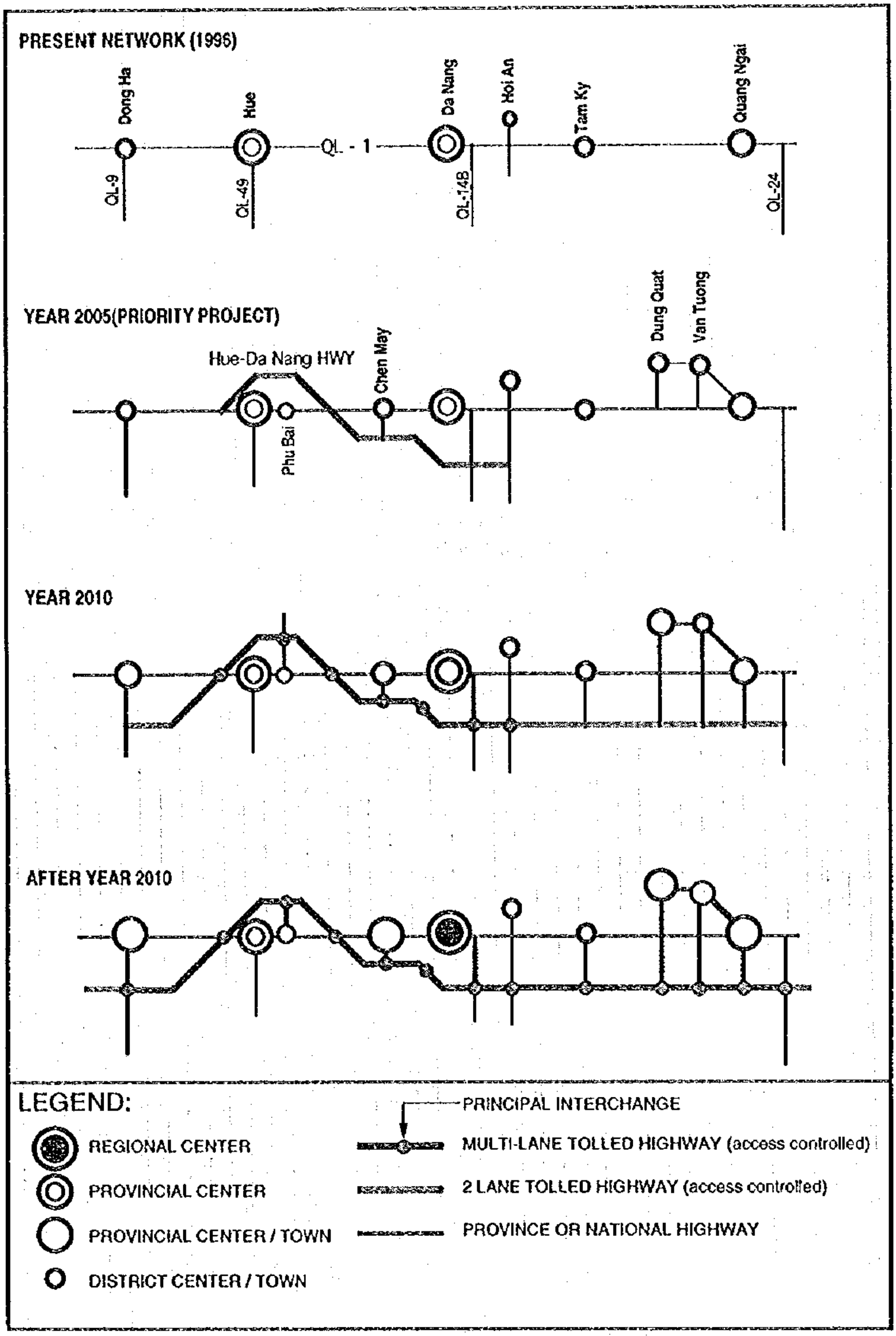
(2) Ratio of forecast demand to assignment capacity.

(3) HDH not expected to be open by year 2000.

These findings confirm that the focus of additional improvements (beyond those incorporated in the future road network) must center on the critical Highway 1 corridor. In response, a staged implementation concept for the north-south spine has been defined (Figure 5.14).

