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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
REPUBLIC OF THE PHILIPPINES

FEASIBILITY STUDY
ON
PAN-PHILIPPINE HIGHWAY REHABILITATION PROJECT
(MINDANAO SECTION)

FINAL REPORT
APPENDIX

MAY 1995

KATAHIRA & ENGINEERS INTERNATIONAL
NIPPON ENGINEERING CONSULTANTS CO., LTD.

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ORIGIN-DESTINATION MATRIX OF COMMODITY TRANSPORT ON STUDY ROAD

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(in Kilograms / day)

Origin	Destination																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1: Metro Manila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2: Visayas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,301	0	0	1,001	0	0	7,301
3: Surigao City	0	0	0	0	0	0	9,452	879	0	27,557	78,079	0	0	46,864	25,194	0	0	26,284	0	1,680	215,989
4: Bacuao	0	0	0	0	0	0	0	0	0	0	5,800	0	0	0	0	0	0	0	0	0	5,800
5: Placer / Sison	0	0	0	0	0	0	0	0	0	2,240	448	0	0	0	0	0	0	0	0	0	2,688
6: Tubod	0	0	0	0	0	0	0	0	0	952	0	0	0	0	0	0	0	0	0	0	952
7: Alegria	0	0	22,906	0	0	0	9,395	0	0	0	0	0	0	0	0	0	0	0	0	0	32,303
8: Kitcharao	0	0	4,913	0	0	0	662	0	0	0	0	0	0	0	0	0	0	0	0	0	5,575
9: Santiago	0	0	560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	560
10: Cabadbaran	0	0	42,472	0	21,319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63,791
11: Butuan City	0	0	75,048	0	81	448	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75,577
12: Naspit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13: Bayugan	0	0	224	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	224
14: San Francisco	0	9,165	1,758	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,923
15: Cagayan de Oro	0	4,153	63,753	0	560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68,466
16: Surigao der Sur	0	0	280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	280
17: Davao del Norte	0	1,790	6,531	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,321
18: Davao City	0	4,648	27,416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32,064
19: Davao Oriental	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20: Rest of Mindanao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	19,756	245,863	0	21,961	448	19,508	879	0	30,749	84,327	0	0	46,864	31,495	0	0	27,285	0	1,680	530,815

Source : Study Team

TABLE 5.1-1(2) O-D MATRIX OF AGRICULTURAL PRODUCTS PASSING C-1

(in kilograms / day)

Origin	Destination 2	3	7	10	11	18	Total
2: Visayas	0	0	0	0	0	1,001	1,001
3: Surigao City	0	0	5,628	3,150	2,667	0	11,446
5: Placer / Sison	0	0	0	0	448	0	448
6: Tubod	0	0	0	952	0	0	952
7: Alegria	0	15,060	5,260	0	0	0	20,320
8: Kitcharao	0	2,464	172	0	0	0	2,636
10: Cabadbaran	0	0	0	0	0	0	0
11: Butuan City	0	3,256	0	0	0	0	3,256
13: Bayugan	0	224	0	0	0	0	224
14: San Francisco	9,165	0	0	0	0	0	9,165
15: Cagayan de Oro	4,153	11,200	0	0	0	0	15,353
16: Surigao der Sur	0	280	0	0	0	0	280
17: Davao del Norte	1,790	6,531	0	0	0	0	8,321
18: Davao City	4,648	24,408	0	0	0	0	29,056
Total	19,756	63,423	11,060	4,102	3,115	1,001	102,457

TABLE 5.1-1(3) O-D MATRIX OF MANUFACTURED FOODSTUFF PASSING C-1

(in kilograms / day)

Origin	Destination 3	7	8	11	15	Total
3: Surigao City	0	3,823	879	4,701	716	10,120
7: Alegria	7,849	0	0	0	0	7,849
8: Kitcharao	1,567	0	0	0	0	1,567
11: Butuan City	45,410	0	0	0	0	45,410
15: Cagayan de Oro	36,532	0	0	0	0	36,532
18: Davao City	151	0	0	0	0	151
Total	91,508	3,823	879	4,701	716	101,628

TABLE 5.1-1(4) O-D MATRIX OF MINERAL OIL PRODUCTS PASSING C-1

(in kilograms / day)

Origin	Destination 3	5	10	15	Total
2: Visayas	0	0	0	6,301	6,301
3: Surigao City	0	0	2,800	0	2,800
10: Cabadbaran	38,165	21,039	0	0	59,205
11: Butuan City	22,939	0	0	0	22,939
15: Cagayan de Oro	0	0	0	0	0
Total	61,105	21,039	2,800	6,301	91,245

TABLE 5.1-1(5) O-D MATRIX OF CONSTRUCTION MATERIALS PASSING C-1

(in kilograms / day)

Origin	Destination 3	5	7	10	11	14	18	Total
3: Surigao City	0	0	0	14,320	57,520	46,864	25,520	144,224
5: Placer / Sison	0	0	0	2,240	0	0	0	2,240
7: Alegria	0	0	4,135	0	0	0	0	4,135
10: Cabadbaran	2,695	0	0	0	0	0	0	2,695
11: Butuan City	560	0	0	0	0	0	0	560
14: San Francisco	0	0	0	0	0	0	0	0
15: Cagayan de Oro	0	560	0	0	0	0	0	560
Total	3,255	560	4,135	16,560	57,520	46,864	25,520	154,414

TABLE 5.1-2(1) ORIGIN-DESTINATION MATRIX OF TOTAL COMMODITY PASSING STATION C-2

Origin	Destination 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1: Metro Manila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2: Visayas	0	0	0	0	0	0	0	0	0	0	0	0	0	538	15,364	0	0	0	15,902
3: Surigao City	0	0	0	0	0	0	0	0	0	0	0	0	14,436	0	0	0	0	0	14,436
4: Cabadbaran	0	0	0	0	40,925	0	0	0	56,006	63,595	0	19,865	0	0	0	0	0	0	179,492
5: Butuan City	0	0	0	26,227	45,734	3,048	0	0	90,032	134,577	14,833	14,454	29,926	120	19,690	0	0	2,134	380,775
6: Nasipit	0	0	0	0	0	0	0	0	10,160	0	10,160	0	0	0	308	0	0	0	20,628
7: Cagayan de Oro	0	0	0	0	0	0	0	0	29,701	3,453	0	73,633	2,366	3,048	38,663	0	0	0	150,864
8: Iligan City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9: Bayugan	0	0	0	99,207	156,063	12,287	35,022	17,079	0	0	0	0	0	0	0	0	0	0	319,658
10: San Francisco	0	0	0	12,192	109,086	4,000	7,218	0	0	0	0	0	0	0	0	0	0	0	132,496
11: Trento	0	0	0	0	19,270	0	0	0	0	0	0	0	0	0	0	0	0	0	19,270
12: Tandag	0	0	401	0	842	10,266	1,016	0	0	0	0	0	0	0	0	0	0	0	12,525
13: Bislig	0	0	8,020	0	16,842	2,032	39,034	0	0	0	0	0	0	0	0	0	0	0	65,928
14: Davao del Norte	0	19,248	0	0	23,470	4,552	18,632	0	0	0	0	0	0	0	0	0	0	0	65,901
15: Davao City	7,218	11,449	12,657	0	59,208	23,193	32,546	0	0	0	0	0	0	0	0	0	0	0	146,270
16: Digos	0	0	3,208	0	0	5,080	0	0	0	0	0	0	0	0	0	0	0	0	8,288
17: Gen. Santos	0	0	0	0	16,226	0	11,495	0	0	0	0	0	0	0	0	0	0	0	27,721
18: Rest of Mindanao	0	10,000	0	0	6,604	0	6,416	0	0	0	0	0	0	0	0	0	0	0	23,020
Total	7,218	40,697	24,286	137,626	493,368	64,457	151,379	17,079	185,899	201,625	24,993	107,952	46,728	3,707	74,025	0	0	2,134	1,563,174

Source : Study Team

TABLE 5.1-2(2) O-D MATRIX OF UNPROCESSED AGRICULTURAL PRODUCTS PASSING C-2

(in kilogram / day)

Origin	Destination 1	2	3	5	6	7	8	9	10	13	14	15	Total
1: Metro Manila	0	0	0	0	0	0	0	0	0	0	0	0	0
2: Visayas	0	0	0	0	0	0	0	0	0	0	538	3,170	3,708
3: Surigao City	0	0	0	0	0	0	0	0	0	0	0	0	0
4: Cabadbaran	0	0	0	0	0	0	0	30	0	0	0	0	30
5: Butuan City	0	0	0	19,437	3,048	0	0	4,939	962	2,246	0	528	31,161
6: Nasipit	0	0	0	0	0	0	0	0	0	0	0	0	0
7: Cagayan de Oro	0	0	0	0	0	0	0	1,767	2,540	842	3,048	10,193	18,390
8: Iligan City	0	0	0	0	0	0	0	0	0	0	0	0	0
9: Bayugan	0	0	0	65,151	12,287	0	17,079	0	0	0	0	0	94,517
10: San Francisco	0	0	0	29,146	4,000	0	0	0	0	0	0	0	33,146
13: Bislig	0	0	6,416	16,842	0	31,922	0	0	0	0	0	0	55,180
14: Davao del Norte	0	0	0	23,470	4,552	0	0	0	0	0	0	0	28,021
15: Davao City	7,218	7,439	3,727	29,724	23,193	15,938	0	0	0	0	0	0	87,239
16: Digos	0	0	0	0	5,080	0	0	0	0	0	0	0	5,080
17: Gen. Santos	0	0	0	5,050	0	0	0	0	0	0	0	0	5,050
18: Rest of Mindanao	0	0	0	6,604	0	6,416	0	0	0	0	0	0	13,020
Total	7,218	7,439	10,143	195,424	52,160	54,276	17,079	6,736	3,502	3,088	3,586	13,892	374,542

TABLE 5.1-2(3) O-D MATRIX OF PROCESSED AGRICULTURAL PRODUCTS PASSING C-2

(in kilogram / day)

Origin	Destination 2	4	5	7	9	10	11	13	18	Total
2: Visayas	0	0	0	0	0	0	0	0	0	0
4: Cabadbaran	0	0	5,080	0	0	0	0	0	0	5,080
5: Butuan City	0	26,227	13,153	0	8,020	4,015	922	1,524	2,134	55,996
7: Cagayan de Oro	0	0	0	0	0	0	0	0	0	0
9: Bayugan	0	0	37,430	1,203	0	0	0	0	0	38,633
10: San Francisco	0	0	48,895	7,218	0	0	0	0	0	56,113
11: Trento	0	0	10,426	0	0	0	0	0	0	10,426
13: Bislig	0	0	0	0	0	0	0	0	0	0
14: Davao del Norte	11,228	0	0	0	0	0	0	0	0	11,228
15: Davao City	0	0	21,790	0	0	0	0	0	0	21,790
18: Rest of Mindanao	0	0	0	0	0	0	0	0	0	0
Total	11,228	26,227	136,774	8,421	8,020	4,015	922	1,524	2,134	199,266

TABLE 5.1-2(4) O-D MATRIX OF MANUFACTURED CONSUMER GOODS PASSING C-2

(in kilogram / day)

Origin	Destination 2	3	5	7	9	10	11	12	13	15	Total
2: Visayas	0	0	0	0	0	0	0	0	0	0	0
3: Surigao City	0	0	0	0	0	0	0	0	0	0	0
5: Butuan City	0	0	8,628	0	58,278	61,030	13,403	6,438	22,600	17,157	187,534
6: Nasipit	0	0	0	0	0	0	0	0	0	308	308
7: Cagayan de Oro	0	0	0	0	24,887	913	0	69,061	1,524	17,345	113,729
9: Bayugan	0	0	9,958	0	0	0	0	0	0	0	9,958
10: San Francisco	0	0	4,064	0	0	0	0	0	0	0	4,064
11: Trento	0	0	0	0	0	0	0	0	0	0	0
12: Tandag	0	401	842	1,016	0	0	0	0	0	0	2,259
13: Bislig	0	1,604	0	0	0	0	0	0	0	0	1,604
14: Davao del Norte	8,020	0	0	0	0	0	0	0	0	0	8,020
15: Davao City	0	802	3,706	234	0	0	0	0	0	0	4,741
16: Digos	0	3,208	0	0	0	0	0	0	0	0	3,208
Total	8,020	6,015	27,198	1,250	83,165	61,943	13,403	75,498	24,124	34,809	335,425

TABLE 5.1-2(5) O-D MATRIX OF FORESTRY PRODUCTS PASSING C-2

(in kilogram / day)

Origin	Destination 4	5	7	9	10	15	Total
4: Cabadbaran	0	0	0	196	0	0	196
5: Butuan City	0	0	0	2,005	4,064	2,005	8,074
7: Cagayan de Oro	0	0	0	0	0	5,537	5,537
9: Bayugan	87,979	35,729	0	0	0	0	123,708
10: San Francisco	12,192	0	0	0	0	0	12,192
11: Trento	0	8,844	0	0	0	0	8,844
13: Bislig	0	0	7,112	0	0	0	7,112
15: Davao City	0	0	0	0	0	0	0
17: Gen. Santos	0	11,176	0	0	0	0	11,176
Total	100,171	55,749	7,112	2,201	4,064	7,542	176,840

TABLE 5.1-2(6) O-D MATRIX OF MINERAL OIL PRODUCTS PASSING C-2

(in kilogram / day)

Origin	Destination 4	9	10	11	12	Total
4: Cabadbaran	0	6,681	8,017	0	19,865	34,563
5: Butuan City	0	12,403	34,206	0	8,017	54,626
6: Nasipit	0	10,160	0	10,160	0	20,320
9: Bayugan	11,228	0	0	0	0	11,228
10: San Francisco	0	0	0	0	0	0
11: Trento	0	0	0	0	0	0
12: Tandag	0	0	0	0	0	0
Total	11,228	29,244	42,223	10,160	27,882	120,737

TABLE 5.1-2(7) O-D MATRIX OF CONSTRUCTION MATERIALS PASSING C-2

(in kilogram / day)

Origin	Destination 2	3	5	6	7	9	10	12	13	15	Total
2: Visayas	0	0	0	0	0	0	0	0	0	0	0
3: Surigao City	0	0	0	0	0	0	0	0	14436	0	14,436
4: Cabadbaran	0	0	34,945	0	0	49,099	55,579	0	0	0	139,623
5: Butuan City	0	0	1,604	0	0	1,143	29,333	0	3556	0	35,636
6: Nasipit	0	0	0	0	0	0	0	0	0	0	0
7: Cagayan de Oro	0	0	0	0	0	3,048	0	4,572	0	5588	13,208
9: Bayugan	0	0	0	0	13,244	0	0	0	0	0	13,244
10: San Francisco	0	0	0	0	0	0	0	0	0	0	0
12: Tandag	0	0	0	10,266	0	0	0	0	0	0	10,266
13: Bislig	0	0	0	0	0	0	0	0	0	0	0
15: Davao City	0	8,128	0	0	16,374	0	0	0	0	0	24,502
18: Rest of Mindanao	10,000	0	0	0	0	0	0	0	0	0	10,000
Total	10,000	8,128	36,549	10,266	29,618	53,290	84,912	4,572	17,992	5,588	260,915

TABLE 5.1-3(1) ORIGIN-DESTINATION MATRIX OF TOTAL COMMODITY PASSING C-3

(in kilogram / day)

Origin	Destination																						Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	19	21	22	23	24	
1: Metro Manila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2: Visayas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,298	0	0	0	2,298
3: Surigao City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12,616	0	0	0	12,616
4: Butuan City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	872	1,875	0	0	0	2,747
5: Cagayan de Oro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57,445	0	3,943	75,492	0	66,476	0	203,355
6: Bayugan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,360	0	0	0	0	0	0	4,360
7: San Francisco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61,378	0	0	0	61,378
8: Bunawan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9: Trento	0	0	0	0	0	0	0	0	0	0	0	0	9,136	0	32,590	14,089	0	24,004	127,342	14,929	0	0	222,090
10: Tandag	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25,664	0	0	0	25,664
11: Bislig	0	0	0	0	0	0	0	0	0	0	0	0	3,837	0	0	17,440	0	0	86,013	0	0	0	107,290
12: Cateel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13: Monkayo	0	0	872	0	0	0	916	0	2,457	0	0	0	12,075	24,120	0	0	0	0	1,930	0	0	0	42,369
14: Compostela	0	0	0	4,824	0	0	0	0	804	0	0	0	804	0	0	0	0	0	0	0	0	0	6,432
15: Nabunturan	0	0	0	7,236	0	0	11,936	0	4,316	0	0	0	23,139	0	0	0	0	0	0	0	0	0	46,627
16: Tagum	0	0	0	33,768	17,424	0	1,918	0	3,276	0	4,020	0	82,321	0	0	0	0	0	0	0	0	0	142,728
17: Asuncion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18: Maco	0	0	0	0	0	0	0	0	0	0	0	0	8,643	0	0	0	0	0	0	0	0	0	8,643
19: Panabo	0	0	0	0	402	0	0	0	4,883	0	0	985	0	0	0	0	0	0	0	0	0	0	6,270
20: Mati	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21: Davao City	0	0	16,119	99,096	42,178	804	37,874	4,824	129,485	24,260	126,029	0	35,513	0	0	0	0	0	0	0	0	0	516,182
22: Digos	0	0	17,440	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17,440
23: Gen. Santos	0	2,180	0	8,584	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,764
24: Rest of Mindanao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	2,180	34,431	153,508	60,004	804	52,644	4,824	145,222	24,260	130,049	985	175,468	24,120	32,590	93,333	0	28,819	394,607	14,929	66,476	0	1,439,253

Source : Study Team

TABLE 5.1-3(2) O-D MATRIX OF AGRICULTURAL PRODUCTS PASSING C-3

(in kilogram / day)

Origin	Destination															Total
	2	3	4	5	7	9	10	11	13	15	16	19	21	22	23	
2: Visayas	0	0	0	0	0	0	0	0	0	0	0	0	2,298	0	0	2,298
3: Surigao City	0	0	0	0	0	0	0	0	0	0	0	0	11,330	0	0	11,330
4: Butuan City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5: Cagayan de Oro	0	0	0	0	0	0	0	0	0	0	1,829	2,616	16,877	0	33,672	54,995
7: San Francisco	0	0	0	0	0	0	0	0	0	0	0	0	22,392	0	0	22,392
9: Trento	0	0	0	0	0	0	0	0	4,824	32,421	11,810	24,004	64,806	14,929	0	152,794
10: Tandag	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11: Bislig	0	0	0	0	0	0	0	0	3,837	0	17,440	0	23,352	0	0	44,629
13: Monkayo	0	0	0	0	916	1,825	0	0	2,744	0	0	0	1,930	0	0	7,415
14: Compostela	0	0	4,824	0	0	0	0	0	0	0	0	0	0	0	0	4,824
15: Nabunturan	0	0	7,236	0	11,936	3,095	0	0	0	0	0	0	0	0	0	22,267
16: Tagum	0	0	3,216	0	872	864	0	4,020	2,195	0	0	0	0	0	0	11,167
19: Panabo	0	0	0	0	0	1,395	0	0	0	0	0	0	0	0	0	1,395
21: Davao City	0	14,671	31,572	3,871	3,652	38,511	3,902	37,063	0	0	0	0	0	0	0	133,243
22: Digos	0	17,440	0	0	0	0	0	0	0	0	0	0	0	0	0	17,440
23: Gen. Santos	2,180	0	8,584	0	0	0	0	0	0	0	0	0	0	0	0	10,764
Total	2,180	32,111	55,432	3,871	17,375	45,691	3,902	41,083	13,600	32,421	31,079	26,620	142,986	14,929	33,672	496,953

