CHAPTER 5

TRAFFIC DEMAND FORECAST

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5.1 APPROACH

In order to investigate the main characteristics of the present traffic pattern on the road network and to forecast the future traffic demand on the network including Study Roads, different traffic surveys were carried out and present OD matrices were established as explained in the previous chapter. To predict future OD matrices, a future socioeconomic framework for the population and other economic and land-use indicators was established for the target years on zonal base. Assignment of these OD matrices for each target year on the future road network produces the future traffic volumes which were estimated in PCU values and break-downed into vehicle categories. The assignment procedure was applied for the cases of "without project" and for the improvement of each Study Road under each of the three improvement options. In addition, the case of improving the selected roads under the adopted improvement options was also considered for the purpose of economic evaluation of the project.

5.2 SOCIOECONOMIC FRAMEWORK

5.2.1 Parameters required

(1) Premises

Traffic along major roads in 1997 was counted at roadside and a roadside OD interview survey was carried at both ends of the Grand Etang Road. Based on these data, OD matrices of PCU base were prepared.

Traffic demand for the future are to be prepared based on OD matrices at present. Therefore, the OD matrices in future shall be prepared in PCU base. Then, hereafter the word "trip" is used for car traffic in PCU base.

Trips per car at present is estimated as 1.75 (Total PCU generated is estimated at 20,871 and total number of cars registered in 1996 was 11,941. Total PCU / Total of cars = 1.75). This figure is assumed not to change in the future.

With Grenada's mountainous topography, tropical weather and poor public transportation service it is natural to consider that a big potential demand to own a passenger car exists. Figure 5.2.1 was quoted and simplified from the study of Hayashi and others; Urbanization, Motorization and the Environment Nexus, Memoirs of the School of Engineering, Nagoya Univ. Vol. 46, No. 1, October 1994.

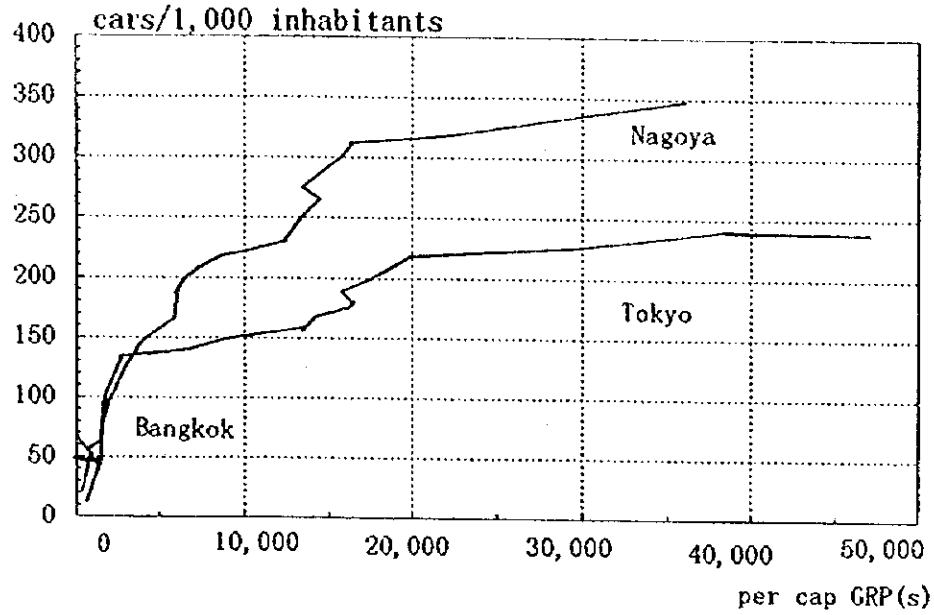


Figure 5.2.1 Per Capita GDP (Current Price) and Car Ownership

The interesting results clarified from the figure are as follows:

1) Per capita GDP and car ownership rate has a strong relationship.
2) Two cities in Japan show the same pattern until 4,000 US Dollars / capita is reached and a different pattern after 4,000 US Dollars / capita.
3) Both cities have ceilings of car ownership rate (Tokyo 240 cars/ 1,000 inhabitants, Nagoya 360 cars / 1,000 inhabitants). These ceilings generally come from the size of city, the service level of public transportation, the service level of roads/parking facilities and so on. Ceilings become clear after 40,000 US Dollars / capita.
4) From 4,000 US Dollars / capita till 40,000 US Dollars / capita car ownership increases smoothly.
5) Grenada's car ownership rate (12%) at present GDP / capita (3,000 US Dollars / capita) fits to the curve.

Based on these understandings we can formulate a universal estimate if the ceiling can be set. Assuming that this formula is applicable to Grenada's case and the rate of trips per car obtained is to be used for the future, GDP forecast and population estimates are only necessary to estimate future traffic demand.

The target year of the study was fixed as 2005 due to the scope of work, but for economic analysis purposes the years of 2015 and 2025 were added as target years in addition to 2005.

5.2.2 Population

Statistics of the last 7 years shows -2.6 % of growth ratio of live births and -0.5 % of growth ratio of deaths, and 0.7 % of growth a year of population. The number of births in 1996 was 2,096, deaths was 782 therefore 1,314 was the increase of gross population. However, the increase of population from 1995 was 400, which means the net emigration was 914 persons.

The ceiling of population saturation is definitely existing because Grenada is a small island. But net emigration discussed above works as a safe guard to over population.

Without significant changes of economic environment the said framework should not change and significant economic change is not foreseen. Based on these understandings the population forecast was executed and the results are shown in Table 5.2.1.

5.2.3 Car Ownership

GDP per capita of Grenada at present is around 3,000 US Dollars so that the ceiling of the car ownership rate can not be identified. As mentioned above Nagoya has a ceiling of 360 vehicles per 1,000 population and Tokyo has a ceiling of 240 vehicles per 1,000 population. Generally speaking, the ceiling of car ownership rate of Grenada may be high due to the poor public transportation services.

The population and number of households in 1996 were 98,893 persons and 22,733 households respectively. Assume fifty percent of households owns two cars and the other fifty percent owns one car as a goal of car ownership and apply to the present population and households. Car ownership per 1,000

person becomes 345 (22,733 x 1.5 / 98,893 x 1,000 = 345). This figure seems to be reasonable, as the ceiling of Nagoya is 360. Then, Nagoya's data was applied to Grenada after it was smoothed and formulated in the following model using the regression analysis technique which results in a high correlation factor (r^2).

$$y = 1.41 x^{0.555} \qquad (r^2=0.99)$$

where, y: car ownership rate (units per 1000 persons)
x: GDP per capita (current US Dollars)

Shares of vehicle types in future were estimated in the following manner.

1) Totals of vehicles were obtained using the formula mentioned above.
2) Numbers of Pickups were obtained as the product of total vehicles and the share of pickups in 1996 and the degradation factor (growth ratio of pickup / growth ratio of total (all types) of vehicles).
3) Numbers of trucks were obtained as growth rate of truck fleet was equal to growth rate of GDP.
4) Numbers of buses was estimated by the following manner:
5) Bus users per bus was obtained as population - (average passenger per passenger car x number of passenger cars) / number of buses assuming all trips excluding walking trips and riding two wheelers trips were served by passenger cars or buses. Applied data of 1996, 81.3 passengers per bus or 0.0125 bus per passenger.
6) Numbers of buses was obtained by product of 0.0123 and bus passengers
7) Numbers of passenger cars was obtained as difference of total numbers of vehicles and summation of Pickups, Trucks and Buses.

Results are seen in Table 5.2.1. Figures in PCU are also seen in the same table.

5.3 FUTURE LAND USE

Requirements of the land by usage were estimated based on socioeconomic data first as total. These requirements were divided into each zone considering zone characteristics. The results are shown in Table 5.3.1 (1~5) for the required target years of 1996, 2001, 2005, 2015 and 2025.

Table 5.2.1 Population, GDP in Future and Car Ownership

Items	Growth Rate (%, 90-97)	Year 1990	1996	1997	2001	2005	2015	2025
Population								
Population (living in Grenada)	0.7	94,700	98,900	99,592	102,41	105,30	112,91	121,07
Live Births	-2.6	2,448	2,096	2,111	2,171	2,233	2,394	2,567
Deaths	-0.5	808	782	787	809	832	892	956
GDP								
GDP at Current Market Price (EC$ mn)	4.9	597	797	836	1,012	1,226	1,978	3,192
GDP at Constant 1990 Price (EC$ mn)	2.2	478	543	555	605	660	821	1,021
GDP / capita (US$ / capita)	4.2	2,333	2,985	3,109	3,661	4,311	6,488	9,763
Car Ownership								
Car Ownership Rate	na	(82)	120	122	134	147	184	231
Total Number of Vehicles	na	(7,807)	11,941	12,182	13,716	15,443	20,776	27,948
of which, Passenger Car	na	(5,454)	8,517	8,793	10,045	11,463	15,852	21,811
Pickup	na	(1,220)	1,620	1,606	1,808	2,036	2,739	3,685
Truck	na	(576)	840	858	937	1,022	1,270	1,579
Bus	na	(557)	964	925	926	922	914	873
Total PCU	na	(8,547)	13,095	13,331	14,928	16,721	22,249	29,648
of which, Passenger Car	na	(5,454)	8,517	8,793	10,045	11,463	15,852	21,811
Pickup	na	(1,220)	1,620	1,606	1,808	2,036	2,739	3,685
Truck	na	(1037)	1,512	1,545	1,686	1,839	2,286	2,842
Bus	na	(836)	1,446	1,387	1,389	1,383	1,372	1,310
PCU/Car	na	1.09	1.10	1.09	1.09	1.08	1.07	1.06

Note: Figures in parentheses are those of 1991.
"na" is not applied.

Table 5.3.1(1) Future Land Use (1996)

Code	Parish	Electoral Zone	Total Area (km2)	1996 Pop/Area (psn/km2)	Population (psn)	Town (km2)	Village (km2)	Industry (km2)	Agricult. (km2)	Forestry (km2)	Others (km2)
National			348	284	98,893	2.35	6.39	0.02	205.20	108.52	22.52
Zonal											
1	Carriacou	Carriacou	34	146	4,965	0.00	0.00	0.00	17.93	13.94	2.13
2	St. Andrew's	St. Andrew's South East	23	235	5,406	0.00	0.39	0.00	16.53	5.21	0.87
3		St. Andrew's South West	29	239	6,930	0.00	0.00	0.00	21.22	6.67	1.11
4		St. Andrew's North East	25	238	5,944	0.20	0.00	0.00	18.12	5.73	0.95
5		St. Andrew's North West	21	241	5,053	0.00	0.00	0.00	15.35	4.85	0.80
6	St. David's	St. David's	39	263	10,250	0.00	0.47	0.00	23.01	13.55	1.97
7	St. George's	Town of St. George's	9	700	6,296	1.41	0.00	0.00	3.86	2.65	1.08
8		St. George's North East	12	758	9,090	0.00	1.62	0.00	4.97	3.84	1.57
9		St. George's North West	8	727	5,814	0.00	1.03	0.00	3.52	2.45	1.00
10		St. George's South East	9	776	6,986	0.00	1.24	0.00	3.60	2.95	1.21
11		South St. George's	14	653	9,137	0.00	1.64	0.02	6.91	3.86	1.57
12	St. John's	St. John's	39	208	8,111	0.36	0.00	0.00	22.92	14.17	1.55
13	St. Mark's	St. Mark's	39	113	4,397	0.19	0.00	0.00	20.27	13.67	4.87
14	St. Patrick's	St. Patrick's East	18	251	4,517	0.00	0.00	0.00	11.49	6.43	0.08
15		St. Patrick's West	26	231	5,997	0.19	0.00	0.00	15.50	8.55	1.76

Table 5.3.1(2) Future Land Use (Continued, 2001)

Code	Parish	Electoral Zone	Total Area (km2)	2001 Pop/Area (psn/km2)	Population (psn)	Town (km2)	Village (km2)	Industry (km2)	Agricult. (km2)	Forestry (km2)	Others (km2)
National			348	294	102,410	2.43	6.62	0.02	204.88	108.52	22.52
Zonal											
1	Carriacou	Carriacou	34	151	5,131	0.00	0.00	0.00	17.93	13.94	2.13
2	St. Andrew's	St. Andrew's South East	23	243	5,586	0.00	0.40	0.00	16.52	5.21	0.87
3		St. Andrew's South West	29	248	7,182	0.00	0.00	0.00	21.22	6.67	1.11
4		St. Andrew's North East	25	245	6,137	0.21	0.00	0.00	18.11	5.73	0.95
5		St. Andrew's North West	21	249	5,239	0.00	0.00	0.00	15.35	4.85	0.80
6	St. David's	St. David's	39	273	10,643	0.00	0.49	0.00	22.99	13.55	1.97
7	St. George's	Town of St. George's	9	726	6,530	1.46	0.00	0.00	3.81	2.65	1.08
8		St. George's North East	12	786	9,435	0.00	1.68	0.00	4.91	3.84	1.57
9		St. George's North West	8	752	6,017	0.00	1.07	0.00	3.48	2.45	1.00
10		St. George's South East	9	804	7,238	0.00	1.28	0.00	3.56	2.95	1.21
11		South St. George's	14	676	9,469	0.00	1.70	0.02	6.85	3.86	1.57
12	St. John's	St. John's	39	215	8,398	0.37	0.00	0.00	22.91	14.17	1.55
13	St. Mark's	St. Mark's	39	116	4,543	0.20	0.00	0.00	20.26	13.67	4.87
14	St, Patrick's	St, Patrick's East	18	259	4,657	0.00	0.00	0.00	11.49	6.43	0.08
15		St, Patrick's West	26	239	6,205	0.20	0.00	0.00	15.49	8.55	1.76

Table 5.3.1(3) Future Land Use (Continued 2005)

Code	Parish	Electoral Zone	Total Area (km2)	2005 Pop/Area (psn/km2)	Population (psn)	Town (km2)	Village (km2)	Industry (km2)	Agricult. (km2)	Forestry (km2)	Others (km2)
National			348	303	105,308	2.49	6.77	0.02	204.67	108.52	22.52
Zonal											
1	Carriacou	Carriacou	34	170	5,766	0.00	0.00	0.00	17.93	13.94	2.13
2	St. Andrew's	St. Andrew's South East	23	249	5,721	0.00	0.41	0.00	16.51	5.21	0.87
3		St. Andrew's South West	29	253	7,348	0.00	0.00	0.00	21.22	6.67	1.11
4		St. Andrew's North East	25	252	6,301	0.21	0.00	0.00	18.11	5.73	0.95
5		St. Andrew's North West	21	255	5,352	0.00	0.00	0.00	15.35	4.85	0.80
6	St. David's	St. David's	39	279	10,875	0.00	0.50	0.00	22.98	13.55	1.97
7	St. George's	Town of St. George's	9	742	6,679	1.50	0.00	0.00	3.77	2.65	1.08
8		St. George's North East	12	803	9,638	0.00	1.72	0.00	4.87	3.84	1.57
9		St. George's North West	8	770	6,160	0.00	1.09	0.00	3.46	2.45	1.00
10		St. George's South East	9	822	7,401	0.00	1.31	0.00	3.53	2.95	1.21
11		South St. George's	14	692	9,689	0.00	1.74	0.02	6.81	3.86	1.57
12	St. John's	St. John's	39	220	8,591	0.38	0.00	0.00	22.90	14.17	1.55
13	St. Mark's	St. Mark's	39	120	4,666	0.20	0.00	0.00	20.26	13.67	4.87
14	St, Patrick's	St, Patrick's East	18	265	4,770	0.00	0.00	0.00	11.49	6.43	0.08
15		St, Patrick's West	26	244	6,351	0.20	0.00	0.00	15.49	8.55	1.76

Table 5.3.1(4) Future Land Use (Continued 2015)

Code	Parish	Electoral Zone	Total Area (km^2)	2015 Pop/Area (psn/km^2)	Population (psn)	Town (km^2)	Village (km^2)	Industry (km^2)	Agricult. (km^2)	Forestry (km^2)	Others (km^2)
National			348	324	112,916	2.68	7.30	0.03	203.95	108.52	22.52
Zonal											
1	Carriacou	Carriacou	34	167	5,663	0.00	0.00	0.00	17.93	13.94	2.13
2	St. Andrew's	St. Andrew's South East	23	268	6,165	0.00	0.44	0.00	16.48	5.21	0.87
3		St. Andrew's South West	29	273	7,916	0.00	0.00	0.00	21.22	6.67	1.11
4		St. Andrew's North East	25	272	6,768	0.23	0.00	0.00	18.09	5.73	0.95
5		St. Andrew's North West	21	275	5,779	0.00	0.00	0.00	15.35	4.85	0.80
6	St. David's	St. David's	39	300	11,707	0.00	0.54	0.00	22.94	13.55	1.97
7	St. George's	Town of St. George's	9	799	7,188	1.61	0.00	0.00	3.66	2.65	1.08
8		St. George's North East	12	865	10,381	0.00	1.65	0.00	4.74	3.84	1.57
9		St. George's North West	8	830	6,638	0.00	1.18	0.00	3.37	2.45	1.00
10		St. George's South East	9	886	7,977	0.00	1.42	0.00	3.42	2.95	1.21
11		South St. George's	14	746	10,437	0.00	1.87	0.03	6.67	3.86	1.57
12	St. John's	St. John's	39	237	9,252	0.41	0.00	0.00	22.87	14.17	1.55
13	St. Mark's	St. Mark's	39	129	5,015	0.22	0.00	0.00	20.24	13.67	4.87
14	St, Patrick's	St, Patrick's East	18	286	5,154	0.00	0.00	0.00	11.49	6.43	0.08
15		St, Patrick's West	26	264	6,856	0.22	0.00	0.00	15.47	8.55	1.76