- The committed upgrading of existing Highway 1 in line with on-going IBRD and ADB projects should, in the first instance, continue. These improvements will essentially transform Highway 1 into a high-order, two-lane road.

Figure 5.14 Staged Implementation Concept for North-South Highway Spine



- Construction of the HDH should, as a priority project, be initiated as soon as possible to ensure availability by (preferably prior to) year 2005. The goal is to establish a two-lane, access controlled facility, in line with criteria previously detailed in Section 5.5.1 and Figure 5.9. It is anticipated that a closed, distance-proportional toll system will be instituted along the HDH.

- By year 2010 (end of the current study's planning horizon) it is likely that a four-lane cross-section will be required along the HDH. Furthermore, two-lane extensions appear justified north as far as Highway 9, and south as far as Highway 24. It is expected that this entire system will continue to be access controlled, and operate as a tolled facility with unified toll structure.

- Extension beyond Highways 9 and 24, as well as upgrading to multi-lane status over the entire extent of the study area, is conceivable beyond year 2010. It is likely that at least partial realization of Government's plan for a Hanoi-HCMC motorway can be integrated with the post-2010 concept assuming recommendations regarding right-of-way acquisition voiced in Section 5.5.1 are indeed implemented.

CHAPTER 6

ECONOMIC VIABILITY OF PRIORITY PROJECTS

CHAPTER 6 ECONOMIC VIABILITY OF PRIORITY PROJECTS

The goal of the economic analysis is direct; namely, to calculate measures of viability for the designated road sector priority improvement projects, to wit:

- the new Hue-Da Nang Highway, a two-lane facility conceived in accordance with guidelines presented in Section 5.5.1; and,
- Highways 24, 49 and 14B upgraded to Class III standard as described in Section 5.5.2.

Techniques, methodologies and findings are described in subsequent sections of this chapter.

6.1 METHODOLOGY OVERVIEW

The principal aim of the economic project analysis is to determine the economic viability of implementing two priority projects:

- Construction of a new Hue-Da Nang Highway ("with" case) as opposed to continued use of existing Highway 1 upgraded in line with on-going IBRD/ADB projects ("without" case); and,
- Improving Highways 24, 49 and 14B to Class III standard ("with" case) as opposed to continued use of existing facilities ("without" case).

The quantified economic benefits which would be realized from implementation of these projects are defined as the savings in vehicle operating costs and time costs when comparing the "with" and "without" project conditions. Resultant benefits catalyzed by the projects are set against the economic project costs to estimate the expected economic return from the resources invested in the projects.

The analysis follows the conventional discounted cash flow methodology in determining the net present value (NPV), internal rate of return (IRR) and benefit cost ratio (B/C). These efficiency measures will indicate the economic viability of the projects and show the sensitivity of the economic viability to changes in costs and benefits.

While these goals are direct, underlying techniques and methodologies are, at times, complex due to a number of considerations.

- The road priority projects represent an essential element of an integrated and coordinated planning approach. Thus, they are directly linked with achievement of regional socio-economic, and macro-economic, targets.
- Projects which satisfy the criteria of economic efficiency are those which, prima facie, exhibit high economic returns. However, a project may not meet strict economic viability criteria but could nevertheless be needed to achieve social or other national objectives, such as improving access to highlands areas (thus catalyzing economic development) or overcoming pronounced physical and mental obstructions to national unity, such as those posed by Hai Van pass.
- Since the road priority projects are intrinsically linked with, and contribute to, the success of the regions socio-economic development fabric, it is logical to surmise that some proportion of resulting non-transport benefits are attributable to transport

projects. Conversely, failure to provide requisite transport infrastructure will likely prevent (at best impede) the ability of the regions economy to evolve to levels postulated within the macro-economic frame. In a more focused sense, additional near-term benefits could also be catalyzed. The projects would, for example, create additional short-term employment in the construction industry and this would have a multiplier effect in the project area. Long-term jobs would also be created through the staff requirements for road, and in the case of the HDH - toll systems, operation and maintenance. Other long-term opportunities would be created in service areas such as food, fuel and traveler needs. The improvements are also expected to have a positive effect on industrial development, with increased efficiency in the transportation of goods, benefiting both producers and consumers. Upgraded roads would also have a favorable influence on tourism development by providing faster and more comfortable travel opportunities.