TABLE 5.1-3(3) O-D MATRIX OF MANUFACTURED CONSUMER GOODS PASSING C-3

(in kilogram / day)

Origin	Destination												Total
	3	4	5	6	7	9	10	11	13	16	19	21	
3: Surigao City	0	0	0	0	0	0	0	0	0	0	0	1,286	1,286
4: Butuan City	0	0	0	0	0	0	0	0	0	0	872	1,875	2,747
5: Cagayan de Oro	0	0	0	0	0	0	0	0	0	4,360	1,327	3,972	9,658
6: Bayugan	0	0	0	0	0	0	0	0	0	4,360	0	0	4,360
7: San Francisco	0	0	0	0	0	0	0	0	0	0	0	1,642	1,642
9: Trento	0	0	0	0	0	0	0	0	4,224	2,279	0	1,562	8,065
10: Tandag	0	0	0	0	0	0	0	0	0	0	0	0	0
11: Bislig	0	0	0	0	0	0	0	0	0	0	0	18,848	18,848
13: Monkayo	872	0	0	0	0	632	0	0	0	0	0	0	1,504
14: Compostela	0	0	0	0	0	804	0	0	0	0	0	0	804
15: Nabunturan	0	0	0	0	0	523	0	0	0	0	0	0	523
16: Tagum	0	0	0	0	1,046	0	0	0	0	0	0	0	1,046
19: Panabo	0	0	0	0	0	0	0	0	0	0	0	0	0
21: Davao City	0	13,921	804	804	32,365	5,049	9,102	21,518	0	0	0	0	83,563
Total	872	13,921	804	804	33,412	7,009	9,102	21,518	4,224	10,999	2,199	29,185	134,048

TABLE 5.1-3(4) O-D MATRIX OF FORESTRY PRODUCTS PASSING C-3

(in kilogram / day)

Origin	Destination 5	9	13	21	Total
5: Cagayan de Oro	0	0	0	872	872
7: San Francisco	0	0	0	23,753	23,753
9: Trento	0	0	0	54,847	54,847
10: Tandag	0	0	0	12,369	12,369
11: Bislig	0	0	0	37,976	37,976
13: Monkayo	0	0	2,616	0	2,616
15: Nabunturan	0	698	0	0	698
16: Tagum	0	2,412	0	0	2,412
21: Davao City	5,624	0	852	0	6,476
Total	5,624	3,110	3,468	129,817	142,019

TABLE 5.1-3(5) O-D MATRIX OF MINERAL OIL PRODUCTS PASSING C-3

(in kilogram / day)

Origin	Destination 4	5	9	11	12	Total
4: Butuan City	0	0	0	0	0	0
5: Cagayan de O.	0	0	0	0	0	0
9: Trento	0	0	0	0	0	0
11: Bislig	0	0	0	0	0	0
12: Cateel	0	0	0	0	0	0
19: Panabo	0	0	0	0	985	985
21: Davao City	8,720	8,720	27,101	37,547	0	82,088
Total	8,720	8,720	27,101	37,547	985	83,073

TABLE 5.1-3(6) O-D MATRIX OF CONSTRUCTION MATERIALS PASSING C-3

(in kilogram / day)

Origin	Destination 4	8	9	10	11	13	15	21	Total
4: Butuan City	0	0	0	0	0	0	0	0	0
5: Cagayan de Oro	0	0	0	0	0	0	0	2,616	2,616
8: Bunawan	0	0	0	0	0	0	0	0	0
9: Trento	0	0	0	0	0	0	169	0	169
10: Tandag	0	0	0	0	0	0	0	0	0
11: Bislig	0	0	0	0	0	0	0	0	0
13: Monkayo	0	0	0	0	0	6,714	0	0	6,714
15: Nabunturan	0	0	0	0	0	23,139	0	0	23,139
16: Tagum	30,552	0	0	0	0	80,126	0	0	110,678
18: Maco	0	0	0	0	0	8,643	0	0	8,643
19: Panabo	0	0	3,488	0	0	0	0	0	3,488
21: Davao City	44,080	4,824	0	11,256	21,180	32,917	0	0	155,447
Total	74,632	4,824	3,488	11,256	21,180	151,539	169	2,616	310,894

TABLE 5.1-3(7) O-D MATRIX OF MANUFACTURED PRODUCERS GOODS PASSING C-3

(in kilogram / day)

Origin	Destination								Total
	3	4	7	9	11	13	14	21	
3: Surigao City	0	0	0	0	0	0	0	0	0
4: Butuan City	0	0	0	0	0	0	0	0	0
5: Cagayan de Oro	0	0	0	0	0	0	0	30,554	30,554
7: San Francisco	0	0	0	0	0	0	0	0	0
9: Trento	0	0	0	0	0	0	0	2,412	2,412
11: Bislig	0	0	0	0	0	0	0	0	0
13: Monkayo	0	0	0	0	0	0	24,120	0	24,120
14: Compostela	0	0	0	0	0	804	0	0	804
21: Davao City	1,448	804	1,857	58,823	8,720	0	0	0	71,652
Total	1,448	804	1,857	58,823	8,720	804	24,120	32,966	129,541

TABLE 5.1-4(1) ORIGIN-DESTINATION MATRIX OF TOTAL COMMODITY PASSING C-4

(in kilogram / day)

Origin	Destination																			Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1: M. Manila/Visayas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2: Surigao City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	162,700	0	0	0	162,700
3: Butuan City	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	152,701	0	43,594	0	196,295
4: Cagayan de Oro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	403,356	46,512	100,053	0	549,922
5: San Francisco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	159,335	0	0	0	159,335
6: Trento	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	142,538	0	0	0	142,538
7: Tandag / Bislig	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	247,385	9,480	0	0	256,865
8: Monkayo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49,774	0	0	0	49,774
9: Nabunturan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	264,109	0	0	0	264,109
10: Tagum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,330,301	33,778	0	0	1,364,079
11: Sto. Tomas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	529,342	0	0	0	529,342
12: Maco	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	187,933	0	0	0	187,933
13: Cateel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11,683	0	0	0	11,683
14: Mati	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	398,930	0	0	0	398,930
15: Panabo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14,220	2,554,865	0	216	28,630	2,597,931
16: Davao City	0	82,366	247,254	200,932	51,892	99,655	146,410	48,433	466,924	1,842,779	150,966	72,025	22,363	466,315	810,810	0	0	0	0	4,711,124
17: Digos	0	0	0	0	0	0	0	0	18,960	2,970	0	0	0	0	42,756	0	0	0	0	64,686
18: Gen. Santos	7,128	0	13,538	66,618	0	0	0	0	0	19,150	0	0	0	0	25,760	0	0	0	0	132,194
19: Rest of Mindanao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	7,128	82,366	260,792	267,550	51,892	99,655	146,410	48,433	485,884	1,864,899	150,966	72,025	22,363	466,315	893,546	6,594,953	89,770	143,863	28,630	11,779,441

Source : Study Team

TABLE 5.1-4(2) O-D MATRIX OF UNPROCESSED AGRICULTURAL PRODUCTS PASSING C-4

(in kilogram / day)

Origin	Destination												
	2	3	7	9	10	11	12	13	14	15	16	19	Total
2: Surigao City	0	0	0	0	0	0	0	0	0	0	63,667	0	63,667
3: Butuan City	0	0	0	0	0	0	0	0	0	0	14,220	0	14,220
5: San Francisco	0	0	0	0	0	0	0	0	0	0	43,271	0	43,271
6: Trento	0	0	0	0	0	0	0	0	0	0	35,160	0	35,160
7: Tandag / Bislig	0	0	0	0	0	0	0	0	0	0	114,708	0	114,708
8: Monkayo	0	0	0	0	0	0	0	0	0	0	40,781	0	40,781
9: Nabunturan	0	0	0	0	0	0	0	0	0	0	77,819	0	77,819
10: Tagum	0	0	0	0	0	0	0	0	0	0	358,763	0	358,763
11: Sto. Tomas	0	0	0	0	0	0	0	0	0	0	391,881	0	391,881
12: Maco	0	0	0	0	0	0	0	0	0	0	161,679	0	161,679
13: Cateel	0	0	0	0	0	0	0	0	0	0	0	0	0
14: Mati	0	0	0	0	0	0	0	0	0	0	127,601	0	127,601
15: Panabo	0	0	0	0	0	0	0	0	0	0	439,712	28,440	468,152
16: Davao City	21,384	76,959	3,792	28,127	193,105	6,120	4,740	8,219	53,672	52,704	0	0	448,821
17: Digos	0	0	0	0	0	0	0	0	0	4,740	0	0	4,740
18: Gen. Santos	0	13,538	0	0	15,358	0	0	0	0	3,982	0	0	32,878
19: Rest of Mindanao	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	21,384	90,497	3,792	28,127	208,462	6,120	4,740	8,219	53,672	61,425	1,869,262	28,440	2,384,140

TABLE 5.1-4(3) O-D MATRIX OF PROCESSED AGRICULTURAL PRODUCTS PASSING C-4

(in kilogram / day)

Origin	Destination										
	5	8	9	10	11	12	14	15	16	18	Total
3: Butuan City	0	0	0	0	0	0	0	0	36,700	43,243	79,943
4: Cagayan de Oro	0	0	0	0	0	0	0	0	79,316	81,163	160,479
5: San Francisco	0	0	0	0	0	0	0	0	0	0	0
7: Tandag / Bislig	0	0	0	0	0	0	0	0	29,436	0	29,436
8: Monkayo	0	0	0	0	0	0	0	0	0	0	0
9: Nabunturan	0	0	0	0	0	0	0	0	21,852	0	21,852
10: Tagum	0	0	0	0	0	0	0	0	159,652	0	159,652
11: Sto. Tomas	0	0	0	0	0	0	0	0	46,807	0	46,807
12: Maco	0	0	0	0	0	0	0	0	0	0	0
14: Mati	0	0	0	0	0	0	0	0	72,930	0	72,930
15: Panabo	0	0	0	0	0	0	0	14,220	126,328	0	140,548
16: Davao City	36,214	10,902	33,916	226,790	33,858	2,929	47,340	102,395	0	0	494,344
17: Digos	0	0	18,960	0	0	0	0	0	0	0	18,960
18: Gen. Santos	0	0	0	0	0	0	0	0	0	0	1,224,951
Total	36,214	10,902	52,876	226,790	33,858	2,929	47,340	116,615	573,021	124,406	2,449,903

TABLE 5.1-4(4) O-D MATRIX OF MANUFACTURED CONSUMER GOODS PASSING C-4

(in kilogram / day)

Origin	Destination 1	3	4	5	6	7	8	9	10	11	12	14	15	16	17	18	Total
3: Butuan City	0	0	0	0	0	0	0	0	0	0	0	0	0	8,153	0	351	8,504
4: Cagayan de Oro	0	0	0	0	0	0	0	0	0	0	0	0	0	277,786	46,512	0	324,298
5: San Francisco	0	0	0	0	0	0	0	0	0	0	0	0	0	41,166	0	0	41,166
6: Trento	0	0	0	0	0	0	0	0	0	0	0	0	0	16,763	0	0	16,763
8: Monkayo	0	0	0	0	0	0	0	0	0	0	0	0	0	1,865	0	0	1,865
10: Tagum	0	0	0	0	0	0	0	0	0	0	0	0	0	77,525	0	0	77,525
14: Mati	0	0	0	0	0	0	0	0	0	0	0	0	0	3,018	0	0	3,018
15: Panabo	0	0	0	0	0	0	0	0	0	0	0	0	0	102,083	0	0	102,083
16: Davao City	0	64,144	24,292	7,362	5,512	52,507	1,711	18,248	593,739	5,948	1,450	89,698	189,275	0	0	0	1,053,887
17: Digos	0	0	0	0	0	0	0	0	2,970	0	0	0	38,016	0	0	0	40,986
18: Gen. Santos	7,128	0	66,618	0	0	0	0	0	0	0	0	0	0	0	0	0	73,746
Total	7,128	64,144	90,910	7,362	5,512	52,507	1,711	18,248	596,709	5,948	1,450	89,698	227,291	528,359	46,512	351	1,743,841

TABLE 5.1-4(5) O-D MATRIX OF FORESTRY PRODUCTS PASSING C-4

(in kilogram / day)

Origin	Destination 4	10	11	15	16	17	18	Total
2: Surigao City	0	0	0	0	11,376	0	0	11,376
3: Butuan City	0	0	0	0	31,398	0	0	31,398
6: Trento	0	0	0	0	72,264	0	0	72,264
7: Tandag / Bislig	0	0	0	0	79,255	9,480	0	88,735
8: Monkayo	0	0	0	0	7,128	0	0	7,128
9: Nabunturan	0	0	0	0	163,892	0	0	163,892
10: Tagum	0	0	0	0	45,188	0	0	45,188
13: Cateel	0	0	0	0	3,792	0	0	3,792
14: Mati	0	0	0	0	113,305	0	0	113,305
15: Panabo	0	0	0	0	18,925	0	216	19,141
16: Davao City	56,928	5,341	3,564	33,264	0	0	0	99,097
Total	56,928	5,341	3,564	33,264	546,522	9,480	216	655,315

TABLE 5.1-4(6) O-D MATRIX OF MINERAL OIL PRODUCTS PASSING C-4

(in kilogram / day)

Origin	Destination 2	6	7	9	10	11	12	14	15	16	Total
3: Butuan City	0	0	0	0	0	0	0	0	0	3,089	3,089
10: Tagum	0	0	0	0	0	0	0	0	0	30,650	30,650
15: Panabo	0	0	0	0	0	0	0	0	0	18,960	18,960
16: Davao City	27,718	31,659	70,022	111,521	320,237	2,851	34,759	140,757	98,749	0	838,274
Total	27,718	31,659	70,022	111,521	320,237	2,851	34,759	140,757	98,749	52,699	890,974

TABLE 5.1-4(7) O-D MATRIX OF CONSTRUCTION MATERIALS PASSING C-4

(in kilogram / day)

Origin	Destination 2	3	4	5	6	7	8	9	10	11	13	14	15	16	Total
2: Surigao City	0	0	0	0	0	0	0	0	0	0	0	0	0	85,536	85,536
3: Butuan City	0	0	0	0	0	0	0	0	0	0	0	0	0	54,886	54,886
10: Tagum	0	0	0	0	0	0	0	0	0	0	0	0	0	431,179	431,179
12: Maco	0	0	0	0	0	0	0	0	0	0	0	0	0	26,255	26,255
14: Mati	0	0	0	0	0	0	0	0	0	0	0	0	0	18,960	18,960
15: Panabo	0	0	0	0	0	0	0	0	0	0	0	0	0	1,719,062	1,719,062
16: Davao City	14,256	45,619	46,180	8,316	19,008	20,050	22,752	135,991	204,853	50,345	14,144	133,056	162,066	0	876,637
Total	14,256	45,619	46,180	8,316	19,008	20,050	22,752	135,991	204,853	50,345	14,144	133,056	162,066	2,335,878	3,212,515

TABLE 5.1-4(8) O-D MATRIX OF MANUFACTURED PRODUCERS GOODS PASSING C-4

(in kilogram / day)

Origin	Destination 2	3	6	7	8	9	10	11	12	14	15	16	Total
4: Cagayan de Oro	0	0	0	0	0	0	0	0	0	0	0	10,391	10,391
9: Nabunturan	0	0	0	0	0	0	0	0	0	0	0	190	190
10: Tagum	0	0	0	0	0	0	0	0	0	0	0	8,797	8,797
11: Sto. Tomas	0	0	0	0	0	0	0	0	0	0	0	78,774	78,774
14: Mati	0	0	0	0	0	0	0	0	0	0	0	56,880	56,880
15: Panabo	0	0	0	0	0	0	0	0	0	0	0	84,650	84,650
16: Davao City	19,008	60,532	43,476	38	13,068	104,129	295,605	47,995	27,577	3,792	113,082	0	728,302
18: Gen. Santos	0	0	0	0	0	0	3,792	0	0	0	2,771	0	6,563
Total	19,008	60,532	43,476	38	13,068	104,129	299,397	47,995	27,577	3,792	115,853	239,682	974,546

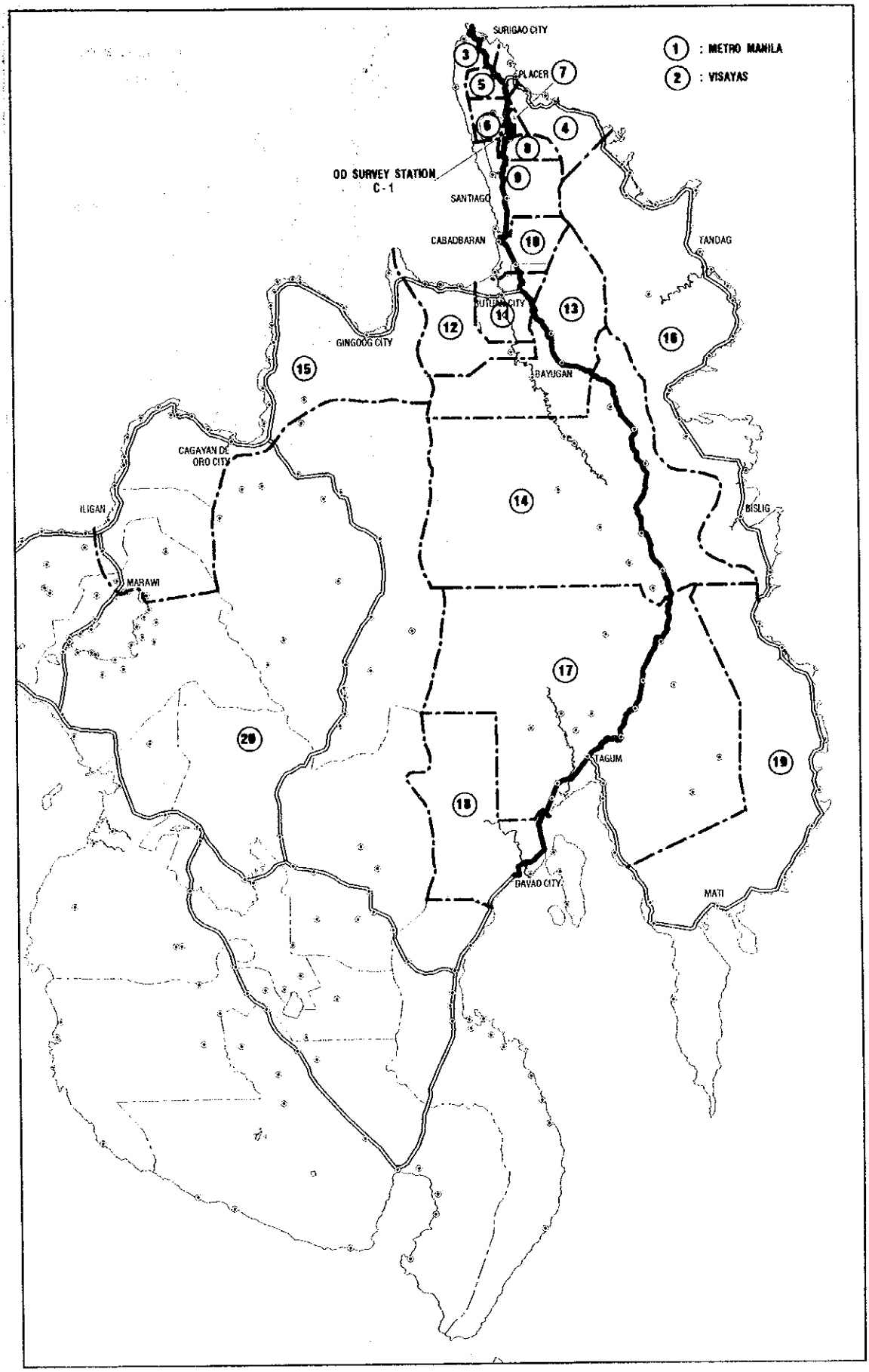


FIGURE 5.1-1 TRAFFIC ZONES
(OD SURVEY STATION C-1)