Table 5.3.1(5) Future Land Use (Continued, 2025)

Code	Parish	Electoral Zone	Total Area (km2)	2025 Pop/Area (psn/km^2)	Population (psn)	Town (km2)	Village (km^2)	Industry (km^2)	Agricult. (km^2)	Forestry (km^2)	Others (km^2)
National			345	348	121,074	2.84	7.71	0.04	203.38	108.52	22.52
Zonal											
1	Carriacou	Carriacou	34	201	6,824	0.00	0.00	0.00	17.93	13.94	2.13
2	St. Andrew's	St. Andrew's South East	23	290	6,659	0.00	0.48	0.00	16.44	5.21	0.87
3		St. Andrew's South West	29	294	8,523	0.00	0.00	0.00	21.22	6.67	1.11
4		St. Andrew's North East	25	288	7,201	0.24	0.00	0.00	18.06	5.73	0.95
5		St. Andrew's North West	21	296	6,215	0.00	0.00	0.00	15.35	4.85	0.80
6	St. David's	St. David's	39	323	12,603	0.00	0.58	0.00	22.90	13.55	1.97
7	St. George's	Town of St. George's	9	839	7,553	1.69	0.00	0.00	3.58	2.65	1.08
8		St. George's North East	12	909	10,905	0.00	1.94	0.00	4.65	3.84	1.57
9		St. George's North West	8	882	7,059	0.00	1.25	0.00	3.30	2.45	1.00
10		St. George's South East	9	931	8,382	0.00	1.49	0.00	3.35	2.95	1.21
11		South St. George's	14	784	10,969	0.00	1.97	0.04	6.56	3.86	1.57
12	St. John's	St. John's	39	253	9,855	0.44	0.00	0.00	22.84	14.17	1.55
13	St. Mark's	St. Mark's	39	139	5,406	0.23	0.00	0.00	20.23	13.67	4.87
14	St, Patrick's	St, Patrick's East	18	309	5,555	0.00	0.00	0.00	11.49	6.43	0.08
15		St, Patrick's West	26	283	7,365	0.23	0.00	0.00	15.46	8.55	1.76

The land use in 2005 is illustrated in Figure 5.3.1. To predict this work, the past changes of land use were examined by cross checking Topographical Maps (prepared in 1979), Aerial Photographs (1992), Land Use Maps prepared by FAO (1995) and Field Surveys done by the team (1997). Only minor changes were seen during the last 18 years (1979-1997). The future land use was imaged on the same line of the past changes.

5.4 ZONE PROFILE

The zonal socioeconomic data related to traffic demand forecast are summarized in Table 5.4.1 based on the applied electoral system of the country.

5.5 FUTURE OD MATRICES

Due to shortage of available and collected data, OD matrices of all purposes by all vehicles were estimated in PCU base for the years 2001, 2005, 2015 and 2025. The PCU of each target year is shown in Table 5.2.1.

These matrices were based on the PCU-base OD matrices of 1997 and expanded in proportion to the increment of vehicles. The concluded OD matrices are shown in Table 5.5.1 to 4.

5.6 ROAD NETWORK

5.6.1 Road Class

For the purpose of establishing link-data system for traffic assignment procedure on the road network, roads of Grenada were classified into five ranks by link based on the field investigation by the team, which were:

1. Four lanes road; Point Salines Airport to Sugar Mill Roundabout
2. Two lanes road, class a; two lanes in general
3. Two lanes road, class b; two lanes with bad surface and/or poor sight distance at curve sections
4. One lane road, class a; one lane in general
5. One lane road, class b; one lane with very bad surface

Classified roads are shown in Figure 5.6.1.

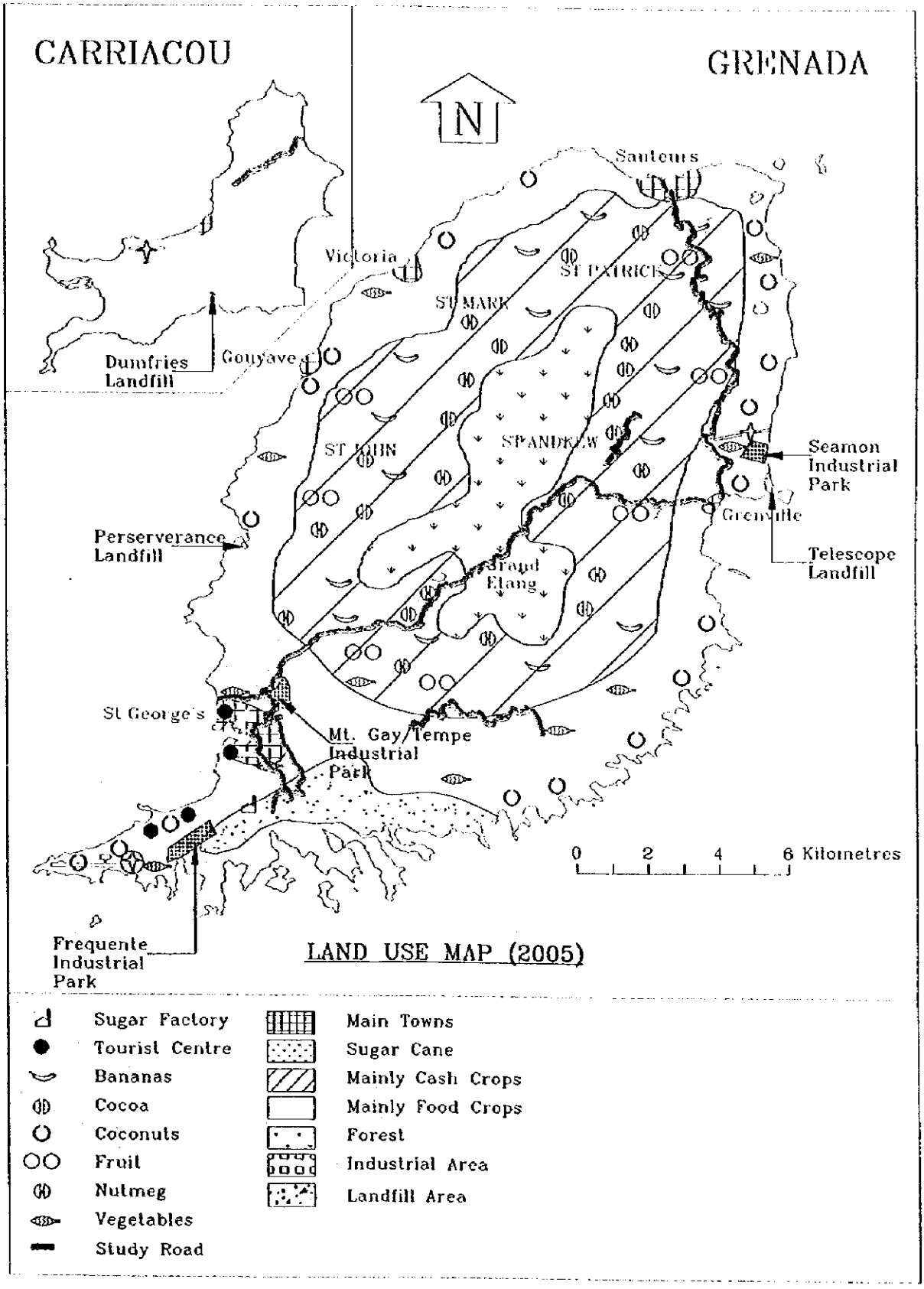


Figure 5.3.1 Land Use Map (2005)

Table 5.4.1 Zonal Profile

Code	Parish	Electoral Zone	Total Area (km2)	1996 Population (psn)	1996 Cars (unit)	2001 Population (psn)	2001 Cars (unit)	2005 Population (psn)	2005 Cars (unit)	2015 Population (psn)	2015 Cars (unit)	2025 Population (psn)	2025 Cars (unit)
National			348	98,893	11,941	102,410	13,716	105,308	15,443	112,916	32,570	121,074	43,633
Zonal													
1	Carriacou	Carriacou	34	4,965	455	5,131	523	5,766	643	5,663	1,242	6,824	1,664
2	St. Andrew's	St. Andrew's South East	23	5,406	496	5,586	570	5,721	638	6,165	1,352	6,659	1,812
3		St. Andrew's South West	29	6,930	1,145	7,182	1,315	7,348	1,476	7,916	3,124	8,523	4,185
4		St. Andrew's North East	25	5,944	436	6,137	501	6,301	563	6,788	1,191	7,201	1,595
5		St. Andrew's North West	21	5,053	371	5,239	426	5,352	478	5,779	1,012	6,215	1,356
6	St. David's	St. David's	39	10,250	753	10,643	865	10,875	971	11,707	2,054	12,603	2,751
7	St. George's	Town of St. George's	9	6,296	1,696	6,530	1,948	6,679	2,186	7,188	4,625	7,553	6,196
8		St. George's North East	12	9,090	1,002	9,435	1,151	9,638	1,291	10,381	2,732	10,905	3,660
9		St. George's North West	8	5,814	711	6,017	817	6,160	917	6,638	1,940	7,059	2,599
10		St. George's South East	9	6,986	1,155	7,238	1,327	7,401	1,487	7,977	3,149	8,382	4,219
11		South St. George's	14	9,137	1,678	9,469	1,927	9,689	2,162	10,437	4,577	10,969	6,131
12	St. John's	St. John's	39	8,111	893	8,398	1,026	8,591	1,150	9,252	2,436	9,855	3,264
13	St. Mark's	St. Mark's	39	4,397	323	4,543	371	4,666	417	5,015	880	5,406	1,179
14	St. Patrick's	St. Patrick's East	18	4,517	387	4,657	444	4,770	497	5,154	1,055	5,555	1,414
15		St. Patrick's West	26	5,997	440	6,205	505	6,351	567	6,856	1,201	7,365	1,608

Table 5.5.1 PCU-base OD Matrix (2001, All Purposes by All Vehicles)

Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1	778	0	0	0	0	0	0	0	0	0	0	0	0	0	0	778
2	0	103	45	19	28	85	134	5	30	138	62	97	35	30	35	846
3	0	22	234	18	193	55	590	22	25	36	631	104	11	8	11	1,960
4	0	19	21	113	50	48	167	5	15	78	118	57	19	15	19	744
5	0	49	189	28	78	32	57	3	9	42	87	31	11	9	11	636
6	0	61	83	44	23	156	92	94	69	216	125	156	61	51	61	1,292
7	0	154	683	164	71	40	515	554	312	65	22	49	17	117	144	2,907
8	0	12	25	7	3	85	548	296	76	139	435	64	10	8	9	1,717
9	0	21	27	29	7	56	415	103	183	52	195	65	24	17	22	1,216
10	0	111	99	47	35	249	47	136	147	349	182	276	104	87	107	1,976
11	0	128	483	159	75	94	40	425	216	249	509	180	64	125	125	2,872
12	0	90	39	64	28	203	38	35	80	318	155	234	84	71	89	1,528
13	0	33	10	24	12	76	13	16	28	120	34	87	66	26	6	551
14	0	25	8	16	17	57	100	5	13	93	132	66	24	79	24	659
15	0	21	14	15	14	52	148	15	15	84	187	61	21	17	91	755
Total	778	849	1,960	747	634	1,288	2,904	1,714	1,218	1,979	2,874	1,527	551	660	754	20,437

Table 5.5.2 PCU-base OD Matrix (2005, All Purposes by All Vehicles)

Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1	916	0	0	0	0	0	0	0	0	0	0	0	0	0	0	916
2	0	127	49	22	29	88	140	5	31	146	70	101	35	31	37	911
3	0	23	293	19	202	57	598	22	24	37	694	104	10	9	11	2,103
4	0	19	22	144	52	49	168	5	15	85	131	58	21	15	19	803
5	0	50	197	30	95	32	59	3	8	46	98	32	12	9	11	682
6	0	60	86	44	23	194	95	95	72	236	145	155	62	52	65	1,384
7	0	158	710	167	75	42	653	560	320	68	24	48	18	122	147	3,112
8	0	13	26	6	4	84	545	385	75	144	471	62	8	7	9	1,839
9	0	23	28	32	8	60	448	109	235	0	229	67	25	19	23	1,306
10	0	127	118	52	39	284	56	155	169	445	0	322	123	100	127	2,117
11	0	135	501	164	80	97	41	428	221	263	646	182	65	129	129	3,081
12	0	93	40	66	30	207	41	33	80	335	174	294	86	73	87	1,639
13	0	34	10	23	14	79	14	16	29	126	40	91	83	27	7	593
14	0	25	8	17	18	59	103	5	14	100	148	65	23	99	24	708
15	0	22	14	15	14	52	152	16	14	87	209	59	23	17	113	807
Total	916	909	2,102	801	683	1,384	3,113	1,837	1,307	2,118	3,079	1,640	594	709	809	22,001

Table 5.5.3 PCU-base OD Matrix (2015, All Purposes by All Vehicles)

Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
1	1,107	0	0	0	0	0	0	0	0	0	0	0	0	0	1,107
2	0	145	65	28	40	121	192	7	43	195	87	138	51	42	1,205
3	0	31	333	26	276	78	838	30	36	52	897	147	15	12	2,786
4	0	28	30	161	71	68	238	7	22	111	168	81	28	22	1,063
5	0	70	268	40	111	45	81	4	12	60	124	44	15	12	901
6	0	86	117	62	32	222	129	134	98	308	177	222	86	72	1,831
7	0	218	969	233	101	56	730	786	442	93	30	70	24	167	4,122
8	0	17	36	10	4	121	778	420	108	197	618	90	14	11	2,436
9	0	30	38	42	10	80	590	145	260	73	278	94	33	25	1,729
10	0	157	141	67	50	353	67	193	210	495	258	392	149	125	2,809
11	0	183	687	226	108	133	56	604	308	353	721	256	92	177	4,082
12	0	128	55	90	41	289	54	51	113	451	220	333	119	101	2,171
13	0	46	13	33	17	109	19	24	40	170	48	124	95	37	785
14	0	37	12	23	25	82	142	8	18	132	187	95	34	112	941
15	0	30	19	21	20	74	210	22	21	119	267	87	30	24	1,073
Total	1,107	1,206	2,783	1,062	906	1,831	4,124	2,435	1,731	2,810	4,080	2,173	785	939	29,041

Table 5.5.4 PCU-base OD Matrix (2025, All Purposes by All Vehicles)

Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
1	1,611	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,611
2	0	193	86	37	52	160	245	9	56	250	112	184	66	56	67	1,573
3	0	42	445	34	364	102	1,079	40	47	67	1,155	193	19	17	20	3,624
4	0	36	40	208	93	89	300	8	29	140	213	102	38	28	35	1,359
5	0	91	355	53	144	59	102	5	15	77	159	57	20	16	20	1,173
6	0	111	154	80	42	292	164	172	131	399	227	288	113	93	114	2,380
7	0	280	1,250	292	128	72	908	992	563	115	37	87	31	215	261	5,231
8	0	22	48	13	6	156	978	536	140	250	779	115	17	13	17	3,090
9	0	41	49	54	12	104	750	188	339	95	353	119	44	33	41	2,222
10	0	201	181	86	62	450	84	244	269	618	321	502	189	160	197	3,564
11	0	237	887	286	137	170	71	761	391	442	899	321	119	229	230	5,180
12	0	168	71	117	54	376	72	63	142	570	282	426	156	134	162	2,793
13	0	62	19	42	22	142	25	31	51	216	63	163	125	49	12	1,022
14	0	47	16	32	33	110	183	11	23	171	239	123	44	150	44	1,226
15	0	41	26	27	26	97	270	29	27	154	341	111	40	33	170	1,392
Total	1,611	1,572	3,627	1,361	1,175	2,379	5,231	3,089	2,223	3,564	5,180	2,791	1,021	1,226	1,390	37,440

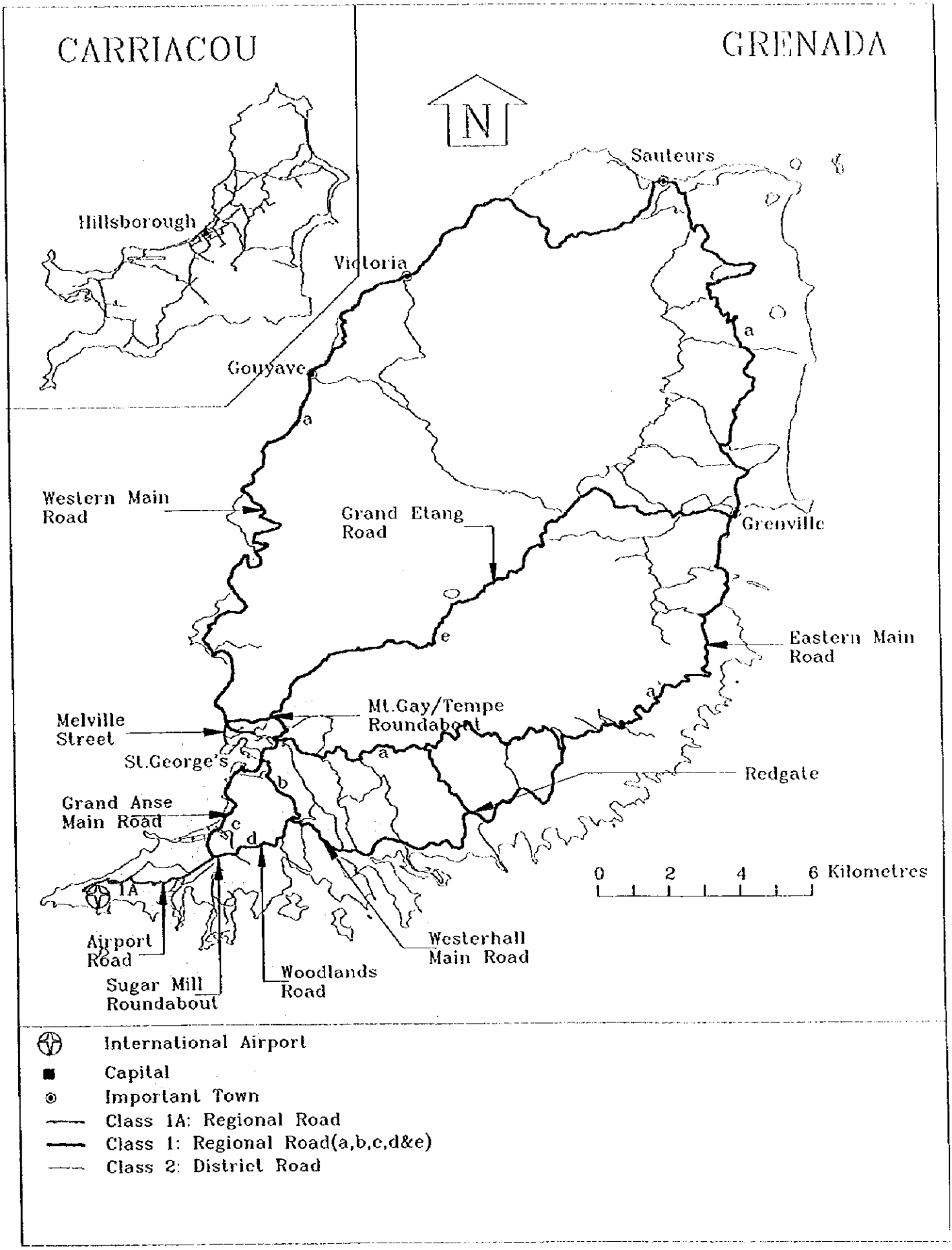


Figure 5.6.1 Present Road Network

5.6.2 Velocity and Road Class

Maximum driving speed by road classification was defined based on the driving speed survey results, as presented in Table 5.6.1.