Nevertheless, in order to ensure a conservative approach, economic viability of road sector projects is based only on direct vehicle-related benefits (savings in running cost and passenger time). Indirect transport, or other non-transport benefits previously described, are excluded from the analytical process.

The analysis, as described in subsequent sections, is conducted in economic terms. That is, financial (market) costs with duties, taxes, transfer fees and similar items having been removed. All monetary units are in constant terms, with 1996 serving as a base year for cost derivation purposes[1].

6.2 VEHICLE OPERATING COST

The VOC (vehicle operating cost) of vehicles using the study area road network is influenced by several key variables, among them vehicle type and speed as well as, in the case of Hai Van pass, vertical and horizontal alignment. Thus, for the current study, investigations initially focused on the formulation of modal unit (US cents/kilometer) 1996 VOC under free-flow and smooth road conditions. These are subsequently modified to mirror operating conditions (speed, volume, capacity) simulated via the transport modeling process by using latest available VOC software/techniques sponsored by the IBRD[2].

6.2.1 Fleet Costs

A number of previous VOC-related investigative efforts were reviewed as background to the current effort. These include the IBRD Sector Review[3] as well as VOC calculations contained in the Highway 9 corridor improvement project[4], the Highway 18 feasibility study[5] as well as the Hai Van tunnel pre-feasibility report[6]. Each of these appears to feature a similar concern, specifically, that the most-recently available data (2-3 years old) presents an unrealistic fleet profile due to an over-representation of over-age, mostly east European, vehicles and out-of-date taxation structure. This fleet condition is also confirmed by a review of Vietnamese vehicle registration statistics (refer Section 2.3). It is equally obvious that the fleet profile is rapidly changing, particularly in the case of cars and motorcycles where modern vehicles of (largely) Japanese origin now (since within 1-2 years) dominate. It is expected that this evolution will

[1] Costs and benefits are expressed in terms of US dollars, converted at a rate of 11,000 VD = 1.00 US$.

[2] "Estimating Vehicle Operating Costs", by R.S. Archondo-Callo and A. Faiz, World Bank Technical Paper Number 234, Washington DC. USA. Includes HDM-VOC (Version 4) software.

[3] "Vietnam Transport Sector Review", op. cit.

[4] "Subregional Transport Sector Study for the Greater Mekong Subregion", op. cit.

[5] "Feasibility Study on the Highway No. 18 Improvement in Viet Nam", op. cit.

[6] "Pre-feasibility Study for Hai Van Pass Tunnel of Highway No. 1", op. cit.

rapidly accelerate, particularly as the need for bus and truck fleet replacement and expansion intensifies. Thus, it is logical to surmise that VOC appropriate to a 20 (or more) year economic review should not be based upon an out-dated fleet profile and tax structure. Instead, the use of a more representative (vis-à-vis the economic evaluation horizon) fleet structure, based on up-to-date (late 1996) data, augmented by the experience of other Asian nations, is more plausible.

A revised vehicle tax structure was issued during early 1996[1] which contains a graduated scale of import duties and sales taxes. Highest duties are assessed on passenger vehicles not exceeding five seats, lowest on commercial vehicles of five or more ton capacity. The impact in terms of economic pricing can be substantial: some 60 percent of the "on the road" price of a small passenger vehicle consists of duties, taxes and fees; a total which reduces to some 23 percent in the case of largest commercial vehicles (Table 6.1). CIF (cost, insurance, freight) vehicle prices were reviewed with industry representatives and fleet operators in order to gain a realistic overview of representative vehicle prices. While differences among various makers do exist, realistic CIF price ranges can nevertheless be defined (Table 6.2). The heavy truck category proved somewhat problematic due to the continued popularity of the low-cost Kamaz truck (8-12 tons, Model 55111, CIF about $33,000). In other Asian countries, technically more advanced models (typically of Japanese or German origin) are preferred, but in Viet Nam the CIF price of these units ranges up to $60,000. A mid-range price was consequently adopted for this vehicle category.