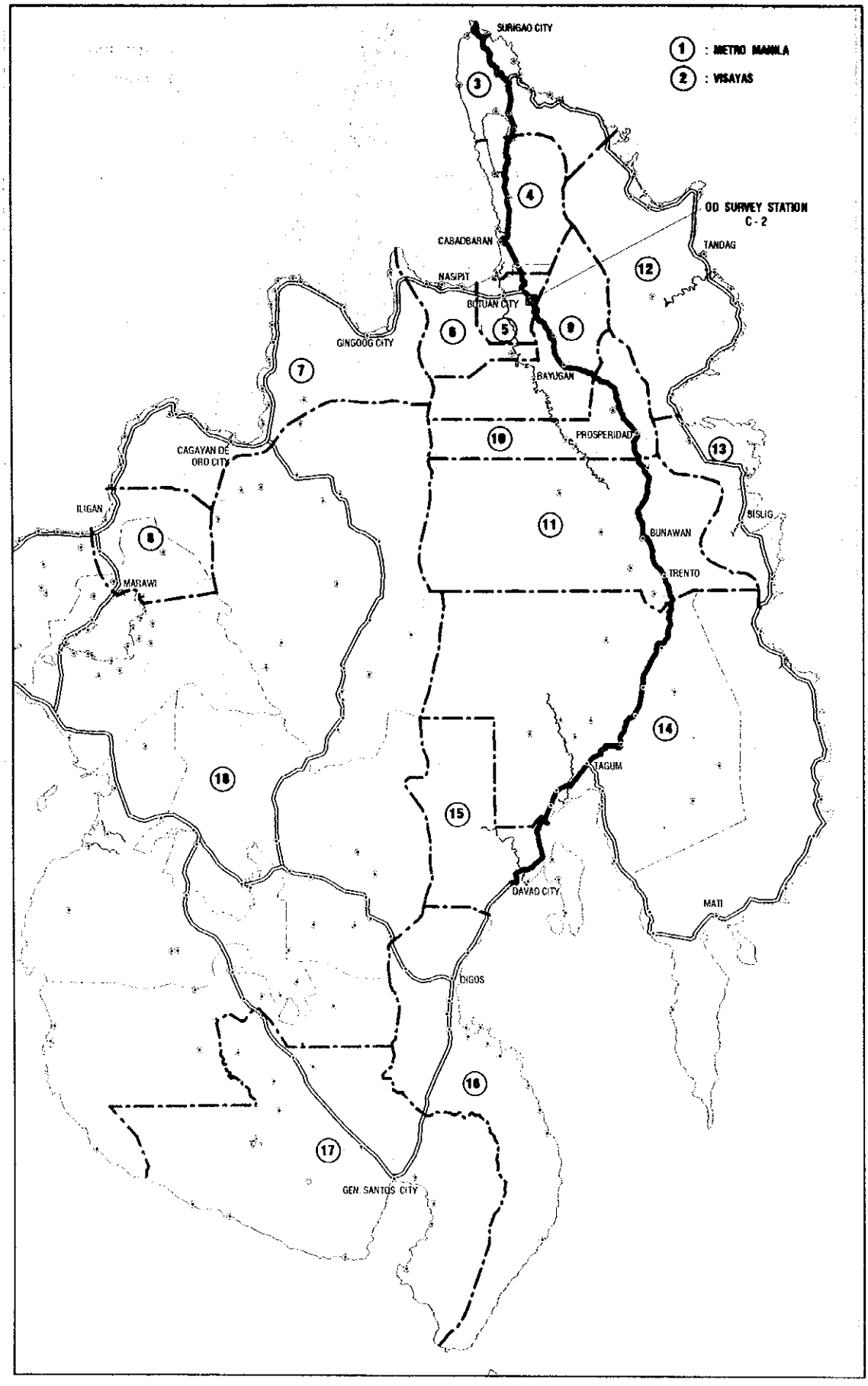


FIGURE 5.1-2 TRAFFIC ZONES
(OD SURVEY STATION C-2)

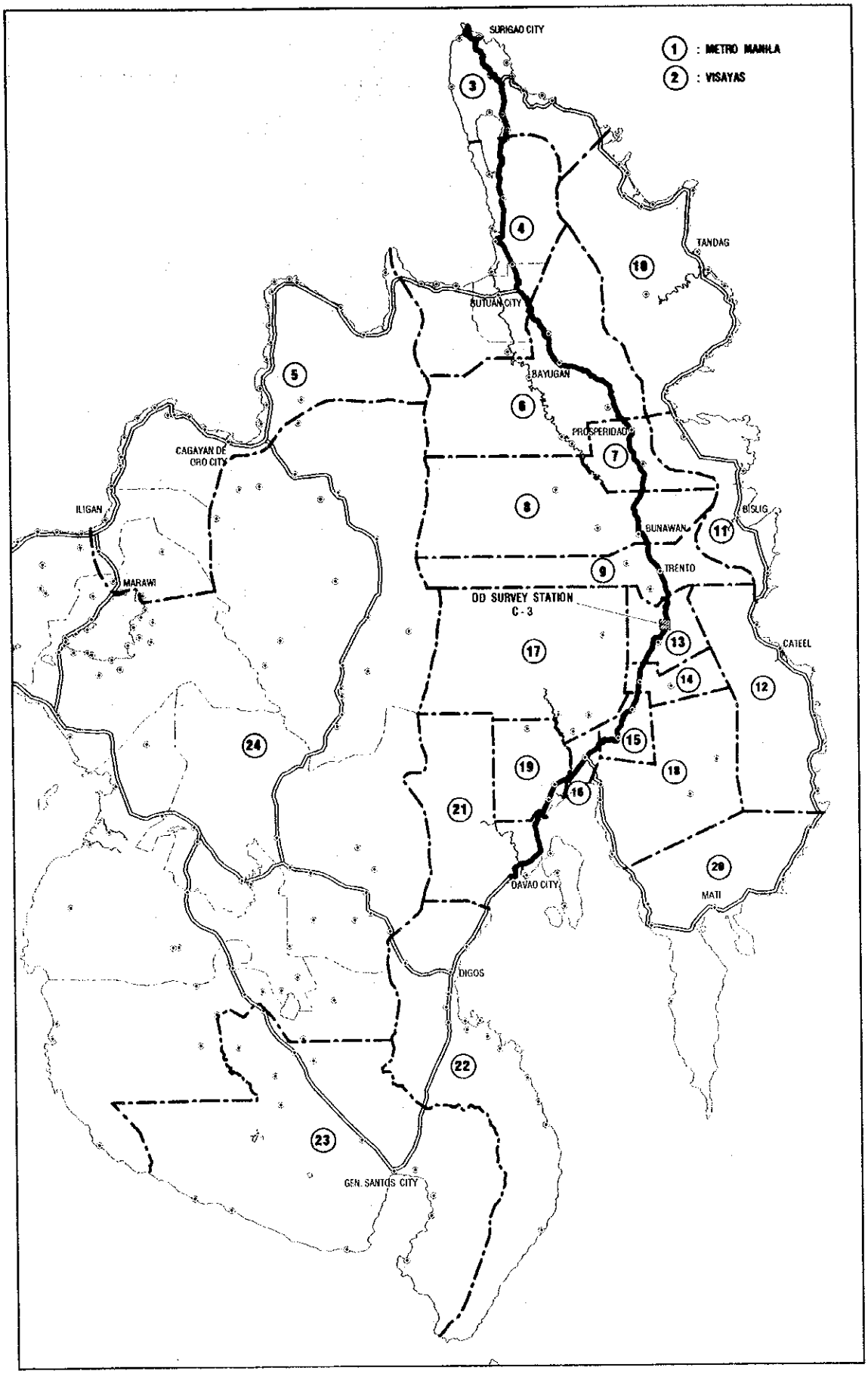


FIGURE 5.1-3 TRAFFIC ZONES
(OD SURVEY STATION C-3)

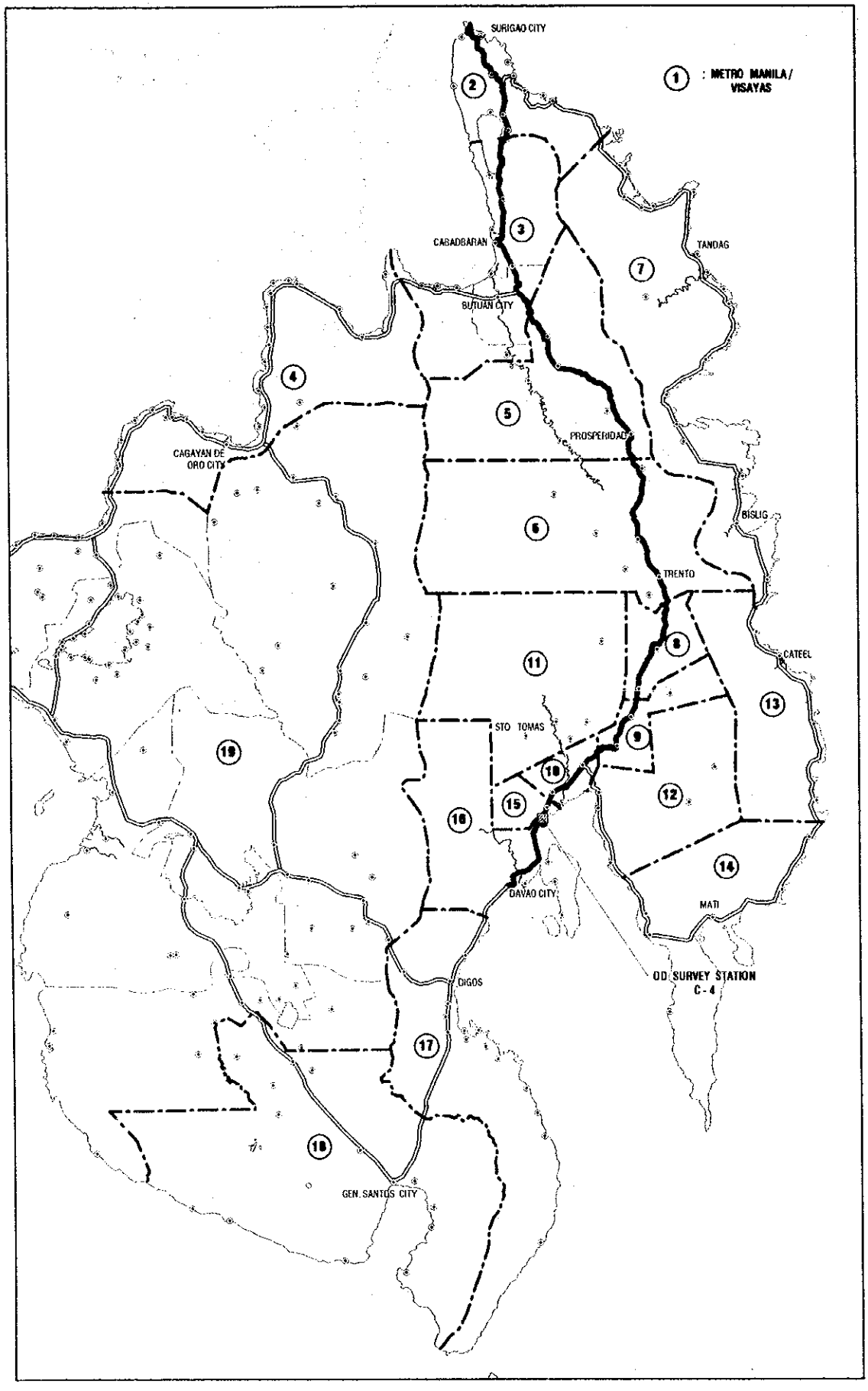


FIGURE 5.1-4 TRAFFIC ZONES
(OD SURVEY STATION C-4)

APPENDIX 5.2

AXLE LOAD

1) Number of Vehicles Weighed and Sampling Rate.

Number of trucks and buses weighed at each survey station is shown in Table 5.2-1. Sampling rate at each survey station is shown in Table 5.2-2. Empty truck ratio which was obtained by the commodity OD survey for each survey station is presented in Table 5.2-3. Above results are summarized as follows:

Survey Station	Location (Boundary at)	No. of Trucks Weighed (Both Directions)	Samplin Rate (Both Directions)	Empty Truck Ratio (Both Directions)	No.of Buses Weighed (Both Directions)
L - 1	Surigao del Norte/Agusan del Norte	242	93%	35%	79
L - 2	Butuan City/ Agusan del Sur	508	76%	45%	85
L - 3	Agusan del Sur/ Davao del Norte	402	78%	48%	82
L - 4	Davao del Norte/ Davao City	942	42%	32%	58

2) Axle Load Distribution

The axle load distribution of loaded trucks for the survey stations L-1, L-2, L-3 and L-4 is shown in Figures 5.2-1, 5.2-2, 5.2-3 and 5.2-4, respectively.

Maximum axle load observed at each surveys station is as follows:

Survey Station	Maximum Axle Load Observed	
	Single Axle	Tandem Axle
L-1	15.8	29.8
L-2	14.0	28.8
L-3	15.4	30.8
L-4	16.5	31.0
Legal Limit	8.0 tons	14.5 tons

TABLE 5.2-1 NUMBER OF VEHICLE WEIGHED

Survey Station	Vehicle Type	South Bound			North Bound			Total		
		Empty	Loaded	Total	Empty	Loaded	Total	Empty	Loaded	Total
L - 1	Truck (2-Axle)	51	33	84	15	79	94	66	112	178
	Truck (3-Axle)	15	17	32	6	14	20	21	31	52
	Truck Trailer	0	0	0	0	0	0	0	0	0
	Semi Trailer	2	5	7	3	2	5	5	7	12
	Total	68	55	123	24	95	119	92	150	242
	Bus	-	-	38	-	-	41	-	-	79
L - 2	Truck (2-Axle)	94	107	201	73	96	169	167	203	370
	Truck (3-Axle)	50	21	71	18	26	44	68	47	115
	Truck Trailer	0	0	0	0	0	0	0	0	0
	Semi Trailer	8	3	11	2	10	12	10	13	23
	Total	152	131	283	93	132	225	245	263	508
	Bus	-	-	41	-	-	44	-	-	85
L - 3	Truck (2-Axle)	62	78	140	63	78	141	125	156	281
	Truck (2-Axle)	18	21	39	14	34	48	32	55	87
	Truck Trailer	0	0	0	0	0	0	0	0	0
	Semi Trailer	9	11	20	10	4	14	19	15	34
	Total	89	110	199	87	116	203	176	226	402
	Bus	-	-	33	-	-	49	-	-	82
L - 4	Truck (2-Axle)	51	163	214	70	210	280	121	373	494
	Truck (2-Axle)	38	125	163	105	95	200	143	220	363
	Truck Trailer	0	0	0	0	0	0	0	0	0
	Semi Trailer	14	27	41	9	35	44	23	62	85
	Total	103	315	418	184	340	524	287	655	942
	Bus	-	-	48	-	-	10	-	-	58

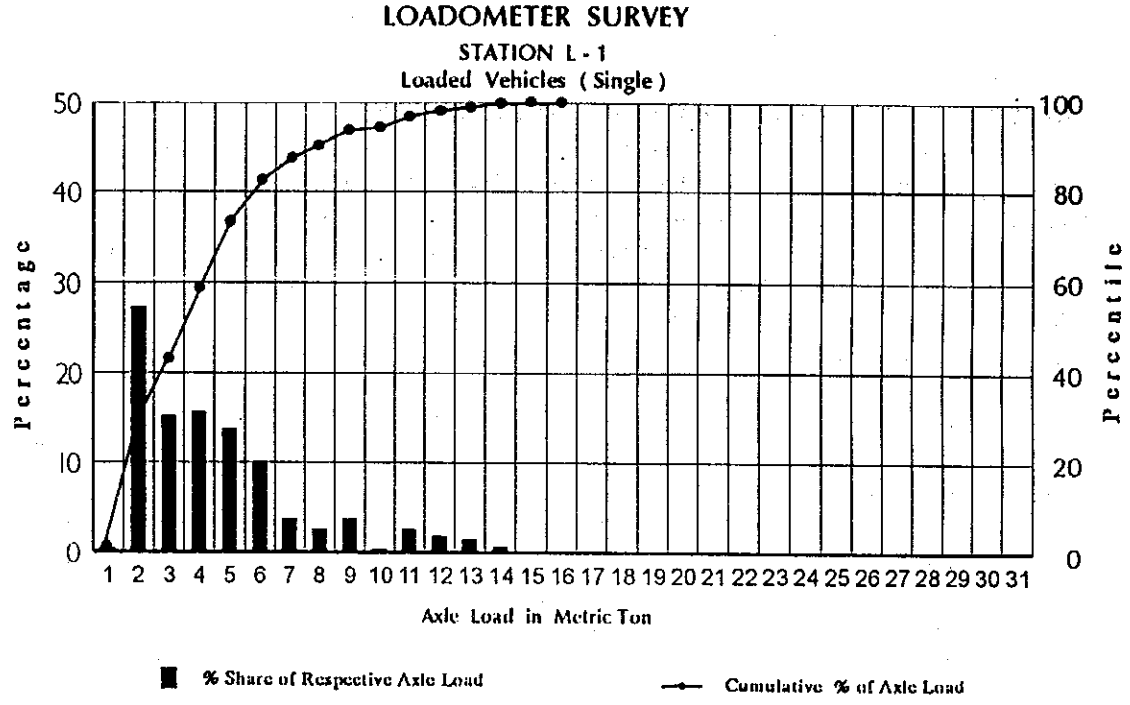
Note: L - 1 : Boundary Between Surigao del Norte and Agusan del Norte
L - 2 : Boundary Between Butuan City and Agusan del Sur
L - 3 : Boundary Between Agusan del Sur and Davao del Norte
L - 4 : Boundary Between Davao del Norte and Davao City