Table 5.6.1 Standard Velocity and Road Class

Road Class	Velocity (km/hr)
Four lanes road	55
Two lanes road, class a	55
Two lanes road, class b	30
One lane road, class a	35
One lane road, class b	15

5.6.3 Capacity and Road Class

The capacity of roads was prepared basically by following the methodology of the Highway Capacity Manual (HCM) as follows:

1) Hourly traffic capacity / lane of typical highway is 1,120 PCU / hour (HCM).It is considered as the standard capacity of a lane.
2) The peak ratio clarified by traffic counts measured by the study team was 0.0955.
3) The standard daily capacity of one lane is considered as 1,120 / 0.0955 = 11,726 PCU / day / lane.
4) A capacity of the road was obtained by applying a degradation factor to the standard capacity. The degradation factors were quoted from the HCM and given a little modification to fit the road conditions of Grenada as presented in Table 5.6.2.
5) In general, shoulder widths of roads in Grenada are in the range of 1 - 0 meter. Considering that the average shoulder width is 0.3 meter (approximately 1 foot), road capacities by class were estimated as presented in Table 5.6.3.

Table 5.6.2 Degradation Factors

Shoulder (ft)	Lane (ft)					
	12	11	10	9	8	7
6	1.00	0.86	0.77	0.70	0.65	0.60
4	0.92	0.79	0.71	0.65	0.61	0.56
2	0.81	0.70	0.63	0.57	0.54	0.49
0	0.70	0.60	0.54	0.49	0.47	0.42

Table 5.6.3 Road Capacity (Daily)

Road Class	Average Road Width (m)	Average Road Width (ft)	Number of Lanes	Average Lane Width (ft)	Degrade. Factor	Road Capacity (PCU)
Four Lane	11.0	36.1	4	9.0	0.53	24,859
Two Lane Class a	6.0	19.7	2	9.9	0.57	13,368
Two Lane Class b	5.0	16.4	2	8.2	0.59	13,837
One Lane Class a	4.5	14.8	1	14.8	0.76	8,911
One Lane Class b	3.5	11.5	1	11.5	0.70	8,208

5.6.4 Maximum Speed and Capacity of the Study Roads

Regarding the improvement of Study Roads, three service levels were proposed as alternatives based on the three improvement options I, II & III of minimum improvement, rehabilitation and optimum improvement as explained in Chapter 7. In response to these proposals, the maximum driving speeds and capacities of the road were to be set in three different levels.

Each study road has several links and each link has different service level especially in lower service level cases. Based on this classification, Table 5.6.4 shows the maximum running speeds and road capacities in that range.

Table 5.6.4 Maximum Driving Speed and Capacity of the Study Roads

Road No.	Road Name	Option I		Option II		Option III	
		Speed	Capacity	Speed	Capacity	Speed	Capacity
R-1	Grand Etang Road	59	16,653	60	16,653	80	18,061
		48	9,382	60	12,666	80	18,061
R-2	Morne Jaloux Road	38	11,493	40	13,369	50	13,369
		38	9,499	40	11,493	50	13,369
R-3	St. David's/ Pardmontemps	38	7,388	45	10,789	50	13,369
		38	7,388	45	10,789	50	13,369
R-4	Mt. Gay / Springs	48	12,666	55	18,061	60	18,061
		48	12,666	55	12,666	60	18,061
R-5	Grenville/ Sauteurs	59	16,653	70	18,061	80	18,061
		59	6,684	70	13,369	80	18,061
R-6	Paraclete/Mt. Horne	42	11,493	60	13,369	60	13,369
		42	7,154	60	11,493	60	13,369
R-7	Dover	40	8,326	60	11,493	60	13,369
		40	11,493	60	11,493	60	13,368

Note: Option I : Minimum class improvement
Option II : Medium class improvement
Option III : Improvement to international standard

5.6.5 Networks

The networks of "Do Nothing" and "Do Nothing plus One" which includes the case of improving one project road under each of the improvement options, were prepared. Basic cases calculated are listed in Table 5.6.5 for the purpose of preliminary evaluation of the Study Roads. The effects of a combination of multiple improvement works examined at the final stages of the Feasibility Study stage.

Table 5.6.5 Cases Calculated

Improvement Level	Network	PCU-base OD (2001)	PCU-base OD (2005)	PCU-base OD (2015)	PCU-base OD (2025)
No Improvement	Do Nothing	x	x	x	x
Option I	R-1 Improvement	x	x	x	x
	R-2 Improvement	x	x	x	x
	R-3 Improvement	x	x	x	x
	R-4 Improvement	x	x	x	x
	R-5 Improvement	x	x	x	x
	R-6 Improvement	x	x	x	x
	R-7 Improvement	x	x	x	x
	All Road Imp.	x	x	x	x
Option II	R-1 Improvement	x	x	x	x
	R-2 Improvement	x	x	x	x
	R-3 Improvement	x	x	x	x
	R-4 Improvement	x	x	x	x
	R-5 Improvement	x	x	x	x
	R-6 Improvement	x	x	x	x
	R-7 Improvement	x	x	x	x
	All Road Imp.	x	x	x	x
Option III	R-1 Improvement	x	x	x	x
	R-2 Improvement	x	x	x	x
	R-3 Improvement	x	x	x	x
	R-4 Improvement	x	x	x	x
	R-5 Improvement	x	x	x	x
	R-6 Improvement	x	x	x	x
	R-7 Improvement	x	x	x	x
	All Road Imp.	x	x	x	x

5.7 DEMAND ON ROADS

Assignment results of the cases of "Do Nothing" and "All Road improved in Option III are shown in Figure 5.7.1 and 2. Due to the simple network, pattern of traffic flow did not change a lot. The only remarkable changes are:

1) Grand Etang Road increased traffic after improvement and Eastern Main Road decreased traffic equal to that increment.
2) Upper Eastern Main Road, St. David's / Perdmontemps section increased traffic and the same section of Lower Eastern Main Road decreased traffic of the same amount of the increment.

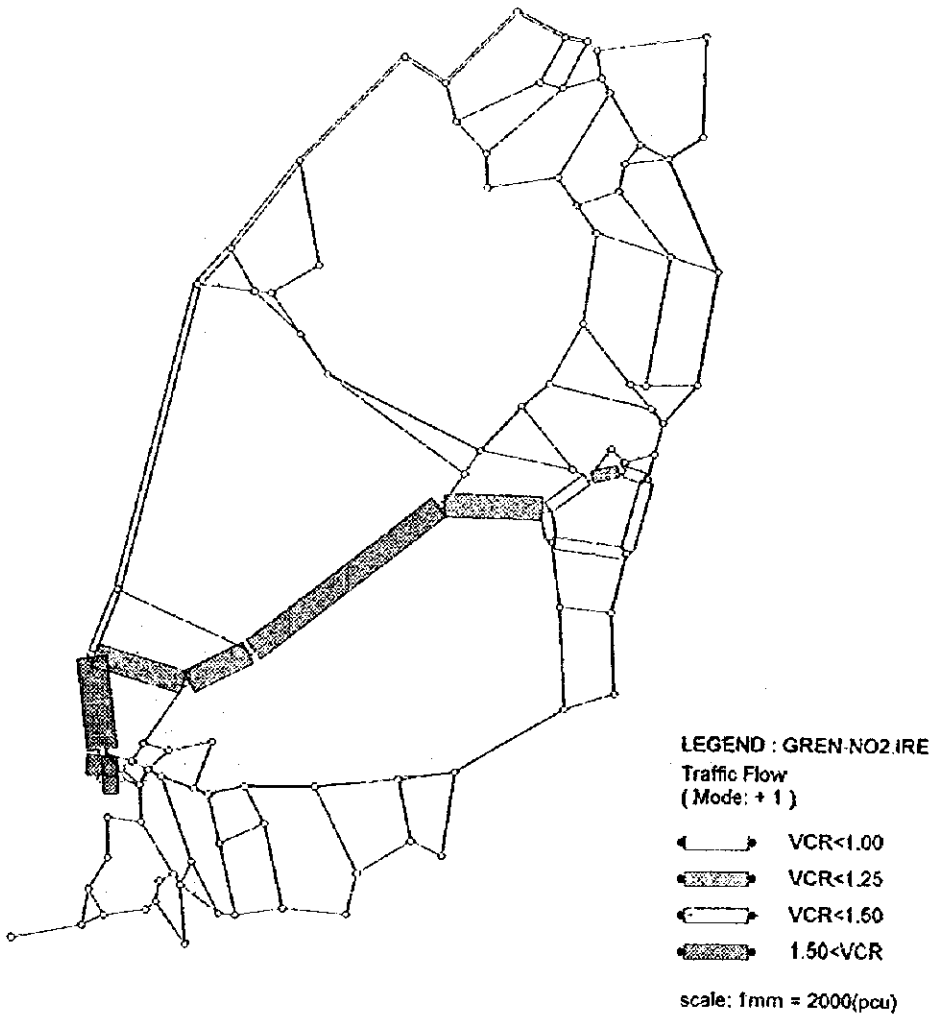


Figure 5.7.1 Assigned Traffic Volumes - Do Nothing Case

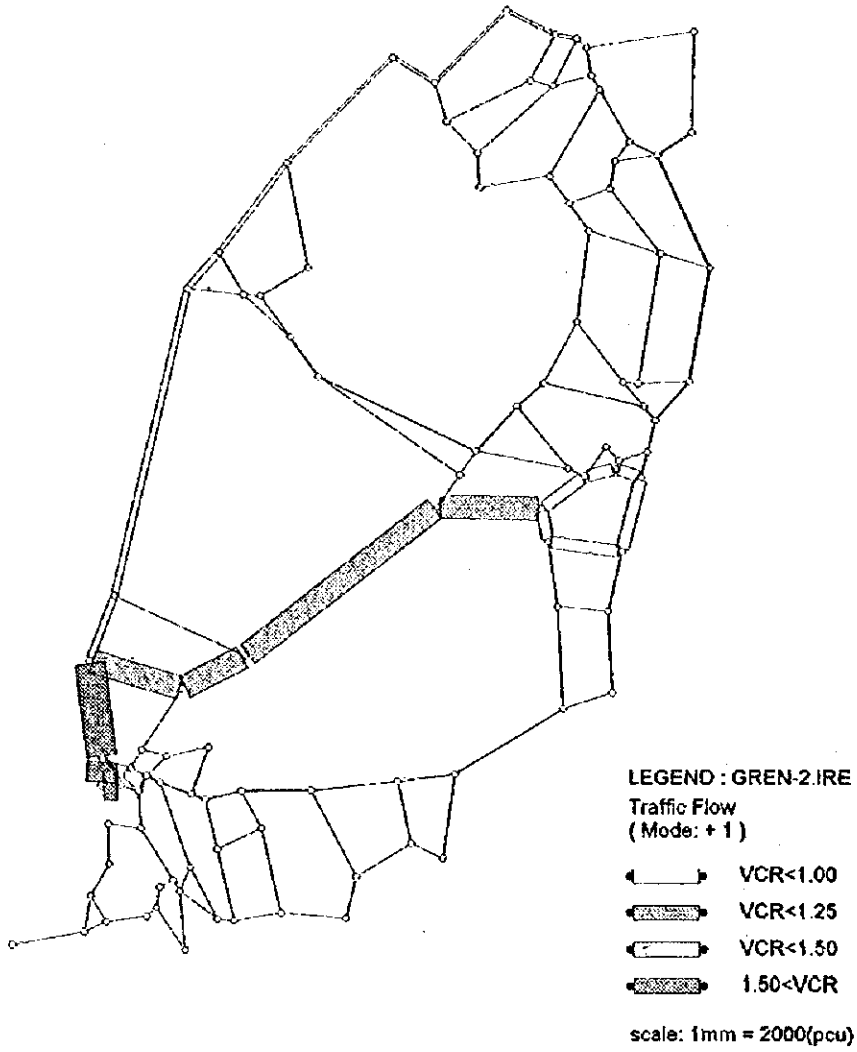


Figure 5.7.2 Assigned Traffic Volumes - Do All in Option III

Although traffic patterns had no significant changes, there were rather significant improvements in driving speed. Table 5.7.1 shows the total PCU-km and the total PCU-hr of both cases. A ratio of decrease of PCU-km was 0.5 % but a ratio of decrease of PCU-hr was 14.4 %.

Table 5.7.1 PCU-km and PCU-hr

Case	PCU-km / Day	PCU-hr / Day
Do Nothing Case (a)	383,452	8,580
Do All in Option III Case (b)	381,565	7,345
Difference (b) - (a)	-1,887	-1,235
Ratio (b) / (a)	0.995	0.856

CHAPTER 6

ENVIRONMENTAL SURVEY AND INITIAL EXAMINATION

CHAPTER 6

ENVIRONMENTAL SURVEY AND INITIAL EXAMINATION

6.1 ENVIRONMENTAL LEGISLATION

Currently the Government of Grenada (GOG) is reviewing legislation regarding environmental management. Environmental Impact Assessment's (EIA's) are not required by legislation but are routinely requested by the Land Development Control Authority (LDCA) for large projects. Although the GOG has not prepared any EIA guidelines that must be adhered to, the EIA should be prepared to current international standards.

6.2 NATURAL ENVIRONMENT

6.2.1 Natural Condition

(1) Overall Weather Condition

In St. George's in January the average daily high temperature is 30°, while the low average is 21°. In July the average daily high is 31° while the low average is 25°. During the rainy season, June, to November, rainfall average's 22 days a month in St. George's and the mean relative humidity is 78%. In the driest months, January to April, there is measurable rainfall 12 days a month and the humidity averages 71 %. Annual rainfall is about 1,500 mm in St. George's and more than 3,000 mm in the Grand Etang rainforest.

Carriacou is substantially drier than Grenada, averaging 1,000 ~ 1,500 mm of rain a year. The maximum rainfall in 24 hours was recorded at 233.3mm in the past 18 years at St. George's. The heavy rainfall on the island of Grenada, especially in the Grand Etang rainforest area, can lead to areas of erosion and disaster on the roads and in agricultural lands as well.

(2) Weather Conditions Along the Study Roads

The weather conditions along the Study Road are as shown in Table 6.2.1.The table shows that R-1, which passes through mountainous area, is subject to the highest rainfall and the lowest temperature in the mid-section.