Table 6.2 - Overview of Financial and Economic Vehicle Prices

Vehicle Type	Price (1996 US$)	
	Financial(1)	Economic(2)
Car	72,300	29,300
Van	58,100	27,400
Medium Bus	65,700	45,300
Large Bus	88,800	61,300
Light Truck	26,500	17,400
Medium Truck	49,400	38,200
Heavy Truck	61,800	47,800
Motorcycle	2,200	1,900

(1) Refer Table 6.1 for conversion factors.
(2) Based on discussions with industry representatives and fleet operators.

6.2.2 Passenger and Crew Costs

The costs associated with passenger and crew represent the "human element" of VOC relationships. These items are, however, allocated differently: crew costs represent and actual monetary cost associated with vehicle operation (professional driver and attendant) and are thus an element of actual vehicle running costs. Passenger time, on the other hand, reflects a benefit accruing to motorists in that economically valuable time is shifted from travel to a more productive purpose. Thus, to minimize ambiguity, VOC is developed with passenger time being a separate, time-based, cost.

[1] "Amendments and Additions to Import Tariff and Minimum Price List at the Bordergates for the Calculation of Import Duties", issued by the Government of Viet Nam, January 1996.

Table 6.1 DERIVATION OF ECONOMIC VEHICLE COST FACTORS

ITEM NUMBER	ITEM	CALCULATION	PRICE COMPONENT (2)			ITEM NUMBER	ITEM	CALCULATION	PRICE COMPONENT (2)		
			COST	TAX	CUM'TV				COST	TAX	CUM'TV
PASSENGER VEHICLE NOT EXCEEDING FIVE SEATS						PASSENGER VEHICLE MORE THAN 24 SEATS					
1	CIF Price (1)		1.000		1.000	1	CIF Price (1)		1.000		1.000
2	Import Duty	55 Percent of Item 1		0.550	1.550	2	Import Duty	50 Percent of Item 1		0.500	1.500
3	Sales Tax	100 Percent of Items 1,2		1.550	3.100	3	Sales Tax	None		0.000	1.500
4	Wholesale Price				3.100	4	Wholesale Price				1.500
5	Dealer Commission	15 Percent of Item 4	0.465		3.565	5	Dealer Commission	15 Percent of Item 4	0.225		1.725
6	Retail Price				3.565	6	Retail Price				1.725
7	Registration Fee	5 Percent of Item 1		0.050	3.615	7	Registration Fee	5 Percent of Item 1		0.050	1.775
8	"On the Road" Price				3.615	8	"On the Road" Price				1.775
		Sum of Components	1.465	2.150				Sum of Components	1.225	0.550	
		Component Percent	40.5	59.5				Component Percent	69.0	31.0	
PASSENGER VEHICLE 5 - 15 SEATS						COMMERCIAL VEHICLE LESS THAN 5 TONS					
1	CIF Price (1)		1.000		1.000	1	CIF Price (1)		1.000		1.000
2	Import Duty	55 Percent of Item 1		0.550	1.550	2	Import Duty	60 Percent of Item 1		0.600	1.600
3	Sales Tax	60 Percent of Items 1,2		0.930	2.480	3	Sales Tax	None		0.000	1.600
4	Wholesale Price				2.480	4	Wholesale Price				1.600
5	Dealer Commission	15 Percent of Item 4	0.372		2.852	5	Dealer Commission	15 Percent of Item 4	0.240		1.840
6	Retail Price				2.852	6	Retail Price				1.840
7	Registration Fee	5 Percent of Item 1		0.050	2.902	7	Registration Fee	5 Percent of Item 1		0.050	1.890
8	"On the Road" Price				2.902	8	"On the Road" Price				1.890
		Sum of Components	1.372	1.530				Sum of Components	1.240	0.650	
		Component Percent	47.3	52.7				Component Percent	65.6	34.4	
PASSENGER VEHICLE 15 - 24 SEATS						COMMERCIAL VEHICLE 5 AND MORE TONS					
1	CIF Price (1)		1.000		1.000	1	CIF Price (1)		1.000		1.000
2	Import Duty	55 Percent of Item 1		0.550	1.550	2	Import Duty	30 Percent of Item 1		0.300	1.300
3	Sales Tax	30 Percent of Items 1,2		0.465	2.015	3	Sales Tax	None		0.000	1.300
4	Wholesale Price				2.015	4	Wholesale Price				1.300
5	Dealer Commission	15 Percent of Item 4	0.302		2.317	5	Dealer Commission	15 Percent of Item 4	0.195		1.495
6	Retail Price				2.317	6	Retail Price				1.495
7	Registration Fee	5 Percent of Item 1		0.050	2.367	7	Registration Fee	5 Percent of Item 1		0.050	1.545
8	"On the Road" Price				2.367	8	"On the Road" Price				1.545
		Sum of Components	1.302	1.065				Sum of Components	1.195	0.350	
		Component Percent	55.0	45.0				Component Percent	77.3	22.7	