TABLE 5.2-2 SAMPLING RATE OF WEIGHTED VEHICLES

Survey Station	Direction	No. of Vehicles Passed during 2 days between 6:00 A.M. and 6:00 P.M.		No. of Vehicles Weighed during 2 days between 6:00 A.M. and 6:00 P.M.		Sampling Rate	
		Trucks	Buses	Trucks	Buses	Trucks	Buses
L-1	South Bound	128	57	123	38	96	67
	North Bound	131	67	119	41	91	61
	Total	259	124	242	79	93	64
L-2	South Bound	402	133	283	41	70	31
	North Bound	266	139	225	44	85	32
	Total	668	272	508	85	76	31
L-3	South Bound	289	152	199	33	69	22
	North Bound	228	128	203	49	89	38
	Total	517	280	402	82	78	29
L-4	South Bound	1,074	686	418	48	39	7
	North Bound	1,187	575	524	10	44	2
	Total	2,261	1,261	942	58	42	5

TABLE 5.2-3 EMPTY TRUCK RATIO OBTAINED BY COMMODITY OD SURVEY

Survey Station	Direction	Number of Trucks			Empty Truck Ratio (%)
		Empty	Loaded	Total	
L-1	South Bound	41	36	77	53.2
	North Bound	13	63	76	17.1
	Total	54	99	153	35.3
L-2	South Bound	132	130	262	50.4
	North Bound	77	123	200	38.5
	Total	209	253	462	45.2
L-3	South Bound	95	83	178	53.3
	North Bound	74	103	177	41.8
	Total	169	186	355	47.6
L-4	South Bound	289	728	1,017	28.4
	North Bound	395	698	1,093	36.1
	Total	684	1,426	2,110	32.4



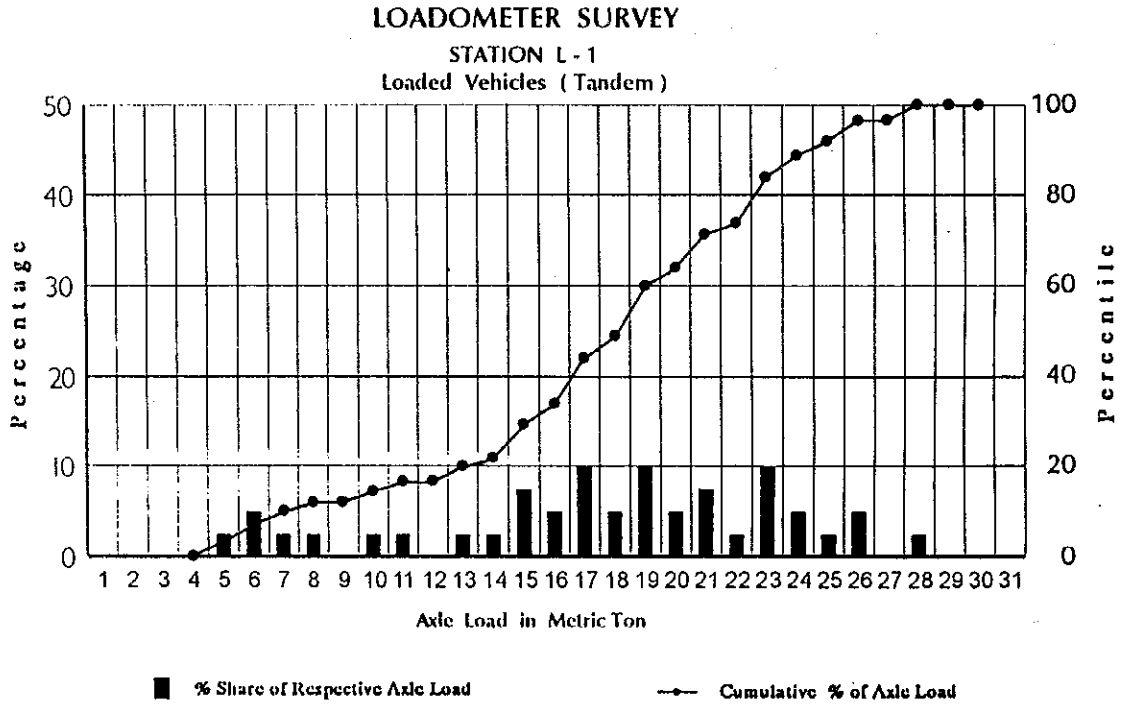
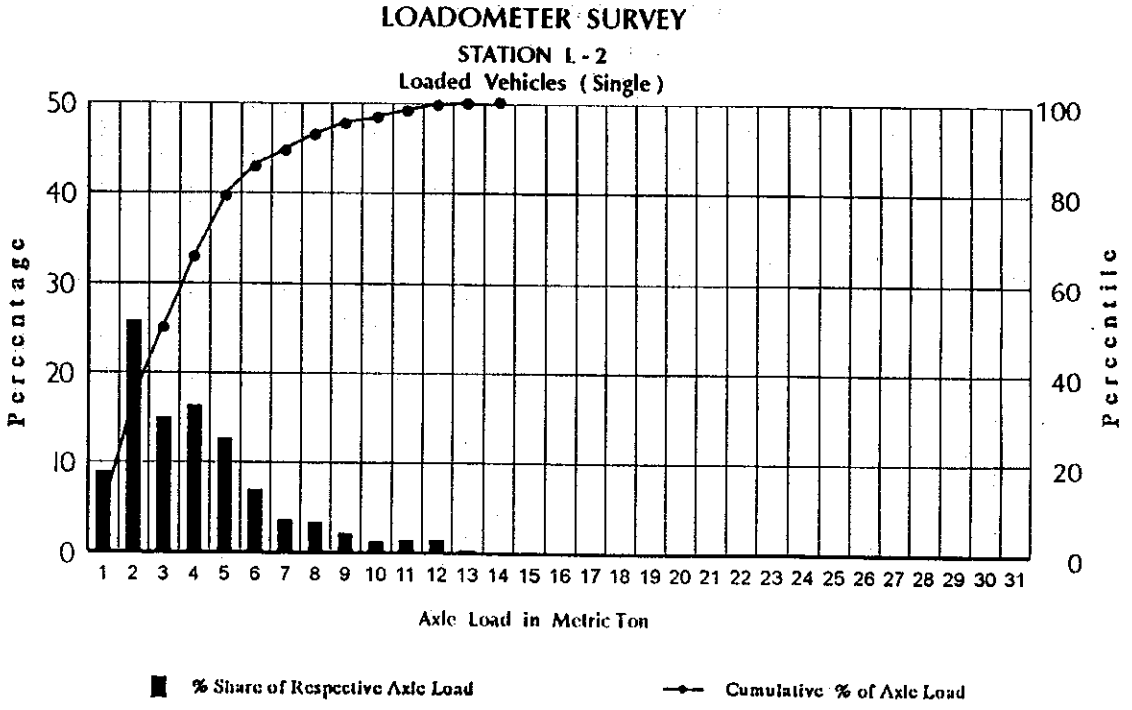


FIGURE 5.2-1 AXLE LOAD DISTRIBUTION PATTERN AT SURVEY STATION L-1



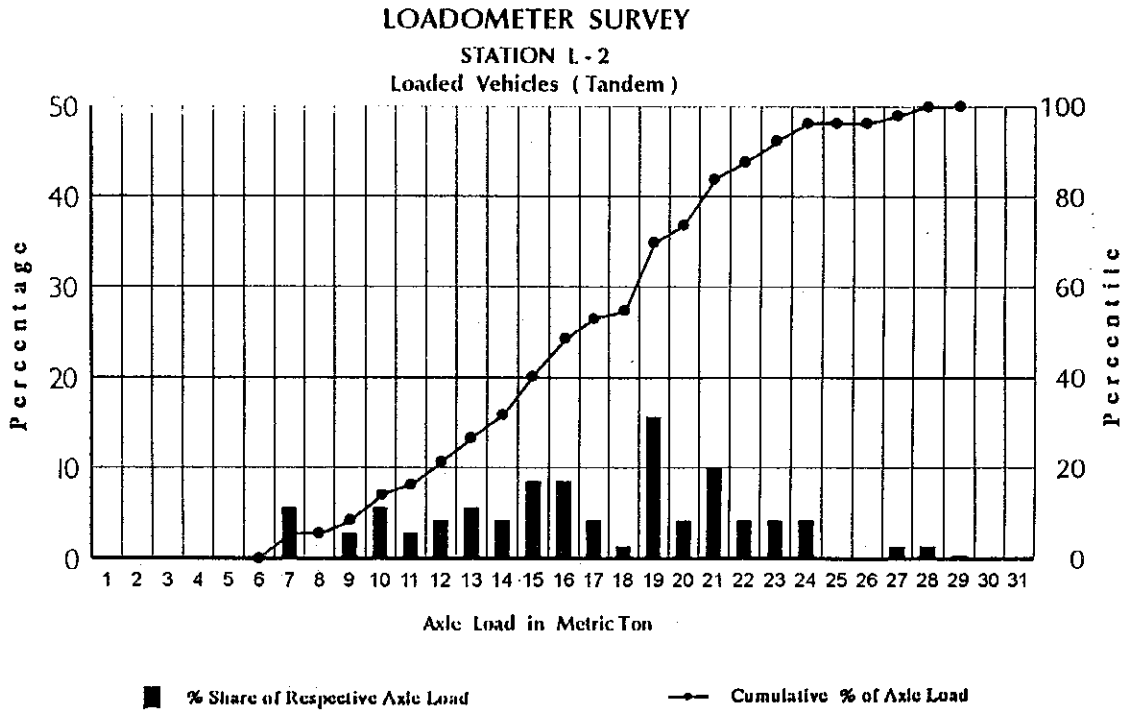
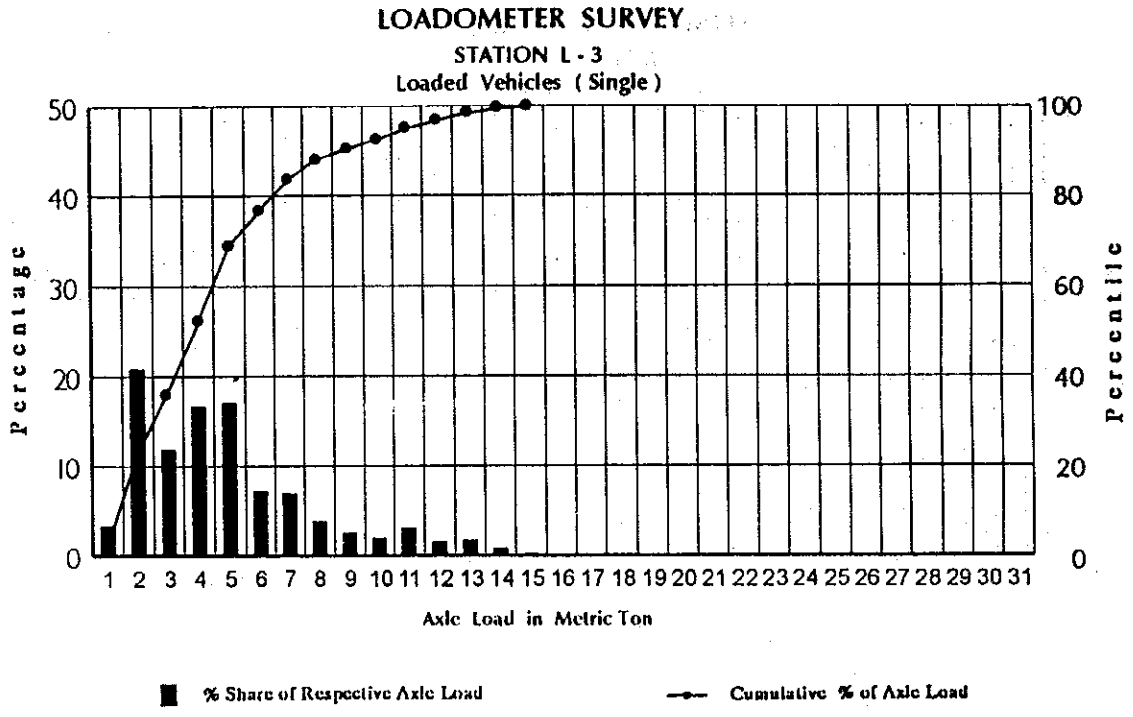


FIGURE 5.2-2 AXLE LOAD DISTRIBUTION PATTERN AT SURVEY STATION L-2



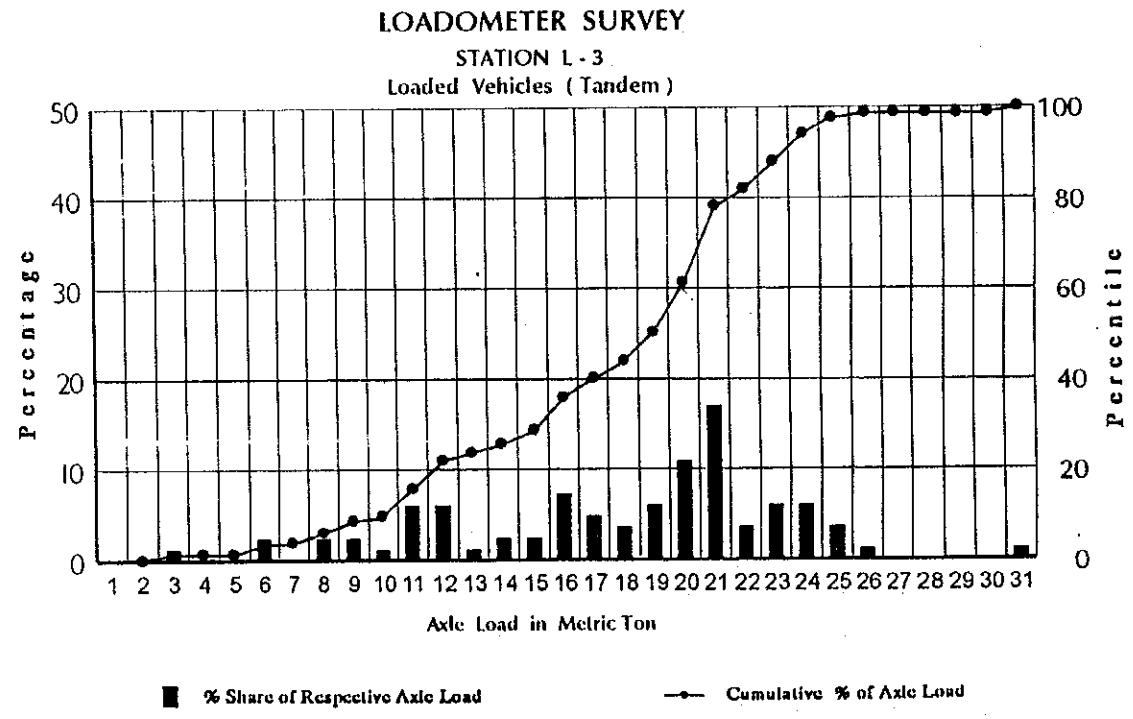
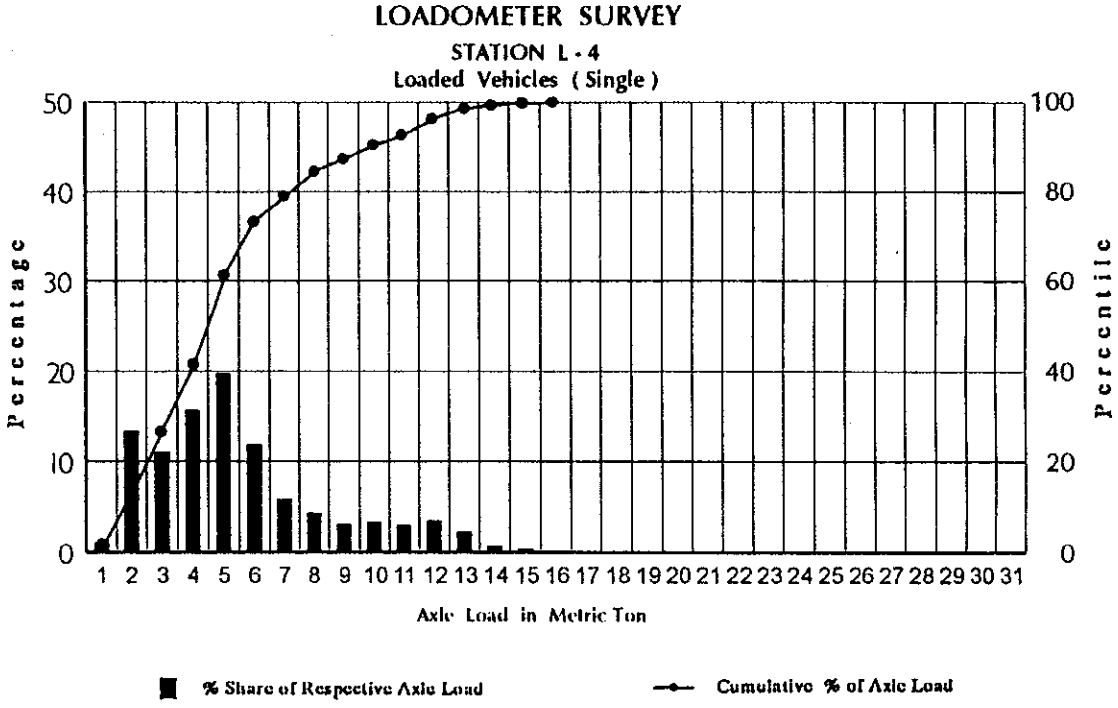


FIGURE 5.2-3 AXLE LOAD DISTRIBUTION PATTERN AT SURVEY STATION L-3



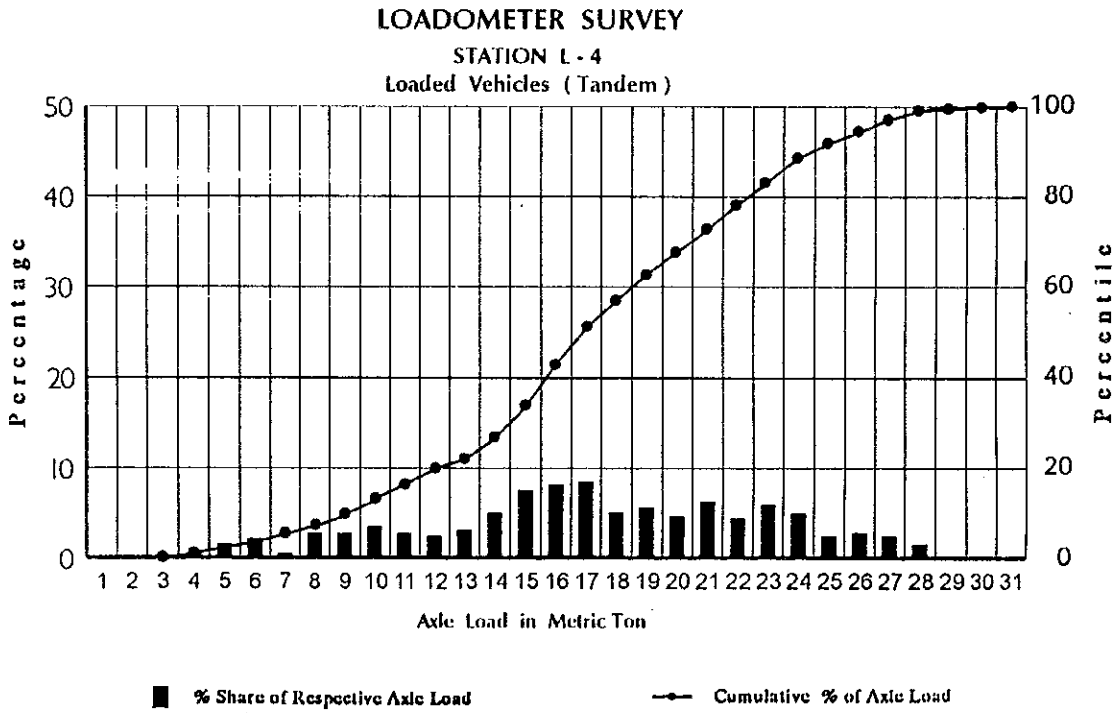


FIGURE 5.2-4 AXLE LOAD DISTRIBUTION PATTERN AT SURVEY STATION L-4

APPENDICES FOR CHAPTER 8

APPENDIX 8.1

FIELD SURVEY FORMS USED FOR THE STUDY

TABLE 8.1-1

FEASIBILITY STUDY ON PAN-PHILIPPINE HIGHWAY
REHABILITATION PROJECT (MINDANAO SECTION)