Table 6.2.1 Weather Conditions Along the Study Roads

No	Name of Study Road	Area Division	Rainfall (mm)	Temperature (°C)
			Mean Annual	Mean Average
1	Grand Etang L = 20.5 km	St. George's ~ 3.2 km	1,500 ~ 2,000	25.0 ~ 27.5
		3.2 km ~ 4.8 km	2,000 ~ 3,000	25.0 ~ 27.5
		4.8 km ~ 6.8 km	3,000 ~ 4,000	22.5 ~ 27.5
		6.8 km ~ 9.8 km	more 4,000	22.5 ~ 25.0
		9.8 km ~ 10.3 km	3,000 ~ 4,000	22.5 ~ 25.0
		10.3 km ~ 12.3 km	3,000 ~ 4,000	25.0 ~ 27.5
		12.3 km ~ 13.5 km	2,000 ~ 3,000	25.0 ~ 27.5
		13.5 km ~ 20.5 km	1,500 ~ 2,000	25.0 ~ 27.5
2	Morne Jaloux L = 4.0 km	White Gun ~ The Cliff-Sugar Factory	1,500 ~ 2,000	25.0 ~ 27.5
3	Perdmontemps / St. David's L = 7.1 km	St. David's ~ 4.8 km	1,500 ~ 2,000	25.0 ~ 27.5
		4.8 km ~ 7.1 km	2,000 ~ 3,000	25.0 ~ 27.5
4	Mt. Gay / Springs L = 5.8 km	Mt. Gay ~ Sugar Factory Down stream about 600 m	1,500 ~ 2,000	25.0 ~ 27.5
5	Eastern Main Road (Grenville ~ Sauteurs) L = 3.1 km	Grenville ~ Sauteurs	1,500 ~ 2,000	25.0 ~ 27.5
6	Paraclete / Mt. Horne L = 3.4 km	Paraclete ~ Mirabeau Estate	1,500 ~ 2,000	25.0 ~ 27.5
7	Dover (Windward ~ Cherryhill) L = 3.1 km	Windward ~ Cherryhill	1,000 ~ 1,500	25.0 ~ 27.5

Data Source: Agro~Climatic Zones map, Land use Division, Ministry of Agriculture

(3) Flora and Fauna

Grenada has a varied ecosystem of rainforest, Montana thickets, elfin woodlands and lowland dry forests, breadfruit, immortal, flamboyant and palms are some of the more prominent trees. About a dozen troops of Mona monkeys, introduced from West Africa centuries ago, live in Grenada's forest areas. Other mammals are nine-banded armadillos (tatou), opossum (manicou), mongoose and a few agouti, the latter recently introduced to the he island.

Bird-life includes hummingbirds, pelicans, brown bodies, osprey hawks, endangered hook-billed kites, hooded tanagers and the Grenada Dove (National Bird). There are no poisonous snakes, but the island does have tree boas. These nocturnal serpents spend their daytimes wound around branches many meters above the ground, and therefore, human contact with the creatures is quite limited. The above flora and fauna's main habitat is in the Grand Etang forest area.

6.2.2 Affected Areas

(1) Area of Possible Natural Disaster and Erosion

As mentioned above, since the project areas on Grenada are subject to very heavy rain, there are many potential disaster, and erosion areas, especially given the steep slope areas along the study road. The disaster and erosion areas along the study road were investigated at the sites and the results are shown in the figures in Appendix 7.

(2) Rivers and Lakes

The rivers and the lakes affected by the project along the study road are as follows:

R-1: St. Johns River/ Beausejour River/ Great River
R-2: Woburn Bay River
The only lake in the project area is the Grand Etang Lake. This lake is off the road and it is not anticipated that it will be affected.
R-3: La Sagesse Bay River / La Petit Bacaye River/ St. Louis River
R-4: Woburn Bay River / Egmont Harbor River / Chemin River
R-5: Great River / Great River-Simon River / Antoine River / Catabasse River / Salle River / St. Patrick River - Irvins Bay River
R-6: Grand Bras River / Simon River / Tributaries of Simon River
R-7: There are no rivers crossing this road.

(3) Coastal Areas

There is no expected direct impact from the project actions on the coastal areas. During construction, marine life and other environmental characteristics should be carefully protected.

(4) Forest Reserves and National Parks

The forest reserve area is the Grand Etang forest. The Grand Etang study road is through forest reserve area.

6.3 SOCIOECONOMIC ENVIRONMENT

6.3.1 People and Properties

The Number of residences along the study roads are shown in Table 6.3.1. According to the table, the total households possibly affected by the project on Grenada are 1,122 and 45 on Carriacou.

People and properties affected by the project are also shown in Table 6.3.1. The population affected by the project are 4,488 on the island of Grenada and 180 on the island of Carriacou. The agricultural land affected by the project are indicated in the Land Use Map which is mentioned in Chapter 2. A site investigation was also conducted. According to the map, the four routes, which are Grand Etang, Eastern Main road, Paraclete/ Mt. Horne, and Perdmontemps / St. David's, are passing the mainly cash crops area which are producing major crops, i.e. Banana, Cocoa, Nutmeg and other fruits (Grapefruits and Breadfruits) for exporting. Two routes which are Mt.Gay/ Springs (R-4) and Morne Jaloux (R-2) are passing the Sugar Cane Land.

Table 6.3.1 People and Properties in the Project Influence Area

No	Study Road	House holds	Population	Agricultural Land **		Other
				Crop's Name	Area (km^2)	
R-1	Grand Etang L = 4.0 km	295	1,180	-Vegetable -Banana/Cocoa - Woods	5.7 6.0 4.5	Commercial Area=1.0 Km/ Housing, Partly Commercial = 3.3 km
R-2	Morne Jaloux L = 4.0 km	126	504	-Sugar -Corn, Potatoes -Vegetable	1.1 1.4 0.5	Housing, Partly Commercial Area=1.0 km
R-3	Perdmontemps/ St. David's: L=7.1 km	151	604	-Vegetable	5.0	Housing, Partly Commercial Area=2.1 km
R-4	Mt. Gay/ Springs L = 5.8 km	157	628	-Sugar -Vegetable -Woods	0.6 0.2 0.2	Commercial Area=1.2 km^2/ Housing, Partly Commercial = 3.6 km^2
R-5	Eastern Main Road (Grenville ~ Sauterus) L = 16.0 km	346	1,384	-Vegetable -Cocoa mixed with Banana	10.7 3.5	Housing partly Commercial Area = 1.8 Km^2
R-6	Paraclete/ Mt. Horne L = 3.4 km	47	188	-Cocoa mixed with Banana -Vegetable	2.9 0.5	
R-7	Dover (Windward ~ Cherryhill)	45	180			

Data Source: The Aero-photograph (S=1; 10,000) and the Site Investigation
* Population = Number of Residences x 4
** Based on the Land Use Map (S=1:25,000), Ministry of Agriculture

6.3.2 Socioeconomic Assets

Socioeconomic assets of areas along the Study Roads are shown in Table 6.3.2 and it is in brief as follows;

Table 6.3.2 Socioeconomic Assets of Area Along the Study Road

No	Name of Study Road	Number of Schools	Number Of Churches	Number of community Centers	Remains and Cultural Assets		Enhancement of Economic Activities-Family Income at present - (EC$ / Month)
					Name	Number	
R-1	Grand Etang (St. George's~Grenville	10	9	6	None	0	4,020 ~ 2,710 ≤ Up
R-2	Morne jaloux (White Gun – Mt. Helicon ~The cliff –Sugar Factory	1	1	2	Fort Frederick Fort Matthew Fort Adolphus	3	4,020 ~ 2,910 ≤ Up
R-3	Perdmontemps / St. David's (St. David's~Perdmontemps)	4	3	7	None	0	2,910 ≤ Up
R-4	Mt. Gay / Springs (Mt. Gay ~ Sugar Factory downstream about 600m)	2	2	2	None	0	4,020 ~ 2,910 ≤ Up
R-5	Eastern Main Road / (Grenville ~ Sauteurs)	5	12	6	None	0	2,710 ~ 2,090 ≤ Up
R-6	Paraclete / Mt. Horne (Paraclete ~ (Mt. Horne) ~ Mirabeau Estate)	1	1	0	None	0	2,710 ≤ Up
R-7	Dover (Windward ~ Cherryhill) - Carriacou	0	0	0	None	0	5,080

Data Source:
1) The Topographic Map (S=1;25,000), Information of the EIA Review Committee of the Project and the Site Investigation
2) Contral Statistics Office, Ministry of Finance
3) US$=2.75 EC$

(1) Schools, Churches and Community Centers

According to the table, the number of schools, churches and community centers along the six Study Roads on Grenada are respectively 23, 28 and 23. On Carricou, the Study Roads do not have any schools, churches or community centers along it.

(2) Remains and Cultural Assets

In Grenada, three forts which are Ft. Fredrick, Ft. Matthew and Ft. Adolphus which were built in the Colonial Period, are existing along the Morne Jaloux study road. There are tourist attractions located on R-2.

(3) Enhancement of Economic Activities

For the time being, although the family incomes of the rural areas are low compared with St. George's which is the capital city of Grenada, it is expected that they will probably be increased with the project implementation.

6.4 INITIAL EXAMINATION ON NATURAL ENVIRONMENT

An Initial Environmental Examination (IEE) of the Natural Environment was carried out in an effort to provide preliminary data for an Environmental Impact Assessment (EIA). The EIA was conducted in the second stage by a local consultant with oversight from the JICA Study Team and the Ministry of Works.

6.4.1 Project Description

The IEE was carried out on the seven (7) existing Study Roads, six (6) of which are on Grenada and one (1) which is on Carriacou. The paved roads are currently in use and it is planned to rehabilitate and improve the roads depending on the priority of each road. It is not planned to realign any of the roads and widening beyond the current right-of-way is limited to very narrow sections and sharp curves.

6.4.2 Environmental Checklist

Road construction may have its effect on a part of the environment within the project area during the construction stage and/or after implementation, therefore, every reasonable precaution and countermeasure should be taken to minimize any

negative impacts and to help speed recovery of the disturbed areas. For the initial and tentative examination and screening, the checklist presented in Table 6.4.1, which identifies and briefly describes the many various impacts which are expected to result from a road project is used. For any particular a road project only a few of these impacts may be significant, and the purpose of this checklist is to identify those likely to be significant for that particular project. Environmental aspects in the checklist are grouped into two parts of the physical and socio-economical environment. The physical environment includes the natural aspects expected to be affected by the project, while the socio-economical environment includes the human factors. The completed checklists are presented in Appendix 7.

6.4.3 Natural Environment Examination

(1) Geology and Soils

Grenada is a volcanic island located near the edge of the Caribbean Tectonic Plate. The geological history of Grenada began approximately 38 million years ago in the upper Eocene Period and continued in the Oligocene Period with the sedimentary deposit known as the Tufton Hall Formation. Volcanic activity continued throughout the Miocene, Pliocene and Pleistoscene Periods. The last volcanic structures are 12,000 years old.

Carriacou is also volcanic and can be divided into two geological zones. The fossiliferous limestone which forms outcroppings in the eastern part of the island is mainly of Miocene age. Volcanic rocks comprising the remaining two thirds of the island consist of lava flows, lava domes and other volcanic products ranging in age from Miocene to Pliocene. Between Grenada and Carriacou there is an active submarine volcanic known as Kick-em-Jenny. Its latest eruption was in 1978. The soils of Grenada are dominated by clay looms, followed by clays and sandy looms. The dominant soil forming factors are climate and topography. Climate being the more important given the differences in total annual rainfall and the length of the dry season. Table 6.4.2 summarizes the environmental characteristics along the study roads.

(2) Topography and Hydrology

Grenada is characterized by rugged mountainous terrain in the interior and a more subdued rolling terrain on the coastal periphery. The principal peak, Mount St. Catherine (840m), rises in the northern half of the island as the centre of a massif surrounded by lessor peaks and ridges. From these central mountains the level descends fairly regularly to the sea. The rolling coastal terrain is probably due to

fluviatile and mass movement processes removing material from elevated areas and depositing that material in the lowlands. There are some lowland areas in the

Table 6.4.1 Checklist for Initial Environmental Examination

Project No. – Project Name

Segment Province Length (km) Project Type

	Check Item	During Construction		After Construction		Remarks
		Assessment	Mitigation Measures	Assessment	Mitigation Measures	
Physical Environment	Air Pollution					
	Water Pollution					
	Noise Pollution					
	Vibration					
	Soil Contamination					
	Land Subsidence					
	Soil Erosion					
	Flora					
	Fauna					
Socioeconomical Environment	Population Change					
	Resettlement					
	Community Cohesion					
	Land-use Pattern					
	Industrial Activity					
	Employment & Income					
	Traffic Build-up					
	Traffic Safety					
	Archaeology					

Assessment: A: High Positive Impact B: Low Positive Impact C: No Impact E: High Negative Impact D: Low Negative Impact

Table 6.4.2 Summary of Environmental Characteristics Along the Study Road

Item	Grand Etang Road L = 20.5 km	Morne Jaloux Road L = 3.2 km	St. David's – Perdmontemps L = 7.1 km	Mt. Gay – Springs L = 5.8 km	Eastern Main Road (Grenville -Sauteurs) L = 16.0 km	Paraclete – Mt. Horne L = 3.2 km	Dover – Carriacou (Windward-Cherynill) L = 3.1 km
I. Natural Environment							
Weather, Annual rainfall (mm)	1,500 – 4,000	1,500 – 2,000	1,500 – 3,000	1,500 – 2,000	1,500 – 2,000	1,500 – 2,000	1,000 – 1,500
Average temperature (°C)	22.5 – 27.5	25.0 – 27.5	25.0 – 27.5	25.0 – 27.5	25.0 – 27.5	25.0 – 27.5	25.0 – 27.5
Topography/ :Topography	F-R-M-R-F	R	M	R	F-R-F	R	R
Geology Slope/Bridge	Em,Cut,/Old, Overflow	Good / Good	Em,Cut/Bailey Bridge	Stable / Flooded	Good/Narrow,	Em/Narrow,Cr	Good / Good
Condition	As-Vi-Ve-Sg-AS	Ps	Ve	Vb-Ps-As-Ps	Scoring	ack	Ps
Geology					Sg-As-Vi-Va-V1-As	Vc	
Flora / Fauna : Flora	Evergreen • Rainforest	Crop / Sugar Cane	Crop	Forest / Sugar Cane	Cash Crop	Cash Crop	
Fauna	Mona Monkey & Animals						
River & Lake (Required Rehabilitation)	5 Bridges / 1 Lake	None	5 Bridges	1 Bridge	5 Bridges	2 Bridges	None
II. Social Environment							
Residences / Population (Number)	295 / 1,180	126 / 504	151 / 604	157 / 628	346 / 1,384	47 / 188	45 / 180
School / Church / Community Centers etc.	10 / 9 / 6	1 / 1 / 2 3 Forts	4 / 3 / 7	2 / 2 / 2	5 / 12 / 6	1 / 1 / 0	None
Land Use	Towns • Suburban Rainforest / Crops	Suburban Crops / Sugar Cane	Suburban Crops	Towns • Suburban Forest / Crops / Sugar	Suburban Crops	Crops	Grass
Economy / Traffic Condition	St.George's & Grenville; - Commercial area - Industries Commuting Road	Tourism; 3 Forts = Frederick; - Sugar Production Tourism Road	Food • Cash Crops -Vegetable, Fruits -Banana, Nutmeg, Daily Life Road	Commercial area -Sugar Production Bypass Road in Cities	Cash Crops / Partly Commercial Daily Life Road	Crops Daily Life Road	Crops Partly Commercial Daily Life Road
III. Pollution	None	Traffic Congestion	None	Traffic Congestion Offensive Odor of Sugar	None	None	None
Topographic Classification:	Flat=Flat Slope / Bridge:	R=Rolling Em=Surface Erosion	M=Mountainous Cut=Sliding				

Geological Classification: As=Alluvial and Superficial Deposits (recent Ld-Lava Domes) St=Tuffori Hall Formation (Late Eocene-Early Oligocene) Ps=Point saline Beds Sg=Great River Beds Va=lake Antoine Volcanics (Mecocene-Pilocene) Vb=Grand Anse Bay Volcanics (Miocene-Pilocene) Vc=Mount St. Catherine Volcanics (Pliocene-Pleistocene) Ve=South East Mountain Volcanics (Miocene) Vg=Mount Granby Volcanics (Miocene-Pleistocene) Vi=Indifferentiated volcanics mainly reworked (Pleistocene) V1=Levera Hill Volcanics (Miocene) Vm-Mount Craven Volcanics (Early Miocene-Pleistocene)

northeast at Levera and in the southwest at Pt. Salines. A summary of terrain of the study road is presented in Table 6.4.2. The rivers and lakes affected by this project are indicated in the figures in Appendix 7.

(3) Natural Vegetation

The existing natural vegetation of Grenada has largely been influenced by land-use history and differences in soil types and rainfall regimes. Except in the higher parts of the mountains, slopes are not excessively steep. As a result, with the small size of the island's land mass, large areas have been cleared for agriculture including fruit, cocoa and nutmeg.

In the interior, practically all the level was originally sold out to estates and cultivation was pushed to the highest practicable limit in most cases, although some owners reserved belts of forest on ridges for protective purposes. The Government began consolidation of a forest reserve in 1897 and today the Grand Etang Reserve now contain over 15 km^2.

Beard provided a classification of Grenada's natural vegetation in 1949 which includes Rain Forest and Lower Montane Rain Forest, Montane Thicket, Elfin Woodland and Palm Brake, Evergreen and Semi Evergreen Seasonal Forest, Deciduous Seasonal Forest/Cactusscrub Littoral Woodland, Swamp and Freshwater Marsh.

There is one Grenadian rain forest tree, "Maytenus Grenadensis" which is considered to be a single-island endemic and two plants; the fern "Donaea sp. (found in the Grand Etang region) and the Palmiste or Cabbage Palm "oreodoa oleracea".