(1) CIF = cost, insurance and freight.

(2) Tax structure defined in "Amendments and Additions to Import Tariff and Minimum Price List at the Bordergates for the Calculation of Import Duties", issued by Government of Viet Nam, January, 1996.

Accurate study area wage information is virtually non-existent. Interesting previous work, based on a national household survey, provides an overview of 1992 household income and expenditure, as well as a relative income distribution[1]. While relative patterns may still be reasonable accurate, it is unlikely that absolute income data retain validity particularly in light of the on-going and rapid evolution of the doi moi-fueled economy. Circumstantial evidence further suggests that any official income data are unlikely to reflect a true level of respondent "wealth". Reasons for this are varied and include subsidized housing and/or food, participation in the unofficial economy, or simply under-reported income (understood to be a common practice, for example, in rental contracts involving foreign nationals[2]).

The 1996 study area GDP/capita is estimated at near $130 per annum, and is, in real terms, expected to roughly double by year 2005. While relative growth is substantial, absolute totals remain low particularly in light of vehicle prices: roughly $2,000 for a motorcycle, and $80,000 - $90,000 for a passenger car. A frequently-used "rule of thumb" by the banking/lending sector is that annual household income should be slightly higher than the price of the desired vehicle. This, in turn, suggests income per capita of near $400 if a new motorcycle is to be viewed in "affordable" terms by a study area household. This disparity is even more pronounced in the case of passenger cars. It is inconceivable that the value of passenger (both foreign and domestic) time can realistically be approximated by any multiple of study area GDP per capita, particularly over the 20 year horizon embedded in the economic review process.

Thus, in the interests of simplicity, a shadow factor of 2.0 is applied to year 2005 GDP capita, which is in turn arrayed against percentile ranges (eight levels) developed by the national household income survey. Car owners are assumed as originating from highest income levels, motorcycle owners from intermediate income levels and bus passengers from moderate income levels (Table 6.3). Wages of drivers and attendants are set at the overall average.

Table 6.3 Empirical Modal Income Distribution

Income Group(1)	Percent of Households(2)	Likely Modal Utilization		
		Car	Motorcycle	Bus
1	3.4	x		
2	6.7	x	x	
3	10.2		x	
4	13.0		x	x
5	19.0			x
6	12.9			x
7	15.1			
8	19.6			
Total	100.0			

(1) 1= highest average income.
(2) Developed from data in "Vietnam Living Standards Survey 1992-1993", op. cit.

Adopted passenger time values consequently total $1.10, $0.59 and $0.30 per hour for car, motorcycle and bus users, respectively, with an average driver/attendant wage of $0.34 per hour.

Passenger time savings are conservatively estimated only for trips of economic value, that is, the proportion of occupants undertaking a journey to/from work or for professional business purposes. Recent overseas data[3] suggest that only some 15-30 percent of inter-province trips, depending on mode, are expended on such endeavors. Instead, the dominant trip purpose (near

[1] "Vietnam Living Standards Survey 1992-1993", State Planning Committee - General Statistical Office, 1994.

[2] "Vietnam Economic Times", October 1996.

[3] 1993/4 national roadside interview conducted in Indonesia.