ROAD REFERENCING SYSTEM SURVEY

Road Link No. ☐☐ Sheet No. ☐ Survey Date ☐☐ ☐☐☐

Road Link Name : From

To

Region No. ☐☐ Province Name ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

RM No.	RM TYPE	REFERENCE MARKER (RM) DESCRIPTION	ODOMETER READING (Km.)	Remark

REFERENCE MARKER TYPE

S	- Start Road Link	K	- Kilometre Post	R	- Regional Boundary
E	- End Road Link	I	- Road Intersection	P	- Provincial Boundary
O	- Others	B	- Bridge	D	- District/City Boundary

REMARKS

PRP- Recommended Permanent Reference Point
SB - Survey Breaks
Z - Obstruction to line of drive

Sketch : Starting Point

Sketch : End Point

TABLE 8.1-2

VISUAL INSPECTION **SURVEY SHEET NO. 1**

General Road Condition Survey

Sheet No. : _____
Survey Date : _____
: _____

Road Link No. ☐☐

Km.	Section	General				South Bound (to Davao City)									North Bound (to Lipata Terminal)								
						Shoulder				Surface Drainage					Shoulder				Surface Drainage				
		Topography	Cross Section Type	Sharp Curve (No.)	Vertical Gradient	Width (m)	Material	Drop Off/or Heave (m)	Scoured (m)	No Ditch (m)	Earth (m)	Riprap (m)	Concrete (m)	Land Use	Width (m)	Material	Drop Off/or Heave (m)	Scoured (m)	No Ditch (m)	Earth (m)	Riprap (m)	Concrete (m)	Land Use
☐☐☐☐	0 - 100							D: H:									D: H:						
	100 - 200							D: H:									D: H:						
	200 - 300							D: H:									D: H:						
	300 - 400							D: H:									D: H:						
	400 - 500							D: H:									D: H:						
	500 - 600							D: H:									D: H:						
	600 - 700							D: H:									D: H:						
	700 - 800							D: H:									D: H:						
	800 - 900							D: H:									D: H:						
☐☐☐☐	900 -							D: H:									D: H:						

Topography
1. Flat
2. Rolling
3. Mountainous

Cross Section Type
1. Flat
2. Cut (⌐)
3. Embankment (⌐)
4. Cut/Embankment (⌐)
5. Cut/Embankment (⌐)
(South Bound View)

Vertical Gradient
1. Less than 3%
2. 3 to 5 %
3. 5 to 7 %
+: Up
−: Down

Shoulder
1. Earth
2. Gravel
3. Concrete

Land Use
1. Rice Field
2. Plowed Field
3. Coconut Field
4. Forest
5. Waste Land
6. Swampy Area
7. Residential/Commercial Area

TABLE 8.1-3

VISUAL INSPECTION | SURVEY SHEET NO. 2

Pavement Distress Survey

Sheet No. : _____
Survey Date : _____
: _____

Road Link No. ☐☐

App. 8.1-3

Section	Pavement Type	Pavement Width (m)	South Bound (to Davao City)													North Bound (to Lipata Terminal)												
			Pavement Slab Under Reconstruction (m.)	Cracks (m.)					Patching (m^2)	Scaling (m^2)	Depression (No.)	Pumping/Water Bleeding (No.)	AC Overlay Removed (m^2)	Pothole (No.)	Uneven Surface (m)	Pavement Slab Under Reconstruction (m.)	Cracks (m.)					Patching (m^2)	Scaling (m^2)	Depression (No.)	Pumping/Water Bleeding (No.)	AC Overlay Removed (m^2)	Pothole (No.)	
				Transverse	Longitudinal	Corner	Block/Alligator	Total									Transverse	Longitudinal	Corner	Block/Alligator	Total							
Km. ☐☐☐☐ 0-100																												
100-200																												
200-300																												
300-400																												
400-500																												
500-600																												
600-700																												
700-800																												
800-900																												
Km. ☐☐☐☐ 900-																												

Pavement Type

1. PCC
2. AC Overlayed PCC
3. Gravel

TABLE 8.1-4

INDIVIDUAL PRESENT SERVICEABILITY RATING

DIRECTION SOUTH BOUND (To Davao City)

ROAD LINK NO. ____________

DATE ____________

NAME OF RATER ____________

VEHICLE ____________

<table>
<tr><th rowspan="2"></th><th rowspan="2">SECTION</th><th colspan="5">SURFACE CONDITION RATING</th><th colspan="3">ACCEPTABLE ?</th></tr>
<tr><th>Very Good
5.0 – 4.0</th><th>Good
4.0 – 3.0</th><th>Fair
3.0 – 2.0</th><th>Poor
2.0 – 1.0</th><th>Very Poor
1.0 – 0.0</th><th>Yes</th><th>No</th><th>Un–decided</th></tr>
<tr><td>KM</td><td>0 – 200</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>200 – 400</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td>600 – 800</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>KM</td><td>800 –</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>KM</td><td>800 –</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td></td><td>600 – 800</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>KM</td><td>800 –</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Points	Surface Condition	
5.0 – 4.0	Very Good	– Very Comfortable
4.0 – 3.0	Good	– Comfortable
3.0 – 2.0	Fair	– Satisfactory
2.0 – 1.0	Poor	– Uncomfortable
1.0 – 0.0	Very Poor	– Very Uncomfortable

TABLE 8.1-5

INDIVIDUAL REHABILITATION REQUIREMENT RATING

DIRECTION SOUTH BOUND (To Davao City)
ROAD LINK NO. ____________________

DATE ____________________
NAME OF RATER ____________________
VEHICLE ____________________

	SECTION	SURFACE CONDITION RATING 5.0 – 4.0	4.0 – 3.0	3.0 – 2.0	2.0 – 1.0	1.0 – 0.0	ACCEPTABLE ? Yes	No	Un-decided
KM	0 – 200								
	200 – 400								
	400 – 600								
	600 – 800								
	800 –								
KM	0 – 200								
	200 – 400								
	400 – 600								
	600 – 800								
	800 –								
KM	0 – 200								
	200 – 400								
	400 – 600								
	600 – 800								
	800 –								
KM	0 – 200								
	200 – 400								
	400 – 600								
	600 – 800								
	800 –								
KM	0 – 200								
	200 – 400								
	400 – 600								
	600 – 800								
	800 –								
KM	0 – 200								
	200 – 400								
	400 – 600								
	600 – 800								
	800 –								
KM									

Points		Surface Condition
5.0 – 4.0	:	No deficiency
4.0 – 3.0	:	Slight deficiencies
3.0 – 2.0	:	Considerable deficiencies but immediate treatment is not required
2.0 – 1.0	:	Considerable severe deficiences, and immediate treatment is required
1.0 – 0.0	:	Reconstruction is immediately required

TABLE 8.1-6

RCPC / RCBC Survey Sheet

Sheet No.: _____
Surveyor : _____
Date : _____

Name of District Office : _____

Location (Km. +)	Type/Size of Culvert (PC : No. + Diameter) (BC : No. of Barrel + Size)	Topography of Culvert Location	Condition									Causing Flood			Slope Condition at Outlet			Remarks
			Culvert			Inlet Facility			Outlet Facility									
			Capacity	Damaged?	Clogged/ Silted	None	Existing (Damaged?)	Clogged/ Silted	None	Existing (Damaged?)	Clogged/ Silted	Yes	No	Unknown	Failed	May Fail	Unknown	
+																		
+																		
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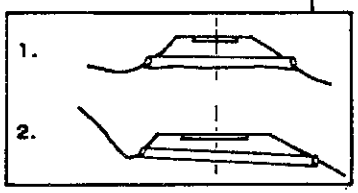


Capacity
1. Sufficient
2. Insufficient
3. Unknown

Damaged
1. Yes
2. No
3. Unknown

Clogged/Silted
0 , 1/4 , 1/3 , 1/2
2/3 , 3/4 , 1

App. 8.1-6

TABLE 8.1-7(1)

Pan Philippine Highway - Mindanao
Bridge Inventory Sheet No. 1

Bridge No. : _____
Bridge Name : _____
Inventory Date : _____

A. GENERAL INFORMATION

(1) Bridge No.		(2) Bridge Name	
(3) Station		(4) River Name	
(5) Bridge Type			
(6) Length (meter)			
(7) Width (meter)	Left Sidewalk=	Pavement =	Right Sidewalk= Total Width=
(8) Straight, Curved, Skew(Deg)		(9) Detour Distance (km)	

B. SUPERSTRUCTURE

Span No.	1	2	3	4	5	6	7
(10) Year Built							
(11) Design Load (ton)							
(12) Span Length (meter)							
(13) Type of Bridge							

RCS = Reinforced Concrete Slab, PCS = Precast Slab, RCDG = Reinforced Concrete Deck Girder
RCBG = Reinforced Concrete Box Girder, PCDG = Prestressed Concrete Deck Girder
IB = Steel I Beam, PG = Steel Plate Girder, PT = Steel Pony Truss, TT = Steel Through Truss, LA = Steel Langer

(14) No.of Main Girders							
(15) No. of Stringers							
(16) No.of Cross Beams							
(17) Girder Condition							

(Concrete) C = Cracking, R=Rebar Exposed , S = Spalling, X=Repaired
(Steel) C = Cracking, R=Rusty, D=Deformation, X=Repaired

Comment							Evaluation
(18) Painting Condition							

(Steel) D = Discoloration, R = Rusty, P = Peeling or Peeled

Comment							Evaluation
(19) Slab Type							

C = Concrete, A = Concrete with Asphalt Overlay , W = Wood

(20) Slab Span (m)							
(21) Slab Condition Top							

C = Cracking, R = Rebar Exposed, S = Spalling, P = Pothole, X = Repaired, Y = Asphalt Patching

Comment							Evaluation
Slab Condition Bottom							

C = Cracking, R = Rebar Exposed, S = Spalling, X = Repaired

Comment							Evaluation
(22) Railing Type							

C = Concrete, S = Steel

(23) Curb & Railing Condition							

C = Curb Damaged , R = Railing Damaged

Comment							Evaluation

(24) River Clearance - Below Superstructure to River Bed at Centerline Span

Distance (meter)							

TABLE 8.1-7(2)

Pan Philippine Highway - Mindanao
Bridge Inventory Sheet No. 2

Bridge No. :
Bridge Name :
Inventory Date :

C. SUBSTRUCTURE

Abutment/Pier No.								
(25) Expansion Joint Type								

N = None, S = Steel, D = Dummy

(26) Expansion Joint Condition								

R = Rusty, L = Loose, U = Uneven, N = None, C = Concrete Spalled at End of Span, S = Proper Seal

Comment							Evaluation	
(27) Bearing Type								

E = Elastomeric Pad, S = Steel Plate, B = Steel Mechanical Bearing, N = None, U = Unknown

(28) Bearing Condition								

M = Missing, N = Not Positioned properly, D = Defective, R=Rusty

Comment							Evaluation	
(29) Bearing Support Condition								

C = Cracked Below , R = Rebar Exposed, S = Spalling
W = Insufficient Width for Support Existing Beam

Comment							Evaluation	
(30) Abutment/Pier Type								

(Abutment) AC = Cantilever, AP = Perched at Top of Slope, AB = Pile Bent Perched At Top of Slope
(Pier) PW = Pier Wall, PT = Pier Tee Shaped , PC = Pier Column, PB = Pile Bent

(31) Abutment/Pier Condition								

C = Cracked, R = Rebar Exposed, T = Tilted, S = Spalled on Vertical Sides

Comment							Evaluation	
(32) Foundation Type								

S = Spread, P = Piles, U = Unknown

(33) Foundation Condition								

S = Settled, E = Pile Exposed - Height in meters, F = Foundation Scoured

Comment							Evaluation	
(34A) Wing Wall Type								

N = None, P = Parallel to Stream, S = Skewed Abutment

(34B) Wing Wall Condition								

C = Cracked, S = Settled, E = Pile Exposed, W = Wing Wall Scoured

Comment							Evaluation	
(35) River Clearance - Below Superstructure to River Bed at Pier								
Distance								

TABLE 8.1-7(3)

Pan Philippine Highway - Mindanao
Bridge Inventory Sheet No. 3

Bridge No. : _____
Bridge Name : _____
Inventory Date : _____

D. RIVER CONDITION

(36A) Water Width(m)		(36B) Velocity at Survey	
(37) Flood Level	m below slab	(38) River Bed Material	
(39) Flow Direction		(40) Degree of Flow to Bridge	Degrees to Bridge
(41) River Condition			
Comments		Evaluation	

E. RIVER BANK AND APPROACH ROAD

Side	Begin Left	Begin Center	Begin Right	End Left	End Center	End Right
(42) River Bank Protection						

N = None, R = Riprap (length in meters), G = Gabion, C = Concrete (length in meters)

(43) River Bank Condition						

D = Damaged, S = Scoured/Eroded, E = Encroachment on Stream

Comment					Evaluation	
(44) Appr. Road Condition	Begin		End			

S=Sinking (height in cm), AS=Scour behind Abutment (length in meters)

Comment		Evaluation

F. SURFACE DRAINAGE

(45) Surface Drainage	
(46) Surf.Drainage Cond.	
Comment	Evaluation

47. R E M A R K S

48. R E C O M M E N D A T I O N S

Bridge Evaluation

Note : Evaluation A: Replacement/Urgent repair needed
B: Repair needed
C: Repair not needed-maintenance only

TABLE 8.1-7(4)

Pan Philippine Highway - Mindanao
Bridge Inventory Sheet No. 4
Station :

Bridge No. : _____
Bridge Name : _____
Inventory Date : _____

SITE PLAN

SIDE VIEW

CROSS SECTION

TABLE 8.1-8(1) SLOPE INVENTORY SHEET FOR CUT SLOPE FAILURE

Pan-Philippine Highway - Mindanao
Slope Inventory Sheet - Cut Slope Failure

Spot No. :
Station :
Inventory Date : , 1994

(1) Nature of Slope			(1) Natural Slope (2) Cut Slope
(2) Occurrence/Potential of Disaster			(1) Occurred (2) Potential of Occurrence
Failure Condition	(3) Type of Failure		(1) Surface Failure (2) Deep Failure (3)
	(4) Failure Width (m)		
	(5) Failure Height (m)		
	(6) Failure Thickness (m)		
	(7) Date Occurred		Day Month Year
	(8) Extent of Affection on Traffic		(1) Shoulder (2) One Lane (3) Two Lanes
	(9) Traffic Interruption Period (day)		
	(10) Countermeasure Taken		(1) None (2) Removal of Materials (3)
	(11) Rainfall Intensity (mm/day)		(1) Below 100 (2) 100-200 (3) 200-300 (4) Above 300
Original Slope Condition	(12) Slope Height (m)		
	(13) Slope Gradient (deg.)		
	(14) Horizontal Shape		(1) Protrude (2) Hollow (3) Straight
	(15) Vertical Shape		(1) Protrude (2) Hollow (3) Straight (4) Overhung (5) Complex
	(16) No. of Berms		
	(17) Degree of Erosion		(1) None (2) Low (3) Medium (4) High
	(18) Slope Protection		(1) None (2) Vegetation (3)
	(19) Vegetation		(1) None (2) Grass (3) Bush
Geological Condition	(20) Material		(1) Hard Rock (2) Soft Rock (3) Gravelly Soil (4) Sandy Soil (5) Cohesive Soil
	Rock	(21) Kind	(1) Granite (2) Diorite (3) Diabase (4) Andesite (5) Schist (6) Dacite (7) Slate (8) Limestone (9) Schalstein (10) Tuff (11) Tuffbreccia (12) Sandstone (13) Shale (14) Mudstone (15) Conglomerate (16) Masa (17) Pyroclastics (18)
		(22) Weathering	(1) Fresh (2) Slightly Weathered (3) Highly Weathered
		(23) Crack	(1) Sparse (2) Regular (3) Irregular (4) Highly Developed
		(24) Direction of Strata	(1) Inclined to Mountain (2) Inclined to Slope (3) Irregular
	Gravelly Soil	(25) Compactness	(1) Tight (2) Slightly Loose (3) Loose
		(26) Gravel Size	(1) Below 10 cm (2) Above 10 cm
		(27) Gravel Shape	(1) Angular (2) Round
	Soil	(28) Compactness	(1) Tight (2) Slightly Loose (3) Loose
		(29) Thickness	(1) Below 1 m (2) 1-5 m (3) 5-10 m (4) Above 10 m
Water Condition	(30) Surface Water		(1) None (2) Not Concentrated (3) Concentrated
	(31) Ground Water		(1) None (2) Seepage (3) Spring
	(32) Drainage Facilities		(1) None (2)
Engineering Judgement	(33) Disaster Potential		(1) Already Occurred (2) Low Potential (3) High Potential
	(34) Cause of Disaster		
	(35) Countermeasures		

Sketch

TABLE 8.1-8(2) SLOPE INVENTORY SHEET FOR EMBANKMENT SLOPE FAILURE

Pan-Philippine Highway - Mindanao
Slope Inventory Sheet - Embankment Slope Failure