Overall, Grenada has less vegetative diversity than other islands in the Lesser Antilles. A summary of the vegetation of the study roads is in Table 6.4.2.

(4) Wildlife

The Oceanic Islands such as Grenada present a relatively poor biological diversity. In Grenada, animal and plant migration would have only occurred by flight, winds, or as part of a large vegetative mat which would form in the Orinoco River and float haphazardly to Grenada. The majority of winged insects and birds are of North American origin indicating the islands is on the Northern Antillean migratory route.

Wildlife in Grenada can be summarized with the following descriptions:

1) Invertebrates

The decopod crustacean fauna of Grenada includes several species of freshwater shrimp and freshwater or terrestrial crabs. With the possible exception of the weevil "Diaprepes", there are no endemic invertebrates in Grenada. The centipede whose bite causes a swelling, is the only dangerous animal per se in Grenada.

2) Fishes

Grenada's fresh water fish fauna consists of about 12 species of gobies, mountain mullets, clingfish, etc. All the known species can move between fresh and salt water and some spawn at sea. Marine fishes and invertibrates found in Grenadian Coastal waters are those typical of the Lessor Antileon Region.

3) Amphibians

Grenada has 4 amphibian species on described below.

- The Giant Toad "Bufo marinas" which was introduced from South America.
- (b) The Highland Piping Frog "Eleutherodactylus urichi euphronides" which is confined to the wet forests around Grand Etang.
- (c) The Piping Frog "E. johnstonei".
- Garman's Woodland Frog "Leptoclactylus wagneri" which is also characteristic of the Grand Etang forests.

4) Reptiles

- Lizards

There are eight species of lizards reported in Grenada which include the Common Anole or Wall Lizard, the Crested Anole or Tree Lizard, the Mbouya Gecko (introduced from Aftrica), the Wood Slave Geck (an object of superstition), Garman's Ground Lizard, Allen's Ground Lizard, the Slipperyback Skink and the Green Iquana.

- Snakes

The following 5 species of snakes, none of which are venomous, are found in Grenada.

- The burrowing species Typhlops tasymicris (possibly endemic) found in St. Davids.

- The white headed warm snake "Leptotyphlops margaritae".
- The Tree Boa "Corallus enydris".
- Boddaert's Tree Snake "Mastigodyas bruesi".
- The constrictor or Cribo "Clelia clelia, a powerful constrictor, feared locally for its strength and it is also an excellent rodent exterminator.
- Two species of snakes are thought to be extinct in Grenada. They are Neuweid's Moon Snake and Shaw's racer.

- Tortoises and Turtles

The morocoy or red legged tortoise is thought to have been indigenous to Grenada and the Grenadines but was hunted to extinction. It has since been reintroduced. There are 4 sea turtles species which nest on the beaches on the Windward Side of Grenada and the Grenadines. The are classified as Leatherbacks, Loggerheads, Hawksbills and Greens.

5) Birds

There are about 150 species of birds that have been identified in Grenada and the Grenadines. The avi fauna is primarily tropical North American. Grenada and the Grenadines have thirty five (35) resident species of land birds and 15 species of breeding sea birds. Two birds are endemic to the island of Grenada only, a subspecies of the Hookbilled Kite and the Grenada Dove. There are several other species such as the Grenada Flycatcher, Scaly-breasted Thrasher, Lesser Antilleon Bullfinch and Lesser Antilleon Tanager that occur in Grenada and are endemic to the Lesser Antilleon region. Forests, wetlands and coastal habitats in the Lesser Antilles provide critical feeding and nesting habitat for the over 100 species of migratory birds. The birds nest in North America and over-winter in the Caribbean or South America.

6) Mammals

There are four (4) native species of terrestrial mammals that occur in Grenada as follows:

- The Nine Banded Armadillo or Tatou "Dasypus novemcinctus"
- The Lessor Chapmans Murine Oppossum "Marmosa fuscata carri"
- The Greater Chapmans Murine Oppossum "Marmosa robinsoni chapmani"
- The Aquote "Dosyprocta albida" (thought to be extinct).

Other mammals include 11 native species of bat, (with feeding habits, that

range from insects and fish to nectar and fruits), the Burmese mongoose (introduced from Jamaica in about 1870 to control rats), and the African Mona monkey (introduced from West Africa during the slave period).

(5) Natural Hazards

1) Hurricanes and Other Storms

Grenada is one of the Windward Islands within the hurricane belt of the Caribbean but it is located south of the 12°N latitude and is generally accepted as a safe zone. The last hurricane to hit Grenada was Janet in 1955. Since then several tropical storms have passed near Grenada.

2) Volcanic Activity

The volcanoes that formed Grenada and Carriacou are not active at the present time except for some hot springs. The "Kick'em Jenny" volcano, a submarine volcano located 7 kilometers north of Grenada, is an active volcano which last erupted in 1977.

3) Earthquakes

Grenada's location near the Carribean Plate margin make's it vulnerable to considerable seismic activity. Earthquakes of magnitude 3.2～3.9 on the Richter scale have been recorded with epicenters less than 50 miles south of Grenada. Grenada has not been subjected to any earthquake that has caused any damage or loss of life.

4) Rainfall

While rainfall in the south of Grenada is not considered heavy it can have quite high intensities and durations. The rainfall in the central interior is considered heavy and the area is wet all year.

5) Flooding

Floods can be the result of downslope rainwater run-off during heavy rains, storms or hurricanes especially over paved or deforested areas, and/or sea-water driven inland by above normal tides and surges. Flooding can cause mudslides and erosion to slopes and rivers. Flooding is known to occur in Grenada.

There are several bridges on the study roads that flood periodically and other flooding occurs in low-lying areas. Landslides due to heavy rainfall are prone to occur in steep slope areas. These potential environmental impacts need to be studied further to ascertain the specific areas requiring design considerations such as bridge reconstruction, channel widening and protection, slope protection, drainage, etc. to mitigate the potential problems.

6) Landslides and Rockslides

Landslides occur when the forces of gravity exceed the strength of the forces holding the soil material together resulting in a mass of soil being pulled downward. The severity of the event depends on the type of soil, the angle of repose and the steepness of the slope at the site. Landslides and rockslides are known to occur in Grenada.

(6) Soil Erosion and Slope Protection

Although the study roads are currently existing, the option of widening is under consideration as an improvement. Therefore, some new construction is anticipated which may affect a part of the environment within the project area. Every reasonable precaution should be taken to minimize the adverse effects and to help speed the recovery of the disturbed areas, not only within the right of way but also on adjacent land that may be affected. Some areas of consideration include:

- Safe transportation, storage and use of toxic materials such as fuels and lubricants
- Careful and selective clearing and grubbing
- Temporary erosion control
- Temporary and permanent slope protection to prevent erosion
- Temporary and permanent drainage structures to prevent erosion
- Geometric design standards to limit excessive slopes and cuts
- Proper construction specifications and control

(7) Hydrology

It is intended to reconstruct several bridges and culverts and to repair others during the construction phase of the project. This will have some impact on the waterways affected. These activities should be accomplished during the season of low flow as much as possible. Riverbanks should be stabilized using gabions on rip-rap in areas of possible scouring. Drainage structures should be installed to divert and disperse surface water flows in a manner to prevent erosion and to

protect slopes. Structures should be lined and energy dissipation used at discharge points to prevent erosion.

(8) Air Pollution

During construction the quality of the air will decrease due to air borne dust, especially during the dry season. Mitigating factors will include spraying down the road to control dust, covering materials so wind does not create dust and minimizing traffic to help control dust.

After construction it may possible that the air quality will improve slightly as a new pavement will help to control dust better than the some existing pavements in poor condition. Air pollution due to increased vehicle emissions is anticipated to be negligible.

(9) Noise and Vibration Pollution

It is clear that during construction there will be an increase in noise and vibration from equipment. Construction specifications should include the requirement for noise damped equipment. After construction noise and vibration pollution is not expected to increase significantly.

(10) Ecosystems

The highest priority road in the study, the Grand Etang Road, traverses through the Grand Etang Forest Reserve. This sensitive ecosystem is home to much of Grenada's flora and fauna. The other six roads do not seem to traverse through or near any sensitive ecosystems and therefore should not have any negative impact.

The Grand Etang Forest Reserve is not known to contain any threatened or endangered species of Grenadian plants. There is no expected direct impact from the project actions on any coastal ecosystems.
Grenada's wildlife does include several threatened or endangered species as described below.

- It appears that no invertebrates are threatened or endangered.
- Grenada's freshwater fish fauna may be threatened due to sedimentation and pollution in rivers. Two species are considered rare, the Tete-chien and the "Go-bird" Fish.
- Information is lacking about amphibians but they are not thought to be threatened.

- Among Reptiles the Iguana is reportedly becoming increasingly rare due to hunting and is considered threatened. Other species may be in danger of extinction due to the Mongoose predation. Most snakes are either rare or their status is uncertain. Two snakes are endangered and possibly extinct, the Moon Snake and Shaw's Racer. All marine turtles are listed as endangered by the IUCN.
- The Grenada Dove and the Hook-billed kite are listed as endangered by the International Council for Bird Preservation and the US Fish and Wildlife Service. The Carribean Conservation Association lists an additional 14 birds that are endangered in Grenada and another 34 species of birds are listed as vulnerable. The IUCN lists the Grenada Dove, the Grenada Hook Billed Kite and the Tundra Peregrine Falcon as regionally endangered birds.
- The GOG/OAS considers the Tatou to be endangered, the Lesser Chapman's Marine Opposum to be vulnerable and the Greater Chapman's Marine Opposum to be rare. The Agoute is endangered, possibly extinct.
- Bats are not considered threatened in Grenada.
- Mona monkeys and mongoose are considered pests and are not threatened in Grenada.

Many of the above endangered or threatened wildlife species are found mainly in the Grand Etang Forest Reserve. However, as the Grand Etang Road already exists, the impact of the project is limited to the affect of reconstruction and possible widening on Grenada's wildlife living in the Grand Etang Forest Reserve. Consideration should be given to limiting this impact.

(11) Materials

It is anticipated that all raw materials required for the reconstruction and improvement project will be obtained from existing quarries and crushing operations. It is expected that the surfacing will be Asphalt Concrete and will be supplied by the existing government plant. If this should prove otherwise then the specifications should be written such that the batching plant sites, layout, equipment and provisions for transporting materials shall be approved by the Engineer to ensure that no environmental damage occurs. In addition materials should be covered when stored and during transportation to mitigate fugitive dust impact.

(12) Waste Disposal

Construction related impacts to land resources could occur as a result of improper disposal of solid waste and accidental spills of environmentally harmful materials such as petroleum products. It should be mandatory during construction to develop and implement a solid waste management plan for the duration of all activities that ensure safe and appropriate handling of all solid wastes. The dumping place for excavated materials should be carefully selected to protect streams and vegetation.

To ensure stability disposal sites should be treated in a manner similar to that for borrow pits including grading and contouring to conform to surrounding topography and revegetation. In addition, environmentally hazardous materials such as motor oil used during construction are stored in designated areas which have been improved to accept such storage and in containers designed to contain spills and minimize contaminated run off.

6.4.4 Socioeconomic Environment Examination

(1) Land Use

Chapter 2 indicates the land use for the Study Roads. Based on the land use map and a site investigation, the land use is indicated in Table 6.3.1. According to the map, the four routes comprising Grand Etang, Eastern Main Road, Paraclete/Mt. Horne and Perdmontemps/St.Davids are mainly passing through cash crops areas. These areas produce main crops such as Banana, Cocoa, Nutmeg and other fruits (Grapefruits and Breadfruits) for exporting. The Grand Etang Road also passes through areas of commercial and residential development and the Grand Etang forest reserve. Additionally, the Eastern Main Road passes through areas of commercial and residential development. The Morne Jaloux Road traverses through mainly residential development and some commercial development. The Mt. Gay/Springs road passes through some sugar cane but mainly residential and commercial development.

Roads have various and far reaching impacts on a variety of individuals and economic sectors not only in areas where they are constructed but also in the regional and national development activities. Viewed in terms of the national development planning, promotion of development in rural areas is an important issue, and roads play a major Sole toward this end by promoting trade and commerce and improving living conditions.

Reduced travel time and increased commercial activity between towns are potential benefits of newly reconstructed and improved roads. The abilities of

farmers to reach markets in a timely manner and without damaging crops is significant. Also tourists would benefit as they would have more time to see the island. It might leave cruise ship passengers with a better impression and promote them to return as stay-over tourists.

The social environment would be improved because drivers would be less fatigued when driving to and from work. The improvement in the transportation conditions may help people in local areas in utilizing and gaining access to social services facilities such as hospitals, schools, community services, etc.

(2) Demography

The number of households along the study roads are indicated in Table 6.3.1. According to the table, the total number of households possibly directly affected by the project on Grenada are 1,122 and 45 on Carriacou. Based on an average of 4 persons per household, the total number of persons directly affected is approximately 4,488 on the island of Grenada and 180 on the island of Carriacou.

(3) Community Services

The community services located along the study roads include schools, churches and community centers. These are indicated in Table 6.3.2. Carriacou does not have any community services located along the proposed road. Grenada has approximately 23 schools, 28 churches and 23 community centers along the six (6) study roads.

(4) Employment and Income

In the short term of the reconstruction and improvement stage, the construction will provide employment opportunities to work at the site. The construction is expected to last between one (1) and two (2) years. In addition, employment opportunities in new activities expected to be introduced in the effected areas will decrease the unemployment rate and improve the average income not only for individuals but also for government.

Productivity of traditional activities in the island such as agriculture and fishery will increase due to the wider market to be reached by the roads either locally or for export purposes. Improved mobility and higher income of people living in rural areas widen life opportunities. They can comminute to work and schools far from their residence. Furthermore, they will be able to enjoy the other activities of urban areas. This means people will be offered a wider variety of

life without changing their residences which will consequently reduce migration from rural areas to the towns. The property value along the newly reconstructed and improved roads will increase.

(5) Archaeological and Historical Sites

Only one road, has archaeological or historical sites along it. The Morne Jaloux Road has three historically and archaeologically significant structures. They are Fort Fredrick, Fort Matthew and Fort Adolphus. These forts were built in the Colonial Period in the 1700's and are currently tourist attractions. Table 6.3.2 shows the sites.

The impact of the road projects on the historical sites will be slightly negative during construction as visitors may find access blocked at times. Widening plans are not intended at historical site areas so no change or impact will occur to the facilities themselves. After construction tourists will have improved access to the archaeological and historical site and therefore the impact is positive. As the tourism industry is also one of the most important sectors in the regional development roads enhance tourism activities all over the island. Favorable transportation conditions are indispensable to an increasing number of visitors.

(6) Acquisition and Resettlement

Road widening activities may necessitate the relocation of residents living in the existing right-of-way. An acquisition, compensation and resettlement scheme should be developed based on the laws of Grenada.

(7) Traffic Build-Up

For the expected traffic build-up during the construction stage, well planned, signed and advertised detours will be necessary. If a detour is unavailable then one lane of traffic shall be provided during construction. Traffic build-up is not expected after the completion of the construction works since the improved level of service will allow an increase in traffic volume.

6.5 WOMEN IN DEVELOPMENT (WID)

6.5.1 Need for WID Component

As early as 1975, the international aid communities began to consider the issue of women in development as a factor that influences the success of their

economic development programs for developing nations. Although progress had been noted in the awareness of women's issues, little improvement had been shown in the socio-economic situations of women in developing nations. Because women account for approximately half of the population, their role was considered important when any developmental issues were discussed.

Programs to date had grouped the needs for women in developing nations together without regard for the differences that were apparent given their wide-ranging political, economic, social, cultural and religious differences. Also women had been grouped generally within their own nations without considering their diversity due to differences in social class, place of residence, or form of employment. Women had not had a vital role in development projects and generally were not targeted as beneficiaries. There has been a growing awareness that this has had a negative impact, not only on women and their children, but also on society as a whole.

The Japanese government is currently making efforts to involve women in the mainstream of their development projects. When including women in development (WID), or the role of women in the development process, the word "development" does not only refer to the kind of growth that can be measured with economic indicators, but to the total social and economic development of the country. Basically the idea that the foundation and ultimate goal of economic development should be human-oriented social development which improves the quality of life as well as to see women not only as beneficiaries of development, but as the people who make development occur and not just the subject of programs.

6.5.2 Role of Women in Grenada's Development

According to government reports, women make up 50.8% of the population, and head 45% of all households in Grenada. The family's responsibility falls disproportionately on these women. A large number (34%) do not receive child support from their children's fathers and they are mainly responsible for the care, maintenance and upbringing of their children.

Despite this responsibility such women are in the majority of those unemployed. Fifty percent of all unemployed women are heads of households, and nearly two thirds of all unemployed women are between 15-19 years of age. Those who gain employment often end up in low paying, unskilled jobs that are traditionally female.

There are large numbers of under-educated, low skilled women who have had no training to enable them to acquire the marketable skills they need to be able to compete in the formal sectors of the economy. Many of these women live in the lower echelons of the society in depressing socio-economic conditions, and they experience great difficulty in providing for their families, and find it hard to survive.

In Grenada the majority of the population receives primary education. More males than females go through the primary school system and more females than males enter the secondary system. Although with their training women are better equipped to obtain "good jobs", more women than men are unemployed and occupy lower positions in low status jobs. This is common in the 20-24 year age group where such women represent 42% of the unemployed and men 24.8%. This questions whether women have equal access to jobs. Table 6.5.1 shows that the unemployment rate for women is almost double that for men.

Table 6.5.1 Labor Force

Details of Labor Force	Total	% Male	% Female
Labor Force	38,920	51.4%	48.6%
Employed	28,022	56.5%	42.6%
Unemployed	10,898	36.9%	63.0%

Source: Grenada Labor Force Survey, Final Report, Ministry of Finance 1988

Even though the number of females benefiting from secondary education exceeds males, more males than females have obtained university degrees. However, more women in the Caribbean are becoming educated and better able to hold good paying jobs and the number of women choosing to live a single life has increased. These women are independently managing their own households and are not affected by poverty.

Grenada has seen an increase in the number of women in managerial and other positions of seniority in both the public and private sectors. The majority of Permanent Secretary positions are held by women, most finance officers in the Ministry of Finance are female. Many more women are members of the Board of directors of companies or occupying top positions. However, despite the fact that more women than men are often more academically qualified, there are twice as many men as women employed in top managerial and administrative positions. Data has revealed that 53.1% of all employed women worked in areas of production, the service industry and in the agriculture sector and only 3.4% were involved in professional or technical jobs and 1.3% were in an

administrative or management position. There appear to be gaps for training and education as a way to obtain employment and improving social status.

Traditional attitudes of society have a great influence in the sectors where women are employed and where they seek employment even though legislation enables women equal access to all sectors of employment. Women make up the vast majority of the commercial and service sector workers. Also, women's involvement in the agricultural sector is a significant 20.9%. Heavy male dominance is seen in other sectors of the economy. In the agriculture sector, women constitute 35.2% of the work force, in construction 13.9% and 9.7% in transport, storage and communication.

The above information was gathered from the Department of Women's Affairs, Government of Grenada and the following publications:
National Report for the Fourth World Conference on Women in Grenada, Carriacou and Petit Martinique, Prepared by Andrea St. Bernard, April 1993
Report of a Survey on the Status of Women in Grenada, Carriacou and Petit Martinique, Prepared by Pat Ellis Associates, November 1992

6.5.3 WID and the Study Roads

Considerations in the project area related to WID are as follows:

(1) Accessibility to Services and Income Sources and Modes of Transportation

The roads included in the project study range from city to rural areas. Throughout Grenada generally each "village" has a health center, post office, primary school, churches, police station, etc. (reference figures in Appendix 7) When services outside the rural community health centers, post offices, and schools are required, women must travel to the major city areas with some services only available in the capital of St. George's.

Agriculture is the main source of jobs outside the cities. Although efforts have been introduced to provide more jobs in the rural areas, the majority of jobs fall in the tourist belt of South St. George's and the city business districts areas in St. George's, Grenville, Sauteurs, etc. Industry is centered in the South St. George's area of Frequente as well as a smaller industrial park in Grenville. Generally it can be agreed that transportation and thereby the roads that Grenadian women travel on are very important to the employment opportunities for women.

More and more women are learning to drive but the cost of vehicles makes it prohibitory for many families to own them. Largely due to the Grenada's topography, the use of bicycles is mainly for recreational purposes and not as a mode of transportation. This leaves the majority of the population traveling daily by bus to work and for other needs. Buses routes cover a majority of the island but some roads do not have bus traffic. It may be inferred in some instances, that this is due to the current state of the roads as well as the viability of collecting fares on secondary routes connecting villages to the main roads. Although bus stops are located fairly frequently in the cities there is rarely a safe additional pull-off lane to collect and deposit passengers or a covering from the elements. In heavy traffic areas this creates a definite road hazard and fatalities have been noted over the past few years.

Although much can be inferred regarding women's needs for transportation in the project area, ideally a survey should be conducted in the second phase of the feasibility study to enable the study team to best understand the needs of Grenadian women. The survey could provide information regarding the needs for transportation and roads in the project communities and their perspective as to how the current situation does or does not meet their needs (i.e. as drivers or passengers). It could also identify potential problems or benefits effecting women in the study area with regard to construction such as employment opportunities or isolation from services during construction.

(2) The Study Roads in Relation to Women's Accessibility to Services and Income Sources

While each of the study roads is different in that some are primary roads and some are more secondary, they also have many things in common. The smaller secondary roads provide a route for transportation between villages and their services (community centers, health centers, schools, police stations, and post offices) and connect with the more primary roads running into the cities. These roads (especially R-6 and R-3) are generally very narrow and do not have shoulders. They also have less traffic and are used as pedestrian paths as well as for vehicular traffic. They generally do not have "bus stops", instead passengers are picked up anywhere along their route. The buses do not always cover the entire project area although they may utilize portions of them.

The larger primary roads (R-1, R-4, and R-5) are wider, although few roads in Grenada offer much width. The routes have designated bus stops close to the city areas. Once they reach into the less populated areas, passengers are picked up wherever they are seen. There are very few off-road pick-up points

for safe gathering of passengers and none in the project area are covered. Of the study roads, only one (Road 1) has designated bus stops with off road stops.

All of the study roads have many characteristics in common that have their basis in Grenada's natural topography. Because of the mountainous terrain roads are generally cut on slope, and of varying to very steep grades and because of the curves they provide little site distance. Because of the narrow width there are few flat shoulders and generally there are no sidewalks for safe pedestrian traffic. The guardrails utilized in some areas are in need of repair and in some locations where needed are not provided. The surfaces vary a great deal throughout the study area and can best be analyzed in other sections of this report. It can be said that vehicular and pedestrian traffic suffers considerably on parts of R-4 (Springs starting to first junction), parts of R-6 and on R-3. Although law regulates speeds, they vary depending on the condition of the roads, with some of the study roads hardly passable without four-wheel drive vehicles.

All of these characteristics are of concern to Grenada's women. Foremost in their minds are opportunities for income and the health, safety and education of their families. These routes should take into consideration issues such as getting children to and from school safely and safe access and transport on public transportation.

(3) Beneficiaries of the Proposed Road Projects and Opportunities for Improvement

1) Owners of Private Vehicles

Women vehicle owners would largely benefit from the proposed project. In many cases the current state of the roads causes excessive wear and tear on vehicles causing inflated repair bills to vehicle owners. Improved roads would allow these women to have additional money available for other monthly needs for their families. Additionally the current state of many of the roads requires that travelers leave their homes for their intended destinations much earlier than if the roads were in good repair. Quality roads would enable these women to benefit from less travel time.

2) Passengers of buses

The majority of Grenadian women especially in the rural areas travel by bus to work, to school, and for shopping and services. The current state of many of the

roads makes traveling an uncomfortable proposition for the travelers. Improved roads would make travel time safer, more comfortable and faster for these women. Ideally, roads should provide safe pull-off for buses that are covered from the elements. Hazards could develop with improved roads for passengers standing roadside waiting for transportation with improved speeds, aggravating this potential hazard.

3) Pedestrian Traffic

Currently many of the project roads contain hazards for pedestrian traffic and those walking on the road to meet transport. Narrow, winding roads make walking potentially dangerous for pedestrians. Also, uneven surfaces make it difficult for the young and elderly who are less stable. These poor surfaces cause drivers to use both sides of the road avoiding "potholes", endangering pedestrians in the area which include women and their children on their way to jobs, schools and services. Improved roads providing better surfaces, wider roadways and safety features such as guardrails, off road bus stops, sidewalks, road signage and "sleeping police" would benefit all pedestrians including women and their children.

4) Families Living Along the Project Areas

It would be assumed that families living along the project road would benefit from completed road works. Property values can see increases due to better roads. Also, it must be said that the disruption the road works cause an isolation of properties and dust generated should be considered as a negative consequence. This can be a real health problem for those people who suffer from respiratory illnesses.

5) Additional Beneficiaries

It is again felt that a survey conducted in the project area would highlight the needs and beneficiaries of the project. This would be conducted in the second phase of the feasibility study.

(4) Opportunities for Participation by Women on the Project

1) Providing a Forum to Discuss Women's Needs

During the Social Impact Assessment (SIA) of the Study, there was the opportunity to canvas the women in the project area for their input regarding

their needs and the options for involvement in the project, to ensure that the purpose of WID, the involvement of women in the mainstream of development and the insurance that they benefit in actual socioeconomic ways, would become reality. For the SIA, the questionnaire presented in Appendix 8-b was submitted to women's groups such as the Agency for Rural Transformation (ART), Department of Women's Affairs-Government of Grenada, Grenada Community Development Agency (Grencoda), and Grenada National Organization of Women (GNOW) for feed back and assistance in ensuring that women's opinions are heard.

2) Employment on the Project as a Means to Increase Job Opportunities.

While the potential exists for unemployed women in the project areas to benefit economically due to employment during the proposed project, there are barriers for their participation. Generally, as in many nations, road construction and construction in general is seen as "Men's" work and traditionally women have been employed on construction projects in the clerical areas. Women aren't encouraged and may actually be discouraged from taking away what is viewed as a man's job.

Currently the Ministry of Works employs road workers in two areas – Road Maintenance and Road Projects. Women currently make up approximately 40% of the work force in the Maintenance area as laborers cleaning drains, clearing vegetation and patching roads. This is an important source of income for rural women although it is sporadic and is generally accepted as an appropriate occupation for women. However, in the area of road construction/reconstruction, women are barely represented. If present they are employed as traffic controllers and are not generally represented as masons, equipment operators, or laborers. While there is no physical reason why women couldn't be represented in this area, there is little support within the community for women to consider these positions. There is also little formal training opportunities in these areas for men or women. The project could provide this opportunity by targeting women and offering on the job training programs and public awareness programs, which would develop long term benefits in relation to future sustainable employment in this area.

A similar situation is reported in the private sector with women holding positions as clerical staff, traffic controllers and unskilled labor during patching and clearing operations. It is recommended that companies be surveyed in the second phase to collect the data necessary to compile a database. Areas that

should be investigated by number of workers employed and the percentage of men and women, are indicated through the following items:

- Work Area
  - Cleaning Shoulder
  - Patching
    - Mixing
    - Roller/Vibrator Operator
    - Truck Operator
    - Patching
  - Inspection
  - Supervision

- Routine Maintenance
  - Equipment Maintenance

- Road Construction

- Reconstruction
  - Equipment Operators
    - Roller
    - Grades
    - Paver
    - Dump Truck
    - Bulldozer
    - Backhoe
  - Mason
  - Unskilled Labor
  - Inspection
  - Supervision
  - Equipment Maintenance

- Professional Engineers
  - Design
  - Construction Supervision
  - Inspection

From the management perspective, there are three women represented in the Grenada Institute of Professional Engineers. Of the three, two are civil engineers. A private company employs one as a civil engineer and the Ministry of Works employs the other. This project has the potential of employing women

in these management roles as well as supervisors and inspectors with proper training.

The opportunity exists to both find jobs for unemployed women in non-traditional roles but also to open up these higher paying non-traditional roles to women. It is recommended that companies be surveyed in the second phase to collect the data necessary to establish a database. Information which will indicate positions held and compare salary range by job type for men and women in the road construction industry as indicated below:

- Position Held

- Traditionally Female
  - Clerical Workers
  - Traffic Control
  - Unskilled – Patching, Clearing

- Traditionally Male
  - Heavy Equipment Operators
  - Masons
  - Unskilled – Construction Work

With regards to training programs available for women there have been some attempts to involve women in training for non-traditional careers. In 1995 Grenacoda (Grenada Community Development Agency) conducted an on the job training program for women interested in non-traditional jobs. They trained several women as painters, construction workers, and tilers. They believe these women are still employed in the construction industry. Additionally, T. A. Marryshow Community College currently has one training course in building construction. Again, although not specifically road construction, it does have three female students in a total class of 26 students.

NEWLO (New Life Organization) has a vocational and life skills program for young adults age 17 – 25. Following three months of training in Personal Development the students do skills training in one of 14 skill areas. Six of those areas are construction related including Masonry, Plumbing, Electrical Installation, General Maintenance, Woodwork/Carpentry, and Appliance Repair. After this training they go on the job as apprentices to further their skills. Although their programs are offered equally to men and women, in the last four years there have been very few women that have chosen these areas. It is felt this is due to the uncertainty of employment and possible discrimination. Of the

few women involved, they have been in the electrical and general maintenance areas. The program is flexible and can provide trainees for areas not currently available after they have completed the Personal Development phase of the program.

These agencies and training programs mentioned could be involved in the development of vocational training or on the job training during the project. It would be important to include during this training the subject of how to deal with discrimination and possible sexual harassment. It would also be important to include the male co-workers in training sessions on the same subject.

3) Barriers to the Employment of Women on the Project:

While job opportunities may exist on the project despite the anticipated barriers associated with non-traditional roles, the potentially targeted group of unemployed, largely younger women also have the concern regarding childcare while they are at work. This situation needs further evaluation and consideration. Many larger companies in many nations offer day-care facilities for women and men with young children as an opportunity to increase productivity and job satisfaction by solving this potential parental concern.

Another challenge would be bringing women into skilled and unskilled non-traditional roles without training. As stated there are limited programs available, which prepare masons and construction workers. Most skills in these areas and in heavy equipment operation are learned informally on the job. The opportunity exists to develop and subsidize an apprenticeship program as well as working with existing educational facilities to create appropriate programs.

Many of the trades require that specialized tools be carried to the work site. The cost of these tools could prove prohibitive for some. In this case a tool program could be instituted which would allow women to purchase tools and pay for them over time with payroll deductions.

The greatest challenge remains in changing the attitudes of both men and women regarding their acceptance of women working in this field. Society must be sensitized as to the high rate of women unemployed, the need for these women as heads of households for income generating activities, and the appropriateness of road construction as a means to provide society with the opportunity for women. Also it could be anticipated that road contractors might be resistant to employment of women in non-traditional roles. Some incentives or penalties such as gaining points for employing women or offering training

programs for women in their bids may need to be offered for them to comply with the inclusion of women.

Temporary or short-term employment outside the project also seems possible by women benefiting from providing food and services to the workers along the proposed project areas. While temporary, it is still one means by which women would gain economic benefit from the project.

PART III

SELECTION OF PRIORITY ROADS

CHAPTER 7

BASIC IMPROVEMENT PLAN

CHAPTER 7

BASIC IMPROVEMENT PLAN

7.1 BASIC IMPROVEMENT POLICIES

The road improvement policies are governed by engineering requirements such as demand-acceptability of road users, and investment requirements which are usually restricted due to funds available for road improvement. Taking into consideration the two (2) requirements, the basic improvement policies were proposed, as discussed hereunder, based on the flow diagram presented in Figure 7.1.1.

(1) Engineering Requirements

The basic engineering policies for road improvement are established based on the highway functional classification. As presented in Chapter 2, roads in Grenada are classified into five (5) classes which do not necessarily correspond with highway functional classification.

The Study, therefore, is focused on establishment of the highway functional classification of the Study Roads based on the AASHTO Geometric Design Standard and the Highway Capacity Manual.

In accordance with the highway functional classification established, the following design concepts are proposed. The design standard is discussed in Chapter 10.

- Highway Functional Classification
- Level of Service
- Design Speed
- Roadway Width

There are, however, the minimum engineering requirements which should be secured for the safety of road users. These include the followings:

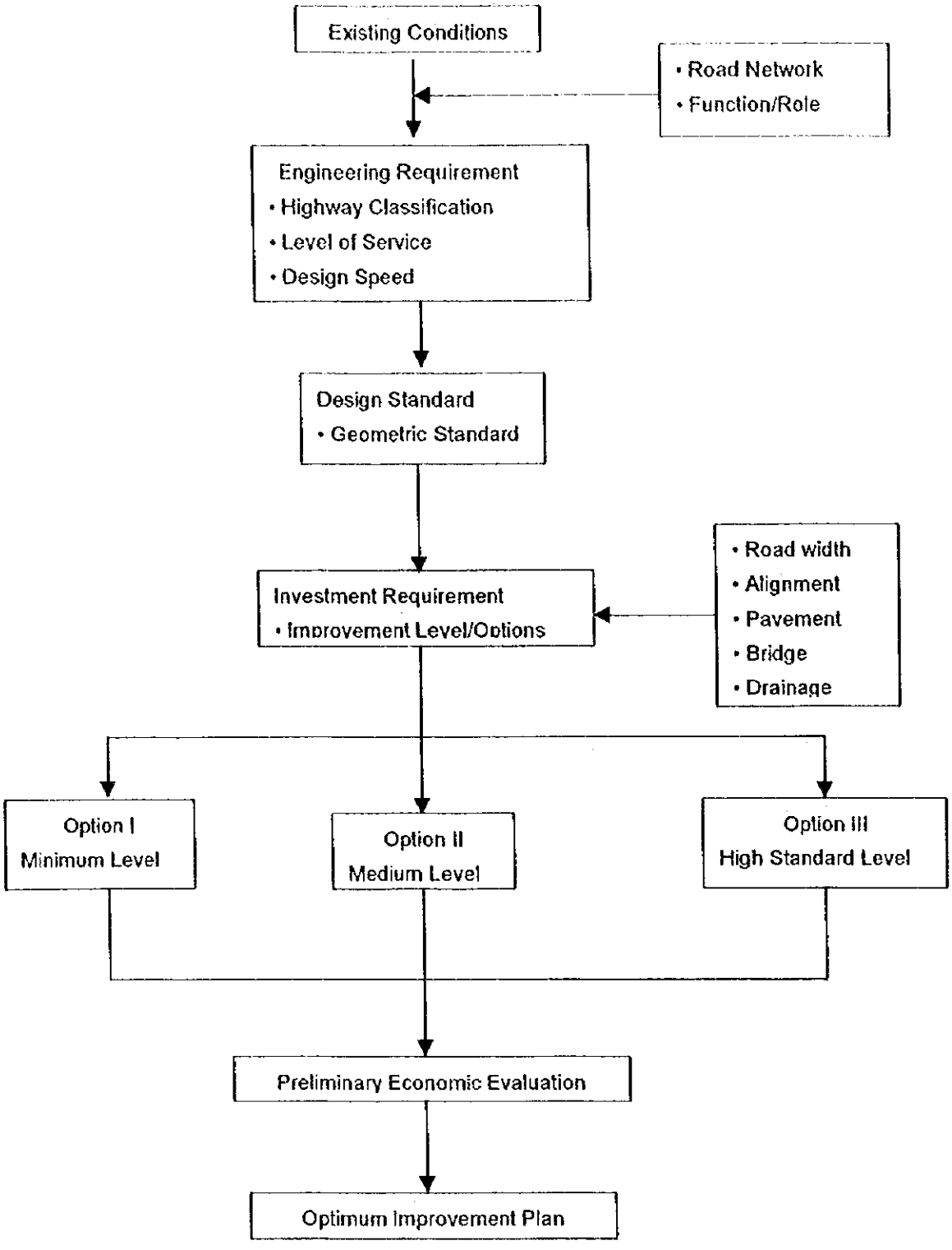


Figure 7.1.1 Establishment of Basic Improvement Plan

- Overlay/reconstruction of pavement, where existing conditions of which are below
- acceptable.
- Reconstruction of old bridges which are dangerous and hazardous to traffic
- Provision of side ditches to collect drainage water which are hazardous to traffic and will damage the pavement life.
- Provision of minimum safety facilities such as guardrails, road signs, etc.