Spot No. : _____
Station : _____
Inventory Date : _____, 1994

(1) Nature of Slope		(1) Natural Slope (2) Embankment Slope	
(2) Occurrence/Potential of Disaster		(1) Occurred (2) Potential of Occurrence	
(3) Location		(1) Inside of Curve (2) Mountainside (3) Valley Crossing (4) Bridge Approach (5) Adjacent to River (6)	
Failure Condition	(4) Type of Failure	(1) Surface Failure (2) Deep Failure (3)	
	(5) Failure Width (m)		
	(6) Failure Height (m)		
	(7) Failure Thickness on Top (m)		
	(8) Date Occurred	Day Month Year	
	(9) Extent of Affection on Traffic	(1) Shoulder (2) One Lane (3) Two Lanes	
	(10) Traffic Interruption Period (day)		
	(11) Countermeasure Taken	(1) None (2) Only Fill (3) Riprap (4)	
	(12) Rainfall Intensity (mm/day)	(1) Below 100 (2) 100-200 (3) 200-300 (4) Above 300	
Original Slope Condition	(13) Slope Height (m)		
	(14) Slope Gradient (deg.)		
	(15) Slope Condition	(1) Cracked (2) Scoured (3) Surface Soil Unstable (4) Nothing Special	
	(16) Foundation Layer	(1) Soil (2) Soft Rock (3) Hard Rock (4) Unknown	
	(17) Surface Water	(1) None (2) Not Concentrated (3) Concentrated	
	(18) Slope Protection	(1) None (2) Vegetation (3) Riprap (4)	
	(19) Drainage Facilities	(1) None (2) RCPC (3) RCBC (4) Slope Ditch (5)	
Engineering Judgement	(20) Disaster Potential	(1) Already Occurred (2) Low Potential (3) High Potential	
	(21) Cause of Disaster	(1) Surface Water due to Absence of Culvert (2) Surface Water due to Insufficient/Silted Culvert (3) Improper Treatment of Culvert Outlet (4) Ground Water (5) Scour by River Stream (6)	
	(22) Countermeasures		

Sketch

TABLE 8.1-8(3) SLOPE INVENTORY SHEET FOR DEBRIS FLOW

Pan-Philippine Highway - Mindanao
Slope Inspection Sheet - Debris Flow

Spot No. :_____
Station :_____
Inventory Date :_____, 1994

(1) Occurrence/Potential of Disaster		(1) Occurred	(2) Potential of Occurrence		
Debris Flow Condition	(2) Type of Disaster	(1) Debris Flow	(2) Mud Flow		
	(3) Flow Width (m)				
	(4) Flow Length (m)				
	(5) Date Occurred	Day	Month	Year	
	(6) Extent of Affection on Traffic	(1) Shoulder	(2) One Lane	(3) Two Lanes	
	(7) Traffic Interruption Period (day)				
	(8) Countermeasure Taken				
	(9) Rainfall Intensity (mm/day)	(1) Below 100	(2) 100-200	(3) 200-300	(4) Above 300
Slope Condition	(10) Average Gradient (deg.)				
	(11) Area of Basin (m2)				
	(12) Deposit on Riverbed	(1) None	(2) Slight	(3) Abundant	
	(13) Forest Cover	(1) Below 50%	(2) Above 50%		
Engineering Judgement	(14) Disaster Potential	(1) Already Occurred	(2) Low Potential	(3) High Potential	
	(15) Cause of Disaster				
	(16) Countermeasures				

Sketch

TABLE 8.1-8(4) SLOPE INVENTORY SHEET FOR FALL

Pan-Philippine Highway - Mindanao
Slope Inventory Sheet - Fall

Spot No. :
Station :
Inventory Date : , 1994

(1) Nature of Slope			(1) Natural Slope (2) Cut Slope
(2) Occurrence/Potential of Disaster			(1) Occurred (2) Potential of Occurrence
Fall Condition	(3) Type of Fall		(1) Debris Fall (2) Rock Fall (3)
	(4) Fall Width (m)		
	(5) Fall Height (m)		
	(6) Fall Thickness (m)		
	(7) Fallen Rock Size		(1) Below 20cm (2) 20-50cm (3) Above 50cm
	(8) Date Occurred		Day Month Year
	(9) Extent of Affection on Traffic		(1) Shoulder (2) One Lane (3) Two Lanes
	(10) Traffic Interruption Period (day)		
	(11) Countermeasure Taken		(1) None (2) Removal of Materials (3)
	(12) Rainfall Intensity (mm/day)		(1) Below 100 (2) 100-200 (3) 200-300 (4) Above 300
Original Slope Condition	(13) Slope Height (m)		
	(14) Slope Gradient (deg.)		
	(15) Horizontal Shape		(1) Protrude (2) Hollow (3) Straight
	(16) Vertical Shape		(1) Protrude (2) Hollow (3) Straight (4) Overhung (5) Complex
	(17) No. of Berms		
	(18) Slope Protection		(1) None (2) Vegetation (3)
Geological Condition	Debris Fall	(19) Matrix Condition	(1) Hard (2) Soft (3) Loose (4) Loose with Detached Cobble
		(20) Gully	(1) Few (2) Many (3) Very Many
		(21) Detached Rock/ Cobble	(1) None (2) Stable (3) Unstable
	Rock Fall	(22) Kind of Rock	(1) Granite (2) Diorite (3) Diabase (4) Andosite (5) Schist (6) Dacite (7) Slate (8) Limestone (9) Schalstein (10) Tuff (11) Tuffbreccia (12) Sandstone (13) Shale (14) Mudstone (15) Conglomerate (16) Masa (17) Pyroclastics (18)
		(23) Weathering	(1) Fresh (2) Slightly Weathered (3) Highly Weathered
		(24) Crack	(1) Sparse (2) Regular (3) Irregular (4) Highly Developed
		(25) Direction of Strata	(1) Inclined to Mountain (2) Inclined to Slope (3) Irregular
Water Condition	(26) Surface Water		(1) None (2) Not Concentrated (3) Concentrated
	(27) Ground Water		(1) None (2) Seepage (3) Spring
	(28) Drainage Facilities		(1) None (2)
Engineering Judgement	(29) Disaster Potential		(1) Already Occurred (2) Low Potential (3) High Potential
	(30) Cause of Disaster		
	(31) Countermeasures		

Sketch

TABLE 8.1-8(5) SLOPE INVENTORY SHEET FOR LANDSLIDE

Pan-Philippine Highway - Mindanao
Slope Inventory Sheet - Landslide

Spot No. :_____
Station :_____
Inventory Date :_____, 1994

(1) Occurrence/Potential of Disaster		(1) Occurred	(2) Potential of Occurrence			
Landslide Condition	(2) Type of Landslide	(1) Rock	(2) Talus	(3) Soil		
	(3) Landslide Width (m)					
	(4) Landslide Height (m)					
	(5) Date Occurred	Day	Month	Year		
	(6) Extent of Affection on Traffic	(1) Shoulder	(2) One Lane	(3) Two Lanes		
	(7) Impact on Traffic	(1) Low	(2) Medium	(3) High		
	(8) Traffic Interruption Period (day)					
	(9) Countermeasure Taken	(1) None	(2)			
	(10) Rainfall Intensity (mm/day)	(1) Below 100	(2) 100-200	(3) 200-300	(3) Above 300	
Slope Condition	(11) Presence of Irregular Surface and Cliff	(1) Unnoticed	(2) Noticed	(3) Remarkably Noticed		
	(12) Geology	(1) Sedimentary Rock	(2) Volcanic Rock	(3) Talus	(4) Soil	(5)
	(13) Geological Structure	(1) Fault/Weak Zone	(2) Not Fault/Weak Zone	(3) Unknown		
	(14) Direction of Strata	(1) Inclined to Mountain	(2) Inclined to Slope	(3) Irregular		
	(15) Degree of Saturation	(1) Dry	(2) Wet	(3) Seepage	(4) Spring	
	(16) Slope Gradient (deg.)					
	(17) Continuity of Slide Movement	(1) Unnoticed	(2) Noticed	(3) Remarkably Noticed		
Engineering Judgement	(18) Disaster Potential	(1) Already Occurred	(2) Low Potential	(3) High Potential		
	(19) Cause of Disaster					
	(20) Countermeasures					

Sketch

APPENDICES FOR CHAPTER 9

APPENDIX 9.1

PAVEMENT CORING/SOILS TESTS AND SOFT GROUND SITE GEOTECHNICAL/SOILS INVESTIGATION

1. Pavement Coring and Soils Tests

Pavement corings were undertaken at selected 20 PCC slabs and test pittings were undertaken at the shoulder of selected PCC slabs (see Figure 9.1-1). For cored slabs, slab thickness was measured and compressive strength was tested. At test pitting site, soil layer thickness was measured and a field density test was conducted for each layer. Soil samples were collected for each layer and following tests were undertaken:

- Soil classification
- Compaction test
- CBR test
- Natural moisture content
- Sieve analysis
- Specific gravity
- Liquid and plastic limits

2. Soft Ground Site Geotechnical and Soils Investigation

Five sites were selected for investigation as shown in Figure 9.1-2

	No. of Bore Holes	Total Drilling Length (m)
5 Soft Ground Sites	5	75.0

Standard Penetration Tests (SPT) were undertaken at 1 meter interval and soil samples were collected. Eight undisturbed samples were collected and consolidation tests were undertaken. Following laboratory tests were undertaken for disturbed soils samples:

- Soil classification
- Natural moisture contents
- Sieve analysis
- Specific gravity
- Liquid and plastic limits

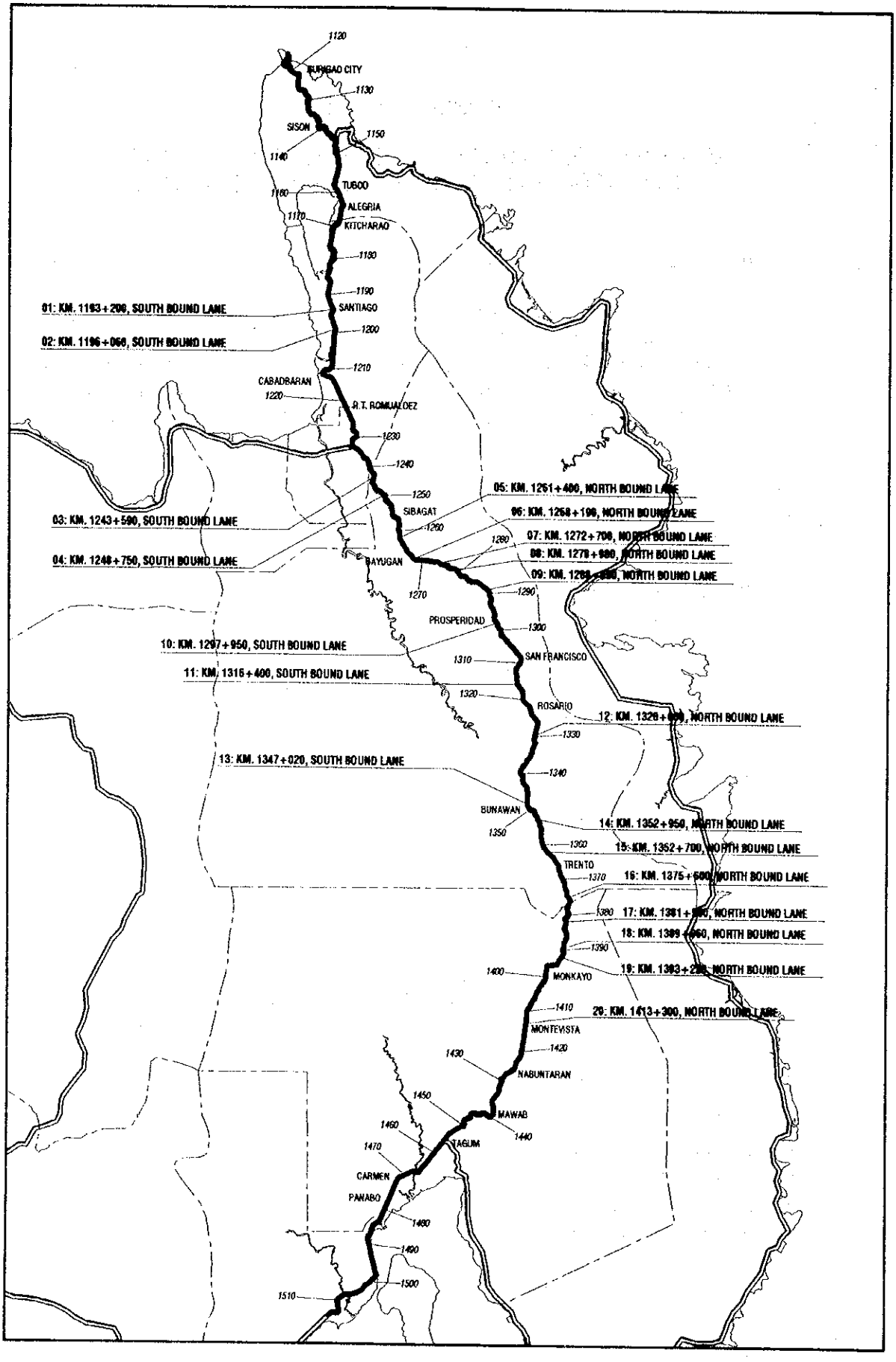


FIGURE 9.1 - 1 PAVEMENT CORING AND TEST PITTING LOCATION

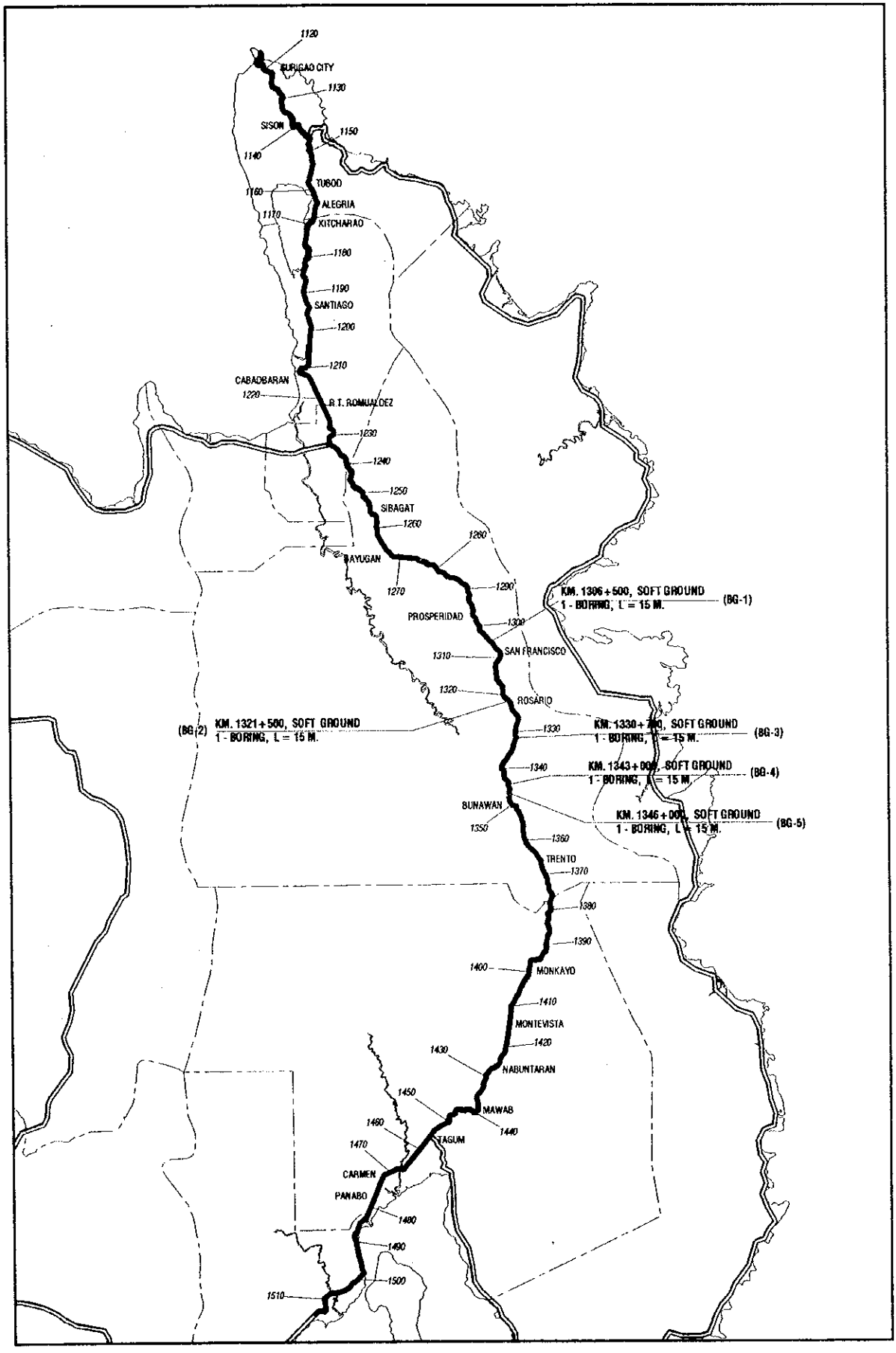


FIGURE 9.1 - 2 GEOTECHNICAL SURVEY LOCATION FOR SOFTGROUND

APPENDIX 9.2

DESIGN PRECEDENTS

This Appendix summarizes the pavement rehabilitation methods selected for Manila North Road and the Pan-Philippine Highway in Luzon and Samar sections.

1. Rehabilitation Projects

Table 9.2-1 shows the major completed and on-going projects for rehabilitation and improvement of the Pan-Philippine Highway.