(2) Investment Requirements

In order to assess the optimum improvement level for the Project, the following three (3) cases of improvement levels and options presented in Table 7.1.1 were proposed for economic evaluation.

Improvement Option I	:	Do Minimum Absolute minimum requirement
Improvement Option II	:	Rehabilitation Safety and minimum function requirement
Improvement Option III	:	Improvement Function and riding quality requirement

The result of economic evaluation suggests the most optimum improvement option for each road of the Project.

Table 7.1.1 Improvement Levels and Options

Option	Option I: Do Minimum	Option II: Rehabilitation	Option III: Improvement
Requirement	Absolute inimum Requirement	Safety and Minimum Function Requirement	Function and Riding Quality Requirement
Road Width	• No improvement (below the class requirements	• Maintain the existing roadway including shoulder, with exceptional widening • Provide min shoulder (class requirement)	• Widen to the road class standard requirement • Provide wide/paved shoulder (class requirement)
Road Alignment	• No improvement	• Improvement horizontal alignment for stopping sight distance	• Improvement sharp curves steep grades • Provide adequate superelevation run off
Pavement	• Overlay/ reconstruction	• Widening and overlay/ reconstruction	• Widening and overlay/ construction • Pavement of shoulder in population areas
Bridge	• Reconstruction of old bridges (dangerous/ hazardous to traffic)	• Reconstruction of old bridges • Reconstruction of temporary bridges	• Reconstruction of old bridges • Reconstruction of temporary bridges • Reconstruction of bridges with insufficient capacity
Drainage	• Provide side ditches	• Provide side ditches • Provide cross drainage	• Provide side ditches • Provide cross pipes • Provide subsurface drainage if necessary
Slope	• No improvement	• Cut slopes for safety (stopping sight distance) • Protect embankment for road widening	• Cut slope and protect embankment to improve sharp curves and steep grades
Safety Facilities	• Minimum safety facility	• Standard facility	• Standard safety facility

7.2 BASIC DESIGN CONCEPTS

7.2.1 Highway Functional Classification

Functional classification, the grouping of highways by the character of service they provide, is necessary for transportation planning purposes. Transportation planning, an integral part of total economic and social development, uses functional classification as an important planning tool.

The Study Roads, therefore, were classified in accordance with these purposes, locations and expected services, as presented later in Table 7.2.7

(1) Definition of Urban and Rural Areas

Urban and rural areas have fundamentally different characteristics with regard to density and types of land use, density of street and highway networks, nature of travel patterns, and the way in which these elements are related. Consequently, urban and rural functional systems are classified separately. Urban and rural areas are defined according to the population forecast in the target year for the design purposes.

- Urban area:
  Urbanized areas - Population of 50,000 and over
  Small urban areas- Population between 5,000 and 50,000
- Rural Areas:
  Areas outside the boundaries of urban areas

(2) Functional Road System for Rural Areas

Rural road systems consist of five (5) classes, i.e. principal arterial (roads), minor arterial (roads), major and minor collectors (roads) and local roads. These are defined as follows:

- Rural Principal Arterial
  Movement between all, or virtually all, urban areas with population over 25,000 and a large majority of those with population.

- Rural Minor Arterial
  Linkage of cities, large towns and other traffic generators (such as major resort areas) that are capable of attracting travel over similarly long distances

- Rural Major Collector Roads
  Linkage of places with nearby larger towns or cities, or with routes of higher classifications.

- Rural Minor Collector Roads
  Linkage of locally important traffic generators with their rural hinterland.

- Rural Local Roads
  Access to land adjacent to the collector network and services travel over relatively short distances.

(3) Functional Road System for Urban Areas

The four (4) functional highway systems for urbanized areas are urban arterial (streets), minor arterial (streets), collectors (streets), and local streets. These are defined as follows:

- Urban Principal Arterial
  Carry most of the trips entering and leaving the urban area, as well as most of the through movements bypassing the central cities.

- Urban Minor Arterial
  Serve for trips of moderate length at a lower level of travel mobility, including urban connections to rural collector roads.

- Urban Collector Street
  Provide both land access services and traffic circulation within residential neighborhoods and commercial and industrial areas.

- Urban Local Streets
  Provide direct access to abutting lands and connection to the higher order systems.

(4) Special Purpose Roads

Some types of roads are different from roads under the functional classification because of special purposes and do not fit into any of the noted classifications. This type of road is referred to as a special purpose road, which includes the following:

- Recreational Roads

- Resource Development Roads
- Local Service Roads

7.2.2 BASIC DESIGN ELEMENTS

The highway should be so designed that when it is carrying the design volume, the traffic demand will not exceed the capacity of the facility even during short intervals of time. The basic design concept is established such that the facility can provide the compatibility and safety for road users. The following basic design elements are discussed in the Study.

(1) Level of Service

The Highway Capacity Manual (HCM, 1994) has established the "Level of Service" concept based on the characteristics of traffic flow. The relationship between level of service and traffic characteristics is designed from degree of congestion. HCM recommends level of service appropriate for design as summarized in Table 7.2.1.

Table 7.2.1 Guide for Selection of Design Level of Service

Highway Type	Type of Area and Appropriate Level of Service			
	Rural Level	Rural Rolling	Rural Mountainous	Urban and Suburban
Freeway	B	B	C	C
Arterial	B	B	C	C
Collector	C	C	D	D
Local	D	D	D	D

Note: General operating conditions for levels of services:

A - free flow, with low volumes and high speeds.

B - reasonably free flow, but speeds beginning to be restricted by traffic conditions

C - in stable flow zone, but most drivers restricted in freedom to select their own speed

D - approaching unstable flow, drivers have little freedom to maneuver.

E - unstable flow, may be short stoppages.

(2) Design Speed

The design speed, one of the most governing factors in highway design, is selected as appropriate for functional classification and environment and terrain conditions. Table 7.2.2 summarizes the minimum design speed recommended by AASHTO, 1994. However, a high design speed shall be applied where environment and terrain conditions are favorable.

Table 7.2.2 Minimum Design Speeds (Km/h)

Highway Classification	ADT / Terrain	Under 50	50 - 250	250 - 400	400 - 1500	1500-2000	Over 2000
Rural Local Roads	Level	50	50	60	80	80	80
	Rolling	30	50	50	60	60	60
	Mountainous	30	30	30	50	50	50
Rural Collectors	Level	60	60	60	80	80	10
	Rolling	50	50	50	60	60	80
	Mountainous	30	30	30	50	50	60
Rural Arterials	Level	100 to 110 (normally used)					
	Rolling	80 to 100 (normally used)					
	Mountainous	60 to 80 (normally used)					
Urban Local Street	-	30 to 50					
Urban Collectors	-	Minimum 50					
Urban Arterials	Central Business	60 – 80					
	Outlying Business	80-100					

(3) Roadway Width

No feature of highway has a greater influence on safety and comfort of driving than the width and condition of the road surface. There is obvious need for a wide, smooth and all-weather surface on highways.

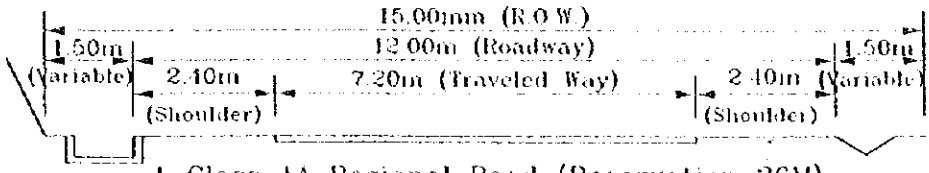
Lane widths of 2.7 to 3.6 m are generally used. The capacity of a highway is affected by the lane width. The effective width of traveled way is reduced when adjacent obstructions such as retaining walls restrict the lateral clearance. The extent of the reduction is shown in Table 7.2.3 based on AASHTO, 1994.

Table 7.2.3 Combined Effect of Lane Width and Lateral Clearance

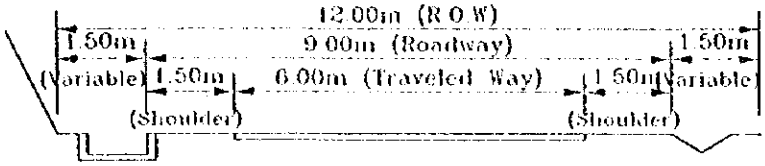
Usable Shoulder Width or clearance to obstruction (m)	Capacity of Narrow Lanes with Restricted Lateral Clearance (% of Capacity of 3.6m Lanes)			
	3.6m Lanes	3.3m Lanes	3.0m Lanes	2.7m Lanes
	Two Lane Roadway			
1.8 m	100	93	84	70
1.2 m	92	85	77	65
0.6 m	81	75	68	57
0	70	65	58	49

Table 7.2.4 summarizes the minimum width of traveling lane and graded shoulder for rural local roads and rural collectors based on the Minimum Width Traveled Way and Graded Shoulder, AASHTO, 1994. Recommended lane widths are 2.7m to 3.6m for urban streets/rural local roads and 3.0m to 3.6m for rural collectors.

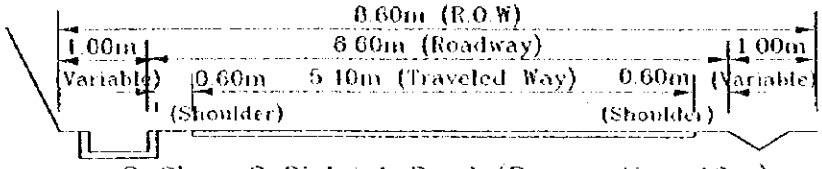
The traveled way is the portion of the roadway for designated movement of vehicles, exclusive of shoulders., as shown in Figure 7.2.1.



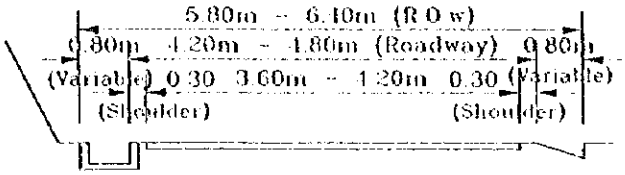
1 Class 1A Regional Road (Reservation 26M)
(Airport Road)



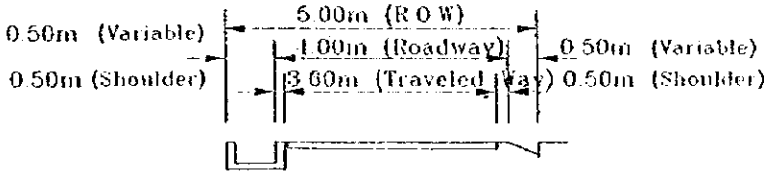
2 Class 1 Regional Road (REservation 12M)
(Specified Road)



3 Class 2 District Road (Reservation 10m)
(Red on 1/50,000 Map)



4 Class 3 Local Road (Reservation 8m)
(Orange on 1/50,000 Map)
(Two-Directional One Lane Road)



5 Class 4 Access Road (Reservation 6m)
(Outlined on 1/50,000 Map)
(Two-Directional One Lane Road)

Figure 7.2.1 Minimum Width Traveled Way

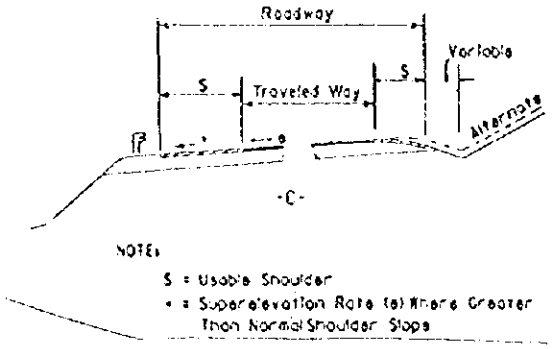


Figure 7.2.2 Typical Cross Section

Table 7.2.4(1) Design Standards of Rural Local Roads

Design Traffic Volumes				
Design Speed (km/h)	ADT Less than 400	ADT 400-1500	ADT 1500-2000	ADT over 2000
Width of Traveled Way (m) c				
30	5.4	6.0a	6.6	7.2
40	5.4	6.0a	6.6	7.2
50	5.4	6.0a	6.6	7.2
60	5.4	6.0a	6.6	7.2
70	6.0	6.6	6.6	7.2
80	6.0	6.6	6.6	7.2
90	6.6	6.6	7.2	7.2
100	6.6	6.6	7.2	7.2
Width of Graded Shoulder - Each Side (m)c				
All Speeds	0.6	1.5ab	1.8	2.4

Note: a: Mountainous Terrain - ADT 400-600, 5.4m width and 0.6m shoulders
b. May be adjusted to achieve a minimum roadway width of 9.0 m for a design speed of 60 km/h or less
c: Where the width of traveled way is shown to be 7.2 m, the width of the traveled way may remain at 6.6 m on reconstructed highways where alignment and safety results are satisfactory.

Table 7.2.4(2) Design Standards of Rural Collectors

Design Traffic Volumes				
Design Speed (km/h)	ADT Less than 400	ADT 400-1500	ADT 1500-2000	ADT over 2000
Width of Traveled Way (m) c				
30	6.0b	6.0	6.6	7.2
40	6.0b	6.0	6.6	7.2
50	6.0b	6.0	6.6	7.2
60	6.0b	6.6	6.6	7.2
70	6.0	6.6	6.6	7.2
80	6.0	6.6	6.6	7.2
90	6.6	6.6	7.2	7.2
100	6.6	6.6	7.2	7.2
110	6.6	6.6	7.2	7.2
Width of Graded Shoulder - Each Side (m)c				
All Speeds	0.6	1.5ab	1.8	2.4

Note: a: Where the width of the traveled way is shown to be 7.2m, the width of traveled way may remain at 6.6 m on reconstructed highways where alignment and safety records are satisfactory.
b: 5.4 minimum for ADT under 250.
c: May be adjusted to achieve a minimum roadway width of 9.0 m for design speeds of 50 km/h or less.

(4) Design Speed and Travel Way Width of Special Purpose Roads

The principal design factors of special purpose roads are summarized as in the following sections and Table 7.2.5.

1) Design Speed

- Recreational Roads
  - Primary access roads 60 km/hr
  - Circulation roads 50 km/h
  - Area roads 30 km/h

- Resource Development and Local Service Roads

Table 7.2.5 Minimum Design Speed

Type of Terrain	Single Lane100 VPD Maximum(km/h)	Two Lane (km/h)
Level	50	60
Rolling	30	50
Mountainous	15	30

2) Width of Traveled Way and Shoulder

Based on AASHTO, 1994, the recommended width of traveled way and shoulder are as presented in Table 7.2.6.

Table 7.2.6 Recommended Width of Traveled Way and Shoulder

Type	Traveled Way Width (m)a	Shoulder Width (m)
Primary access roads (two lanes)	6.6 - 7.2.	0.6 - 1.2
Circulation roads (two lanes)	6.0 - 6.6	0.6 - 1.2
Area roads (two lanes)	5.4 - 6.0	0.0 - 0.6
Area roads (two Lane)b	3.6	0.0 - 0.3

Note: a: Widening on the inside of sharp curves should be provided. Additional width equal to 35 divided by the curve radius in meters is recommended.
b: Roadway widths greater than 4.2m should not be used because of the tendency for drivers to use the facility as a two-lane road.

7.2.3 Recommended Basic Design Concepts

Based on the highway classification and standard for basic design elements discussed in the previous sections, the basic design concepts for the Study Roads are recommended as shown in Table 7.2.7.