TABLE 9.2-1 COMPLETED/ON-GOING REHABILITATION AND IMPROVEMENT PROJECTS ALONG MANILA NORTH ROAD AND PAN-PHILIPPINE HIGHWAY

Project Name	Project Section (Project Status)	Scope of Work
Manila North Road Improvement Project	Rosario-Laoag (completed in 1985)	o Road/Bridge Rehabilitation
Laoag-Allacapan Road Improvement Project	Laoag-Allacapan (completed in 1984)	o Road/Bridge Rehabilitation
The Philippine-Japan Friendship Highway Rehabilitation Project, Section A	Allacapan-Aritao (on-going)	o Slope Protection
The Philippine-Japan Friendship Highway Rehabilitation Project, Section B	Aritao-Sta. Rita (on-going)	
The Philippine-Japan Friendship Highway Rehabilitation Project, Section C	Calamba-Calauag (on-going)	
The Disaster Prevention and Rehabilitation Project (Philippine-Japan Friendship Highway and Naguilian Road)	Calauag-Matnog (on-going) Allen-Calbayog (Proposed for implementation)	

2. Rehabilitation Works

Major rehabilitation/improvement works designed in the above-mentioned projects are shown in Figure 9.2-1, and summarized as follows:

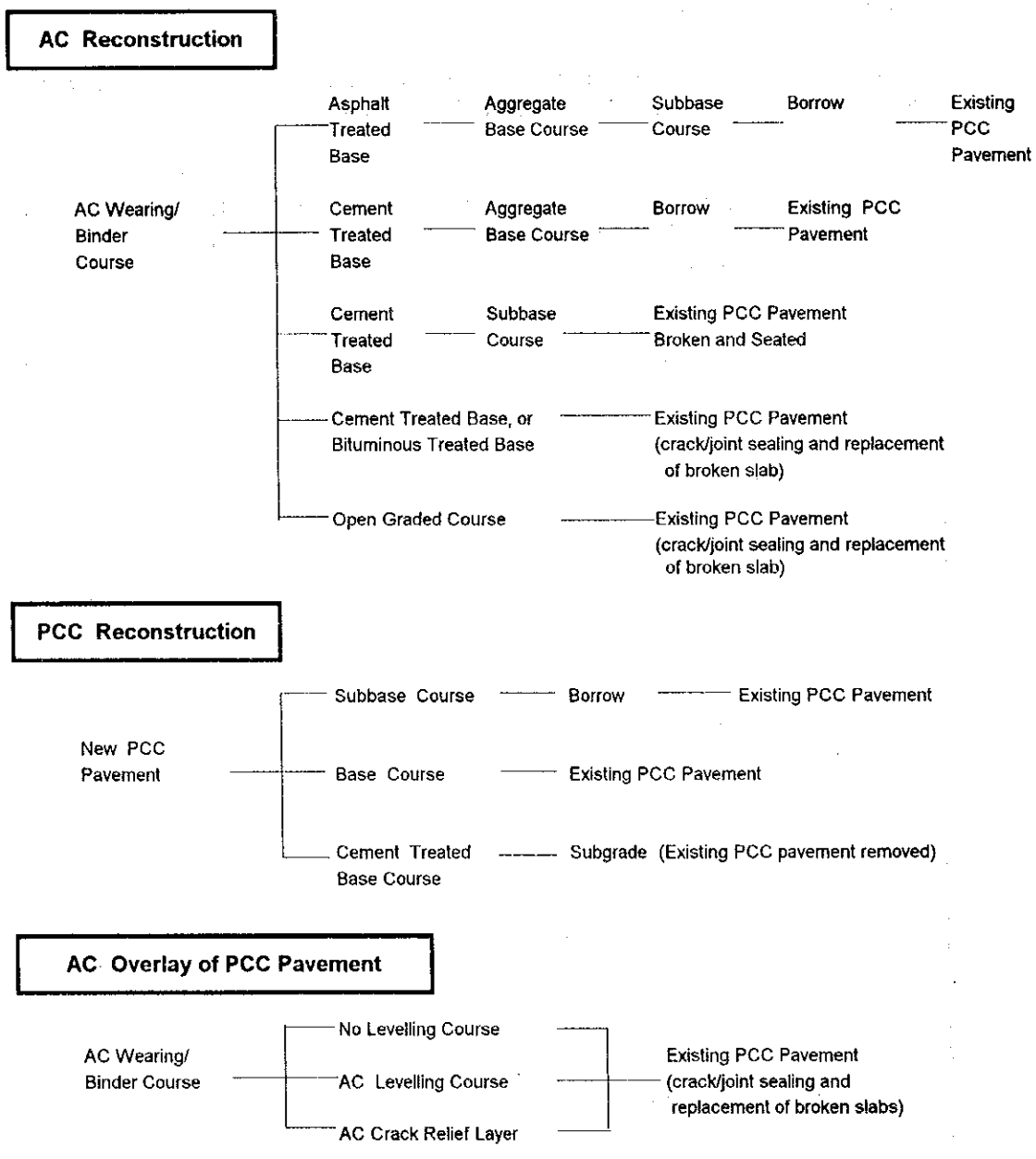


FIGURE 9.2-1 (1) PAVEMENT REHABILITATION METHODS SELECTED FOR MANILA NORTH ROAD AND PAN-PHILIPPINE HIGHWAY

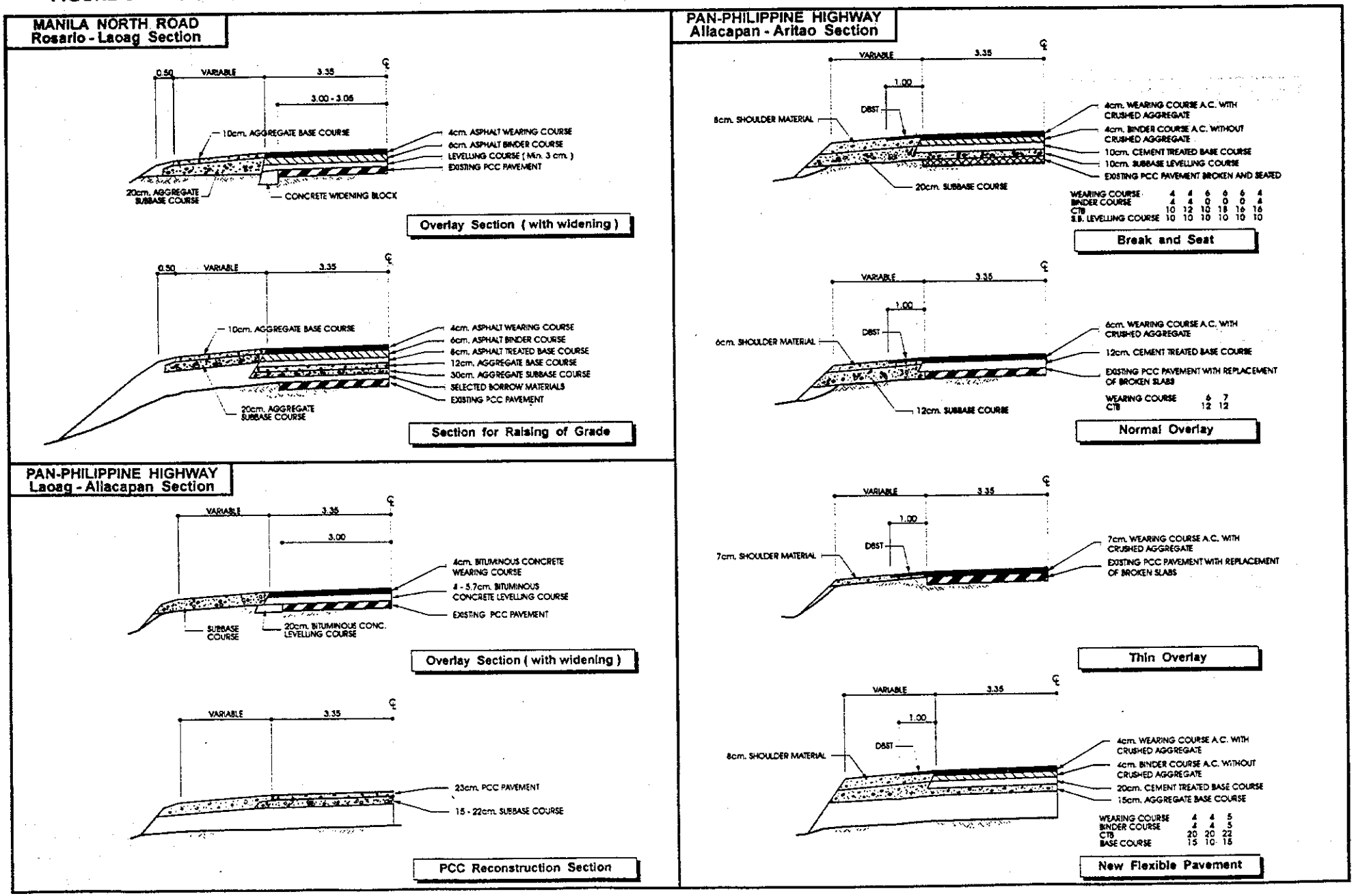
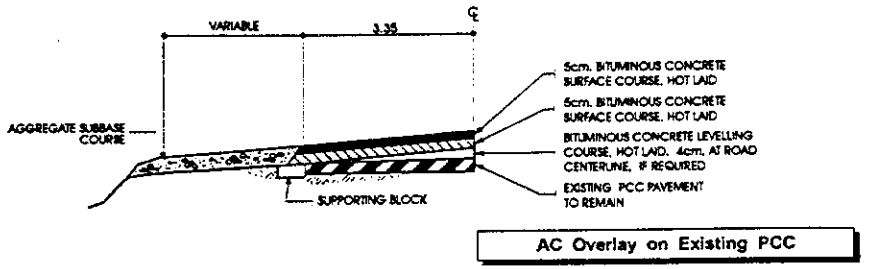
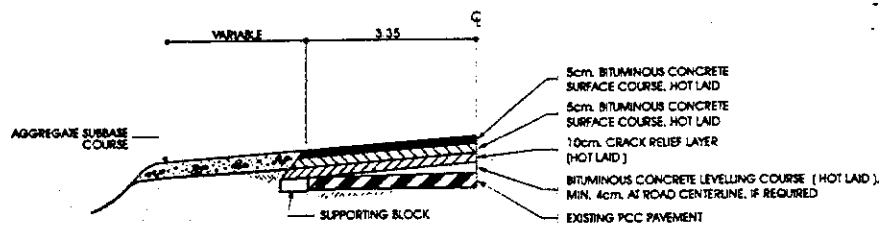


FIGURE 9.2-1 (2) PAVEMENT REHABILITATION METHODS SELECTED FOR MANILA NORTH ROAD AND PAN-PHILIPPINE HIGHWAY

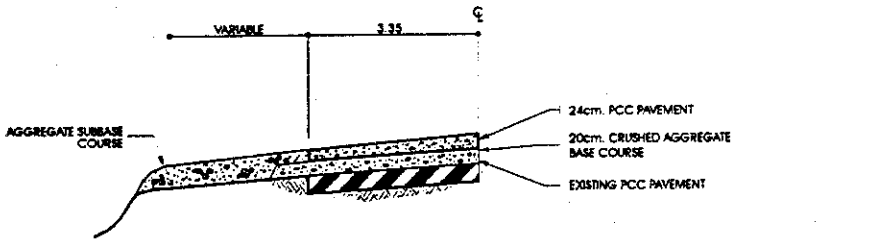
PAN-PHILIPPINE HIGHWAY Aritao - Sta. Rita Section



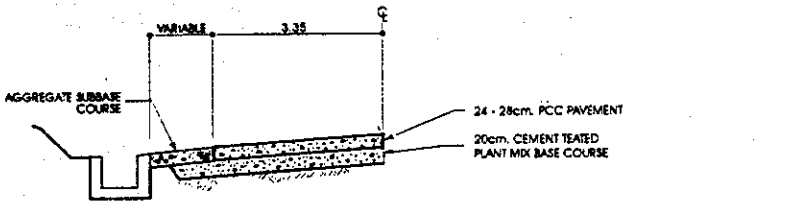
AC Overlay on Existing PCC



AC Overlay on Existing PCC Pavement Mount up Type

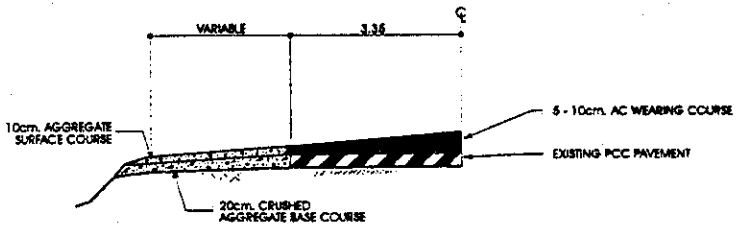


PCC Pavement Reconstruction on Existing PCC

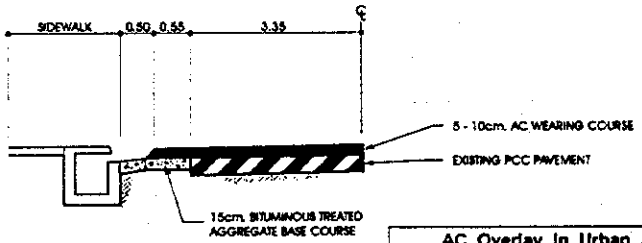


PCC Pavement Reconstruction

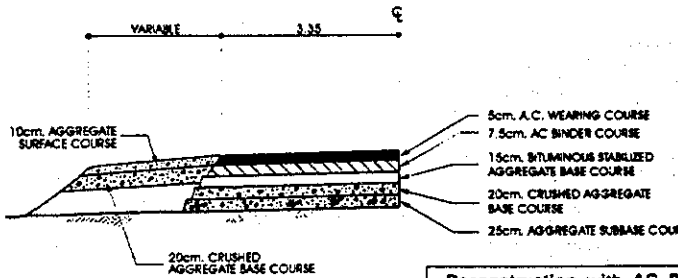
PAN-PHILIPPINE HIGHWAY Calamba - Calauag Section



AC Overlay in Rural Area



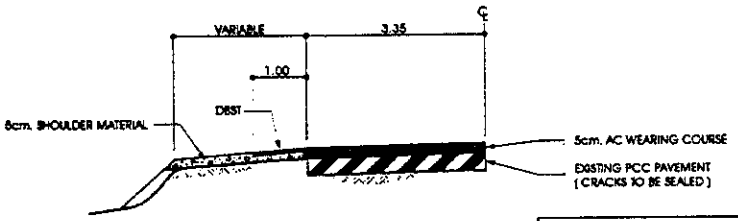
AC Overlay in Urban Area



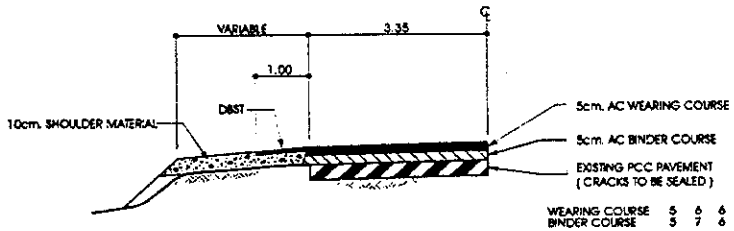
Reconstruction with AC Pavement

FIGURE 9.2-1 (3) PAVEMENT REHABILITATION METHODS SELECTED FOR MANILA NORTH ROAD AND PAN-PHILIPPINE HIGHWAY

PAN-PHILIPPINE HIGHWAY
Calauag - Matnog,
Allen - Calbayog Section

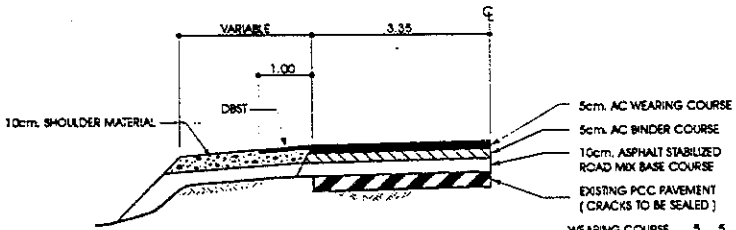


TYPE - 1



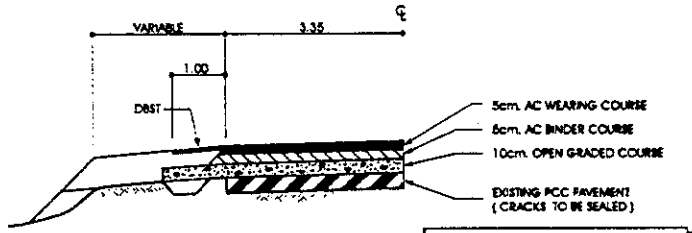
WEARING COURSE	5	6	6	5
BINDER COURSE	5	7	6	5
				5

TYPE - 2



WEARING COURSE	5	5	6
BINDER COURSE	5	5	7
ATB	10	15	15

TYPE - 3



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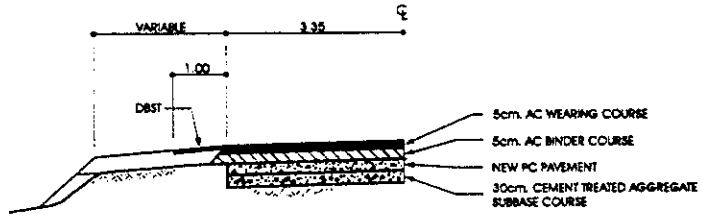

TYPE - 5

App. 9.2-5

APPENDIX 9.3

ESTIMATE OF CONSOLIDATION SETTLEMENT

1. ESTIMATE OF CONSOLIDATION SETTLEMENT AT KM. 1330+700

1.1 Backcalculation of Coefficient of Volume Compressibility

$S = mv.H.P$

where:	S	= Consolidation Settlement	(cm)
	mv	= Coefficient of Volume Compressibility	(cm^2/kgf)
	H	= Depth of weak layer	(cm)
	P	= Consolidation load	(kgf/cm^2)

S = 120cm
H = 670 + 120 = 790cm
P

PCC Pavement	0.23 x 2.45	=	0.5635 tf/m^2
Subbase	0.15 x 1.80	=	0.2700 tf/m^2
Embankment	1.82 x 1.80	=	3.2760 tff/m^2
Traffic load		=	2.2000 tf/m^2
	Total		6.3095 tf/m^2
		=	0.631 kgt/cm^2

$mv = 120/790 \times 0.631 = 0.241$

1.2 Estimate of Consolidation Settlement Based on Backcalculated Coefficient of Volume Compressibility

Assuming that mv remains the same as calculated above, consolidation settlement for the sandwich method is estimated as follows:

$mv = 0.241\ cm^2/kgf$
H = 670 cm
P

AC Pavement	0.11 x 2.33	=	0.233 tf/m^2
Bituminous Treated Base	0.10 x 2.10	=	0.210 tf/m^2
Base Course	0.25 x 1.8	=	0.450 tf/m^2
Subbase	0.30 x 1.8	=	0.540 tf/m^2
Common Material	0.44 x 1.8	=	0.792 tf/m^2
Traffic load		=	0.900 tf/m^2
	Total		3.125 tf/m^2
		=	0.313 kgt/cm^2

$S = 0.241 \times 670 \times 0.313 = 51cm$

1.3 Estimate of Consolidation Settlement Based on Soil Characteristics

$$S = \frac{C_c}{1 + e_o} \times H \times \log \frac{P_i + P}{P_i}$$

where:

C_c = Compression index
e_o = Void ratio before loading
P_i = Effective pressure before loading (kgt/cm^2)
P_o = Consolidation load (kgt/cm^2)

$C_c = 1.26$
$e_o = 1.72$
$P_i = 0.631 + 335 \times 0.0014 = 1.100$ kgt/cm^2

$$S = \frac{1.26}{1 + 1.72} \times 670 \times \log \frac{1.100 + 0.313}{1.100} = 34\text{cm}$$

1.4 Estimated Consolidation Settlement

It is estimated that consolidation settlement will be 35 to 50cm.

2. ESTIMATE OF CONSOLIDATION SETTLEMENT AT KM. 1321 + 500

2.1 Backcalculation of Coefficient of Volume Compressibility

$S = 100cm$
$H_P = 620 + 100 = 720cm$

PCC Pavement	0.23 x 2.45	=	0.5635 tf/m^2
Subbase	0.15 x 1.80	=	0.2700 tf/m^2
Embankment	1.42 x 1.80	=	2.5560 tff/m^2
Traffic load		=	2.0000 tf/m^2
	Total		5.3895 tf/m^2
		=	0.539 kgt/cm^2

$mv = 100/720 \times 0.539 = 0.258$

2.2 Estimate of Consolidation Settlement Based on Backcalculated Coefficient of Volume Compressibility

$mv = 0.258$
$H_P = 620\ cm$

AC Pavement		=	0.233 tf/m^2
Bituminous Treated Base		=	0.210 tf/m^2
Base Course		=	0.450 tf/m^2
Subbase		=	0.540 tf/m^2
Common Material	0.24 x 1.8	=	0.432 tf/m^2
Traffic load		=	1.000 tf/m^2
	Total		2.865 tf/m^2
		=	0.287 kgt/cm^2

$S = 0.258 \times 620 \times 0.287 = 46cm$

2.3 Estimate of Consolidation Settlement Based on Soil Characteristics

$C_c = 3.77$
$e_o = 7.24$
$P_j = 0.539 + 310 \times 0.0014 = 0.973$
$\dot{P} = 0.287$

$$S = \frac{3.77}{1 + 7.24} \times 620 \times \log \frac{0.973 + 0.287}{0.973} = 32cm$$

2.4 Estimated Consolidation Settlement

It is estimated that consolidation settlement will be 30 to 45cm.

APPENDICES FOR CHAPTER 10

APPENDIX 10.1

BRIDGE SITE GEOTECHNICAL AND SOILS INVESTIGATION

Geotechnical and soils investigation was undertaken at nine bridge sites (see Figure 10.1-1) as follows:

Bridge Sites	No. of Bore Holes	Total Drilling Length (m)
For study of reconstruction (San Pedro, Guinoroyan and Kalaw Bridges)	4	91.0
For study of adding span (Other bridges)	9	287.0
Total	13	378.0

Standard penetration tests (SPT) were undertaken at 1 meter interval and soil samples were collected at 2 meters interval. Following laboratory tests were undertaken:

- Soil classification
- Natural moisture content
- Sieve analysis
- Specific gravity
- Liquid and plastic limits

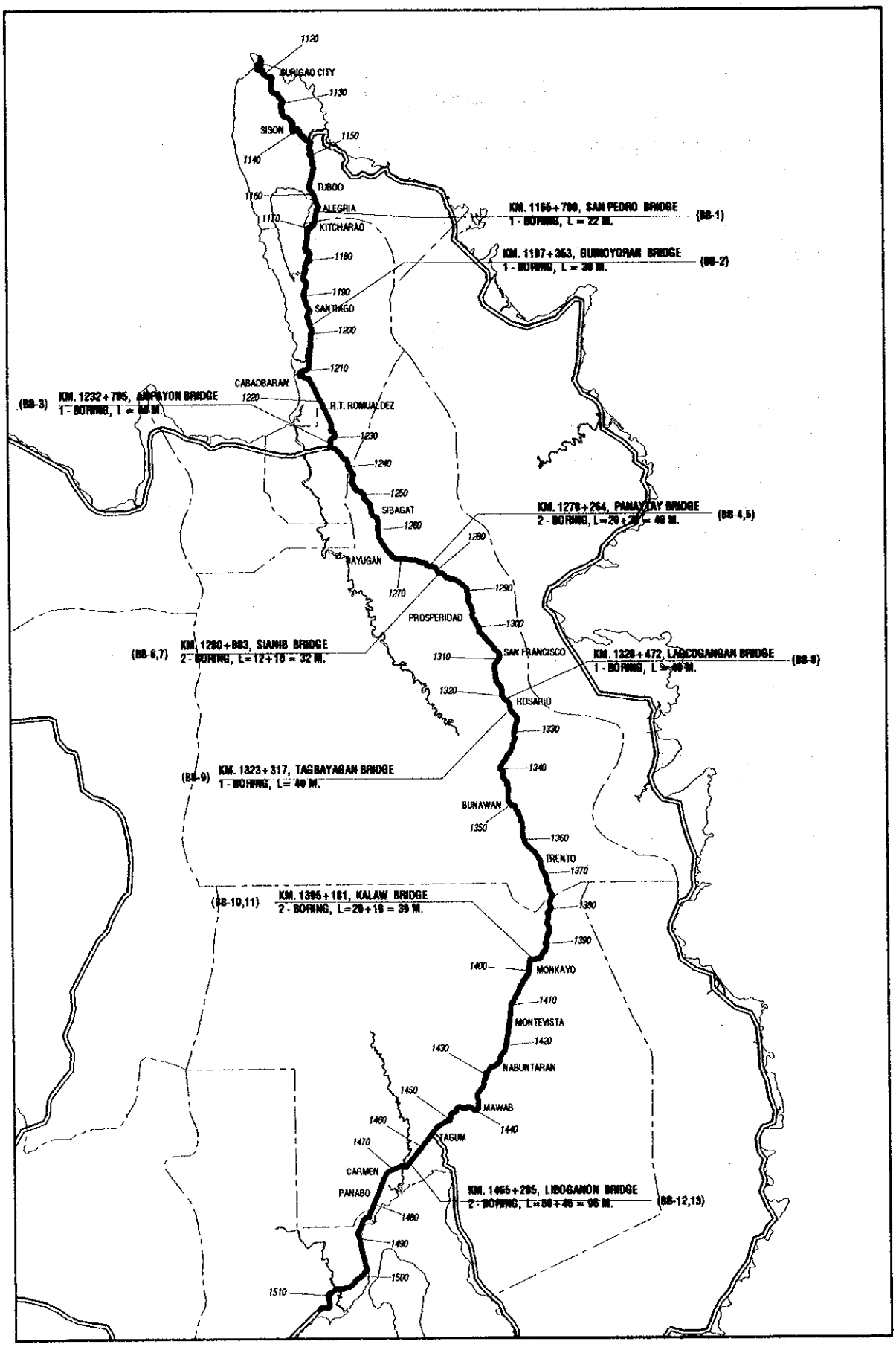

FIGURE 10.1 - 1 GEOTECHNICAL SURVEY LOCATION FOR BRIDGES

APPENDIX 10.2
DESIGN PRECEDENTS

This section summarizes the bridge rehabilitation design in the completed or on-going projects for rehabilitation of Luzon, Samar and Leyte sections of the Pan-Philippine Highway.

Major rehabilitation/improvement works designed in those projects are as follows:

A. Total Reconstruction

B. Partial Reconstruction
- Reconstruction of entire slab of selected or all span(s)
- Reconstruction of all girders of selected or all span(s)
- Reconstruction of substructure

  Example: Construction of new abutment and pier of portal type in which columns and piles are located outside the superstructure abutting on the existing abutment/pier (Talolong Bridge in Calamba-Calauag Section).

C. Widening
- Widening of carriageway/sidewalk

  Example: Widening substructure by adding a column and extending footing, and widening superstructure by adding two girders (Overhead Bridge in Calamba-Calauag Section).

D. Extension
- Construction of additional span(s)

E. Major Repair
- Reconstruction of railing
- Partial reconstruction of slab
- Reconstruction of a part of concrete girders
- Reinforcement of concrete beam

  Example: Provision of lateral tie for precast channel beams with steel bar (Anyatam I Bridge in Aritao-Sta. Rita Section).
- Repair of shoe

  Example: Inserting as many wedge lead sheets (200x200x2mm) as possible between girder and bridge seat, and filling the space with epoxy resin (Darapidap Bridge in Allacapan-Aritao Section).

  Example: Attaching steel brace to the pier and placing H-steel thereon to provide additional support of beams (Biga Bridge in Calamba-Calauag Section).
- Reinforcement of pier/abutment

  Example: Coating pier column with reinforced concrete collar (Iguig II Bridge in Allacapan-Aritao Section).

- Reinforcement of foundation
  Example: Construction of additional piles and widening of footing (Baculud Bridge in Allacapan-Aritao Section).

- Installation of drainage pipe
- Raising superstructure
  Example: Jacking up superstructure by about 50cm and capping substructure to increase freeboard (Puncan II Bridge in Aritao-Sta. Rita Section).

F. Minor Repair
- Repair of slab
- Repair of concrete girder
- Repair of steel beam
- Repainting of steel girder/member
- Repair of substructure
- Provision/reconstruction of slab overlay

G. Protection from Scour
- Provision/reconstruction of abutment slope protection
- Provision/reconstruction of pier foundation protection
- Provision/reconstruction of river bank protection

H. Approach Road Protection
- Provision/reconstruction of approach road embankment slope protection
- Provision of approach slab

I. River Control
- Provision of spurdike
- Provision of consolidation
  Example: Construction of consolidation made of stone masonry and gabion at downstream of the bridge to prevent scour (Darapidap Bridge in Allacapan-Aritao Section).

J. Aseismatic Protection
- Widening of bridge seat
- Provision of mechanical connection device
  Example: Connection of adjacent girders and girder with abutment parapet with steel tie rod to prevent superstructure from falling (Cawayan Bridge in Calauag-Matnog Section).

Table 10.2-1 shows the number of bridges for which rehabilitation/improvement works were designed in the completed or on-going Pan-Philippine Highway rehabilitation projects.

TABLE 10.2-1 NUMBER OF BRIDGES FOR REHABILITATION DESIGN BY TYPE OF WORK

Section			Allacapan -Aritao		Aritao -Sta. Rita		Calamba -Calauag		Calauag -Matnog		Allen -Calbayog		Calbayog -Tacloban	Total
1) Project			P1	P5	P2	P5	P3	P5	P4	P5	P4	P5	P5	
Number of Bridges			11	4	18	1	16	6	12	10	4	2	1	85
2) Type of Work	Total Reconstruction		4	4	1	-	1	6	6	3	1	2	1	29
	Partial Reconstruction	Slab	5	-	7	1	4	-	1	6	-	-	-	24
		Girder	5	-	1	-	1	-	-	-	-	-	-	7
		Substructure	-	-	-	1	1	-	-	-	-	-	-	2
	Widening		-	-	-	-	1	-	-	-	-	-	-	1
	Extension		3	-	1	-	-	-	-	-	-	-	-	4
	Major Repair		3	-	12	1	6	-	4	6	3	-	-	35
	Minor Repair		-	-	4	-	7	-	6	-	3	-	-	20
	Protection from Scour		3	-	4	-	4	-	4	7	3	-	-	25
	Approach Road Protection		-	-	-	-	4	-	2	-	-	-	-	6
	River Control		3	-	-	-	-	-	1	-	-	-	-	4
	Aseismatic Protection		-	-	1	-	3	-	1	-	-	-	-	5

Note. 1) P1 = Philippine-Japan Highway Loan Project, Section A
P2 = Philippine-Japan Highway Loan Project, Section B
P3 = Philippine-Japan Highway Loan Project, Section C
P4 = Disaster Prevention and Rehabilitation Project
(Philippine-Japan Friendship Highway and Naguilian Road)
P5 = Rehabilitation and Maintenance of Bridges along Arterial Roads Project
2) Bridges including more than two types of work are repeatedly counted under each type
3) Two bridges (Naguilian Bridge and San Pablo Bridge) designed in the Project P1 were shifted to the Project P5 for their implementation.

APPENDICES FOR CHAPTER 11

APPENDIX 11.1

CRITERIA TO DETERMINE HIGH OR LOW POTENTIAL OF SLOPES

Potential slopes were divided into two; slopes with high disaster potential and slopes with low disaster potential, according to the following criteria which were established based on the findings in the previous studies such as Feasibility Study of the Philippine Road Disaster Prevention Project (JICA assisted), the Joint Research Project on the Road Slope Protection Works in the Philippines (DPWH and Ministry of Construction, Japan), etc.:

1) Cut Slope Failures

Factors closely related to cut slope failure are as follows:

i) slope height: 30 meters or more
ii) slope gradient: 60° or more
iii) configuration: rectilineal longitudinal shape and overhanging cross-sectional shape
iv) geological composition: sand, sandy soil or weathered sand stone
v) groundwater: abundant

Slopes which meet three or more of the above five factors are judged to be slopes with high disaster potential. Others fall in slopes with low disaster potential.

2) Embankment Slope Failures

Slopes meeting four or more of the following six factors are evaluated to have high disaster potential. Others are evaluated as slopes with low disaster potential.

i) slope having a height of more than 7 meters or facing curved portion of river where river flow hits the slope
ii) fill material: sand or sandy soil
iii) no vegetation cover
iv) surface water concentration
v) slope with deformation
vi) embankment crossing valley

3) Debris Flows

Slopes meeting three or more of the following five factors are evaluated as slopes with high potential, and others as slopes with low potential.

i) slope gradient: 15° or more
ii) abundant stones accumulated on riverbed
iii) presence of marks of hillside failure

iv) stream with a basin of more than 5 ha. in area
v) vegetation covering less than 50% of a total area of slope

4) Falls

Slopes meeting three or more of the following five factors are evaluated as slopes with high disaster potential, others as slopes with low potential.

i) slope height: 20 meters or more
ii) many cracks
iii) no vegetation cover
iv) surface water concentration
v) unstable or unsupported rocks/cobbles/boulders

5) Landslides

No slope with potential of landslide is found along the Study Road.

APPENDIX 11.2

TOPOGRAPHIC SURVEY AND GEO-TECHNICAL SURVEY

UNDERTAKEN FOR SLOPES

TOPOGRAPHIC SURVEY

Topographic survey was undertaken at four slope sites as follows:

Type of Slope Failure	Location	Surveyed Length (Along Centerline)
Embankment Slope Failure	Km 1115+800	270m
Cut Slope Failure	Km 1116+200	240m
Landslide	Km 1247+500	440m
Landslide	Km 1249+750	240m
Total		1,190m

Topographic map was prepared for each slope site at a scale of 1 to 500.

SLOPE SITE GEOTECHNICAL AND SOILS INVESTIGATION

Eight slopes were selected for investigation and borings were undertaken as follows (see Figure 11.2-1):

Type of Failure	No. of Bore Holes	Total Drilling Length (m)
Embankment Slope Failure	5	82.0
Cut Slope Failure	1	20.0
Landslide	5	100.7
Total	11	202.7

Standard penetration tests (SPT) were undertaken at 1 meter interval and soil samples were collected at 2 meters interval. For rock layers, core boring was undertaken.

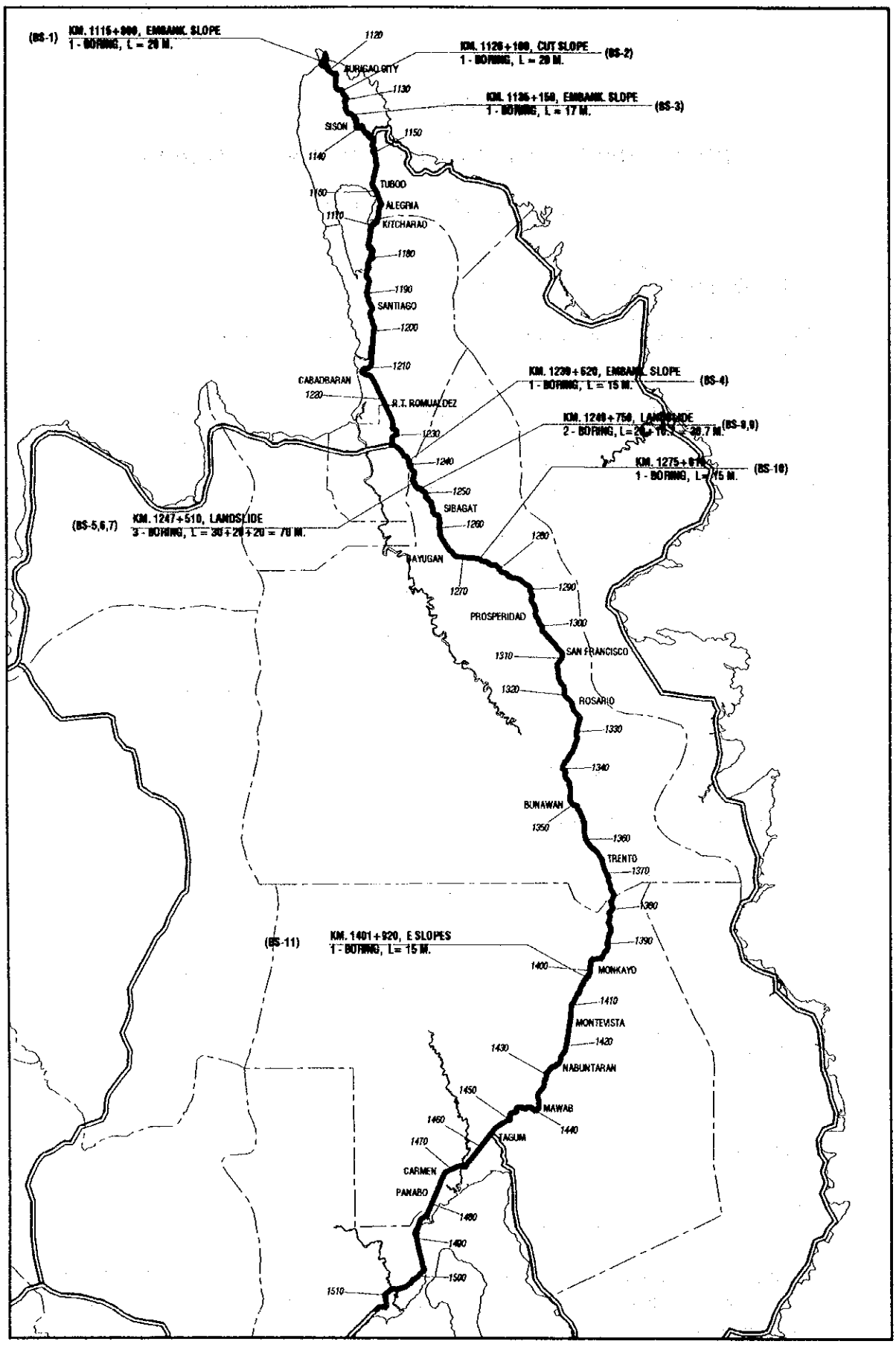

FIGURE 11.2 - 1 GEOTECHNICAL SURVEY LOCATION FOR SLOPES

Following laboratory tests were undertaken:

- Soil classification
- Natural moisture content
- Sieve analysis
- Speciffic gravity
- Liquid and plastic limits

APPENDIX 11.3

DESIGN PRECEDENTS OF SLOPE PROTECTION WORKS

The road rehabilitation projects have been/are being implemented for the Luzon, Samar and Leyte sections of the Pan-Philippine Highway. Disaster prevention works were included in their scope of work. Table 11.3-1 shows the slope protection works by type of disaster which were designed in those completed or on-going rehabilitation projects.

TABLE 11.3-1 DESIGN PRECEDENTS OF SLOPE PROTECTION WORKS IN OTHER SECTIONS OF THE PAN-PHILIPPINE HIGHWAY

Protection Work \ Type of Disaster		Cut Slope Failures	Embankment Slope Failure	Debris Flows	Falls	Remarks
Retaining Walls	Gravity Type Stone Masonry Wall		O			H = 1~5m
	Supported Type Stone Masonry Wall	O	O			H = 1~5m (Cut Slope), 1~7m (Embankment Slope)
	Gravity Type Concrete Wall	O	O			H = 1~5m
	Supported Type Concrete Wall	O				H = 2~7m
	Cantilever Type Concrete Wall	O	O			H = 3~5m
	Gabion Wall	O	O			H = 2~3m, Mat Gabion
Protection Works	Seeding	O	O			
	Wattling	O				
	Grouted Riprap		O			t = 0.3m or more
	Concrete Spraying	O				t = 0.1m, 0.15m
	Concrete Crib	O	O			Stone pitching, Concrete Lining, Sodding
	Cylinder Gabion Pitching	O				dia. = 0.5m
Catch Works	Stone Masonry Catch Wall				O	
	Concrete Catch Wall				O	
	Wire Net				O	
	Rock Fence				O	
Foot Protection	Gabion Foot Protection		O			Mat Gabion
Sabo Dams	Gabion Sabo Dam			O		Mat Gabion
	Stone Masonry Sabo Dam			O		