Table 7.2.7 Recommended Basic Design Concepts

AASHTO Classification		Level of Service	Design Speed(km/)	Min. Traveled way (m)	Study Roads
Rural Roads	Major Collector	C (F,R)	100(F) 80 (R) 60 (M)	7.2	Class 1A
	Minor Collector	C (F,R) D (M)	80 (F) 50 (R) 40 (M)	6.0-6.6	Class 1 (1)Grand Etang Road (5)Eastern Main Road
	Local Road	D	60 (F) 50 (R) 40 (M)	5.4	Class 1 (3)Grand Etang Road (6)Para./Mt Horne
Urban Road	Collector Street	C (F,R) D (U)	Over 50	Lane width 3.0-3.6	Class 1A Class 1 (4)Mt Gay/Springs
	Local Street	D	30-50	Lane width 2.7-3.6	Class 2 (2)Morne Jaloux
Special Purpose Road	• Recreational Road • Resource • Development Road • Local Service Road	-	(1) (2) 60 50 (F) 50 30 (R) 30 10 (M)	(1) 5.4~6.0 (2) 3.6	Class 3 Class 4

Note: F = Flat Terrain
R = Rolling Terrain
M = Mountainous Terrain

Grand Etang Road and Eastern Main Road, categorized as Class 1 road in the country, formulate the north-east-west national trunk road in the road network of the country, and shall be improved as minor collector road in rural area under AASHTO classification.

Mt Gay/Springs Road, Class 1 road in the country, is practically the continuation of Grand Etang Road toward the south, and shall be improved as collector road in urban area under AASHTO classification.

Since these three (3) roads form the north-east-west-south trunk road (longitudinal-lateral backbone national highway or Trans-Grenada Highway), the same design concept shall be applied, though some differences in topography.

Morne Jaloux Road, Class 2 in the country, is the tourism road, but at the same time plays as a detour road of Mt. Gay/Springs road, where urban traffic is congested. This road shall be improved as local street in urban area.

Perdmontemps/St. David's, Paraclete/Mt Horne and Dover roads, which are classified as Class 1 road the country's highway type may be rehabilitated as local road in rural areas under AASHTO Classification.

7.3 PROPOSED IMPROVEMENT MEASURES

7.3.1 Identification of Problems of Study Roads

Based on several types of road surveys, the problems of the Study Roads were identified as presented in Appendix 3. The following sections summarize the main observations on the existing conditions of the different road elements.

(1) Pavement

It was observed that the road network in Grenada was developed some decades before, and since then a considerable effort has been made to maintain the roads to reasonably acceptable conditions. Particularly, such effort has been focused on the arterial roads as well as important primary roads, but some secondary and local roads have been neglected. Therefore, some sections of roads may have been rehabilitated with overlay methods with reasonable costs, while others have been deteriorated to the extent where improvements are possible only with full depth reconstruction, which requires a huge investment.

In regard to the Study Roads, the former includes:

Road No. 1	Grand Etang Road
Road No. 4	Mt. Gay/Springs
Road No. 5	Eastern Main Road (Grenville/Sauteurs)
Road No. 2	Some of Morne Jaloux Road

While the later includes:

Road No. 3	Perdmontemps/St.David's
Road No. 6	Paraclete/Mt. Horne
Road No. 7	Dover (Windward/Cherry Hill) Carriacou.

Modern pavement technology for both design and construction is required. The pavement is the asphalt concrete (AC) except some sections of Dover Road which is Portland Cement Concrete (PCC). The major pavement distresses observed are briefly described as follows:

- Alligator or fatigue cracking (primary traffic load caused)
- Path deterioration (primary traffic load caused)
- Potholes
- Longitudinal cracking (primary traffic load caused)
- Tranverse cracking (primary traffic load caused)
- Raveling and weathering (primary traffic load caused)

(2) Roadway Width

The island of Grenada is dominated by steep cliffs along the coastlines (except many white sand beaches) and the mountainous interior. This topography makes it difficult to provide wide roadways to satisfy the proper road geometric design within viable economic justification.

The traveled way width is usually restricted by steep terrain, and sometimes by house/buildings. Mostly, the shoulders are narrow or neglected especially at the following locations:

- Beginning sections of Road No. 1 Grand Etang Road 5.3m (house/steep terrain)
- End section of Road No. 1 Grand Etang Road 5.5m (steep terrain)
- End section of Road No. 2 Morne Jaloux 3.7 (steep terrain)
- Road No. 3 Perdmontemps/St. David's, 3.5m (steep terrain)

A reasonable width of traveled way with shoulder is preferred to be provided where economically feasible.

(3) Alignment

The study roads mostly pass through mountainous terrain with restricted alignments, both horizontal and vertical, such as sharp curves, hairpin curves, undulated grades and steep gradients as noted below:

- R-1: Grand Etang Road, before and after the Forest Reservation Section (hairpin-curves, steep gradients)
- R-2: Morne Jaloux (hairpin curves, steep gradients)
- R-3: Perdmontemps/St. David's (sharp curves, steep gradients)
- R-4: Mt. Gay/Springs Sharp curves, steep gradients)
- R-6: Paraclete/Mt. Horne (sharp curves, steep gradients)

The following road elements are advisable to be improved for the traffic safety purposes:

- Minimum radius (25 - 35m for 30kmph)
- Maximum grade (16% in mountainous terrain for 30 kmph)
- Stopping sight distance (25 - 30m for 30 kmph)
- Length of steep gradients
- Turn outs on a two-directional - one lane road
- Super-elevations runoff (change in cross slope)

- Cross slopes adequate for vehicle operating speed
- Combination of horizontal and vertical alignment

(4) Bridges

Some of the bridges along the Study Roads were observed to be at the end of their standard life with the following deficiencies:

- Old and dilapidated bridges, Road No. 1 and No. 6
- Spillway bridges (overflow during rainy season due to low elevation), Road No.1
- Inadequate traffic capacity (too narrow width)
- Temporary bridges, Road No. 3 and No. 5
- Bridges with insufficient river opening (causes of overflow), Road No. 5

Those bridges with major structural/capacity deficiencies are recommended for reconstruction.

(5) Drainage

The surface drainage facilities such as side ditches were often observed along the study roads, but some have inadequate capacity. Some sections had no side drainage. The subsurface drainage system could not be observed, no cross pipes were provided at the points of some sag vertical curves, where moisture can collect and cause pavement base failure.

The provision of an adequate drainage system including surface and subsurface facilities is recommended for safety, control of pollutants, economy in maintenance as well as the long life of the pavement structures.

7.3.2 Proposed Improvement Measures

In accordance with the proposed improvement levels and options, the improvement measures were proposed for the Study Roads, as shown in Table 7.3.1, taking into consideration the problems of the roads identified through the field surveys. The improvement measures cover the following engineering items for each improvement option and each Study Road.

- Road alignment
- Road Width
- Pavement
- Bridge
- Drainage
- Slope
- Safety facilities

Table 7.3.1 Improvement Measures for Study Roads

ROAD No	ROAD NAME	LENGTH (KM)	IMPROVEMENT OPTION	ROAD ALIGNMENT	ROAD WIDENING	PAVEMENT	BRIDGE	DRAINAGE	SLOPE	SAFETY FACILITIES
R-1	Grand Etang Road	20.50	II	No improvement	None	Ac overlay on existing road width Overlay thickness is 5 cm	Balthazar Reconstruction St. Cry Greatriver New Const.	Earth side ditch to concrete side ditch	None	Minimum road safety device
			II	Keep stopp sight distance	Widening of narrow section Cut Section 1,730m Embankment Section 600m	Ac overlay on existing road width Scarification and new pavement for bad condition and widening section Overlay Thickness is 5 cm	STA 11+480 1 lane new Br. Const Birch Grove 1 lane new Br. Const. Balthazar Reconstruction St. Cyr Greatriver New Const	Reconstruction of all side ditch Extention of cross drainage	River protection 600m Cut slope 1,730m for widening section	Standard Road safety devices
			III	Keep stopping sight distance Road width follow the geometric design standard (Class 1 Road)	Widening of cut slope 14,650M and embankment 13,770M	Same as Road No. 1	STA 11+480 2 lane new Br. Const Birch Grove 2 lane new Br. Const. Balthazar Reconstruction St. Cyr Greatriver New Const	Reconstruction of all side ditch Extention of Cross drainage	River protection 600m Cut slope 14,650m and embankment slope12,040m	Standard Road safety devices
R-2	Morne Jaloux Road	3.20	II	No improvement	None	Same as Road No. 1	No bridge in this road	Same as Road No. 1	None	Same as Road No. 1
			III	Improvement of the horizontal alignment at the end section	Widening of end section, including 2 hairpin curve and cut slope 940m, embankment 940m	Same as Road No. 1	No bridge in this road	Same as Road No. 1	Cut slope 940m and embankment slope 940 for widening section	Same as Road No. 1
			III	Road width follow the geometric design standard (Class 2 Road)	Widening of cut slope 1,990m and embankment 1,740m	Same as Road No. 1	No bridge in this road	Same as Road No. 1	Cut slope 1,990m and embankment slope 1,740m for widening section	Same as Road No. 1
R-3	St. David's ~ Perdmontemps	7.10	I	No improvement	None	Same as Road No. 1	Reconstruction of Vineyard Br.	Same as Road No. 1	None	Same as Road No. 1
			II	Widening of narrow section	Widening of cut slope 3,800m	Same as Road No. 1	Reconstruction of three (3) br.. Scoring protection of Providence Br	Same as Road No. 1	Cut slope 3,800m for widening section	Same as Road No. 1
			III	Road width follow the geometric design standard (Class 2 Road)	Widening of cut slope 4,800m and embankment 1,400m	Same as Road No. 1	Reconstruction of three (3) br. Scoring protection of Providence Br.	Same as Road No. 1	Cut slope 4,800m and embankment slope 14,000m for the widening section	Same as Road No. 1
R-4	Mt Gay ~ Springs Road	5.80	I	No improvement	None	Same as Road No. 1	None	Same as Road No. 1	None	Same as Road No. 1
			II	Widening of narrow section for the urban section and road width follow design standard for rural section	Widening of cut slope 2,880m and embankment 2,750m	Same as Road No. 1	Scoring protection of Providence Br.	Same as Road No. 1	Cut slope 2,880m embankment slope 2,750m for widening section	Same as Road No. 1
			III	Road width follow the geometric design standard (Class 1 Road)	Widening of cut slope 5800m and embankment 4,250m	Same as Road No. 1	None	Same as Road No. 1	Cut slope 5,800m and embankment slope 2,250m for widening section	Same as Road No. 1
R-5	Eastern Main Road (Grenville ~ Sauteurs)	16.00	I	No improvement	None	Same as Road No. 1	Tempe Br. Construction one lane Br.	Same as Road No. 1	None	Same as Road No. 1
			II	Widening of narrow section for the urban section and road width follow design standard for rural section	Widening of cut slope 4,600m and embankment 2300m	Same as Road No. 1	Reconstruction of two (2) lane, 17m length Br.	Same as Road No. 1	Cut slope 4,600m and embankment slope 2,300m for the widening section	Same as Road No. 1
			III	Road width follow the geometric design standard for rural section	Widening of cut slope 14,100m and embankment 10,700m	Same as Road No. 1	Reconstruction of three (3) br. Scoring protection of Dunbermline Br.	Same as Road No. 1	Cut slope 14,100m and embankment slope 10,700m for the widening section	Same as Road No. 1
R-6	Pareclete ~ Mt. Home Road	3.20	I	No improvement	None	Same as Road No. 1	None	Same as Road No. 1	None	Same as Road No. 1
			II	Widening of narrow section for the urban section and road width follow design standard for rural section	Widening of cut slope 500m and embankment 500m	Same as Road No. 1	Scoring of protection of two (2) Br.	Same as Road No. 1	Cut slope 500m and embankment slope 500m for the widening section	Same as Road No. 1
			III	Road width follow the geometric design standard (Class 1 Road)	Widening of cut slope 3,200m and embankment 3,000m	Same as Road No. 1	One lane new const. Two (2) br. Scouring protection of two (2) Br.	Same as Road No. 1	Cut slope 3,200m and embankment slope 3,000m for the widening section	Same as Road No. 1
R-7	Dover Road (Windward ~ Cherryhill)	3.19	I	No improvement	None	Same as Road No. 1	No bridge in the road	Same as Road No. 1	None	Same as Road No. 1
			II	Widening of narrow section for the urban section and road width follow design standard for rural section	None	Same as Road No. 1	No bridge in the road	Same as Road No. 1	None	Same as Road No. 1
			III	Road width follow the geometric design standard (Class 1 Road)	Widening of cut slope 2,700m	Same as Road No. 1	No bridge in the road	Same as Road No. 1	Cut slope 2,700m for the widening section	Same as Road No. 1

CHAPTER 8

PRELIMINARY EVALUATION

CHAPTER 8

PRELIMINARY EVALUATION

The main objective of this preliminary evaluation is to identify the prioritization ranking of project roads to be selected for the Feasibility Study from the economic and environmental points of view. The economic viability of implementing each and all of the project roads is comprehensively investigated in Chapter 13.

8.1 PRILIMINARY COST ESTIMATE

8.1.1 Preliminary Cost

The economic cost of each project road is estimated to consist of the following:

- Construction Cost
- Land Acquisition Cost
- Engineering Cost

Appendix 9 includes the preliminary financial costs of the three cost items for three (3) improvement options. To estimate the economic costs, preliminary financial costs were shadow-priced utilizing adjustment factors to correct key imbalances, especially for foreign exchange and unskilled labour costs of the local component portion and to eliminate the transfer cost which is composed of compound taxes such as import duties and value added taxes. Adjustment factors are estimated roughly in this stage as 0.9 for the construction and maintenance costs and 1.0 for right-of-way acquisition and engineering costs. The disbursement schedule for the first three items in the economic capital cost of each of the study roads is shown in Table 8.1.1 for the three improvement options. These three items are counted as initial capital investment while the maintenance and repair is counted as annual operational investment.

8.1.2 Maintenance and Repair Cost

The financial cost of the maintenance and repair works was estimated based on the overlay criteria and converted to the economic cost to be used in the economic analysis. This cost is estimated based on the road width for each of the three improvement options without considering price escalation. Table 8.1.2 presents the annual economic maintenance and repair cost for the seven project roads under each of the three improvement options.

Table 8. 1.1(1) Disbursement Schedule of Economic Capital Cost (EC$)

Road	Year	Construction	Engineering	R-O-W	Total
Improvement Option I					
R-1	1998	0	634,050	0	634,050
	1999	2,818,000	399,217	0	3,217,217
	2000	8,454,000	563,600	0	9,017,600
	2001	1,409,000	93,933	0	1,502,933
R-2	1998	0	40,500	0	40,500
	1999	540,000	49,500	0	589,500
	2000	270,000	18,000	0	288,000
	2001	0	0	0	0
R-3	1998	0	137,700	0	137,700
	1999	918,000	107,100	0	1,025,100
	2000	1,836,000	122,400	0	1,958,400
	2001	0	0	0	0
R-4	1998	0	128,700	0	128,700
	1999	858,000	100,100	0	958,100
	2000	1,716,000	114,400	0	1,830,400
	2001	0	0	0	0
R-5	1998	0	371,250	0	371,250
	1999	1,650,000	233,750	0	1,883,750
	2000	4,950,000	330,000	0	5,280,000
	2001	825,000	55,000	0	880,000
R-6	1998	0	66,600	0	66,600
	1999	888,000	81,400	0	969,400
	2000	444,000	29,600	0	473,600
	2001	0	0	0	0
R-7	1998	0	61,650	0	61,650
	1999	822,000	75,350	0	897,350
	2000	411,000	27,400	0	438,400
	2001	0	0	0	0
Improvement Option II					
R-1	1998	0	1,246,500	105,000	1,351,500
	1999	4,748,571	732,071	105,000	5,585,643
	2000	14,245,714	949,714		15,195,429
	2001	5,935,714	395,714		6,331,429
R-2	1998	0	132,300	25,000	157,300
	1999	1,764,000	161,700	25,000	1,950,700
	2000	882,000	58,800		940,800
	2001	0	0		0
R-3	1998	0	282,150	40,000	322,150
	1999	1,504,800	194,370	40,000	1,739,170
	2000	4,138,200	275,880		4,414,080
	2001	0	0		0
R-4	1998	0	193,950	80,000	273,950
	1999	1,034,400	133,610	80,000	1,248,010
	2000	2,844,600	189,640		3,034,240
	2001	0	0		0

Table 8. 1.1(2) Disbursement Schedule of Economic Capital Cost (EC$)

Road	Year	Construction	Engineering	R-O-W	Total
R-5	1998	0	531,000	35,000	566,000
	1999	2,124,000	318,600	35,000	2,477,600
	2000	6,372,000	424,800		6,796,800
	2001	2,124,000	141,600		2,265,600
R-6	1998	0	85,950	0	85,950
	1999	1,146,000	105,050	0	1,251,050
	2000	573,000	38,200		611,200
	2001	0	0		0
R-7	1998	0	87,300	0	87,300
	1999	1,164,000	106,700	0	1,270,700
	2000	582,000	38,800		620,800
	2001	0	0		0
Improvement Option III					
R-1	1998	0	2,113,650	420,000	2,533,650
	1999	7,045,500	1,174,250	420,000	8,639,750
	2000	21,136,500	1,409,100		22,545,600
	2001	14,091,000	939,400		15,030,400
R-2	1998	0	254,700	60,000	314,700
	1999	3,396,000	311,300	60,000	3,767,300
	2000	1,698,000	113,200		1,811,200
	2001	0	0		0
R-3	1998	0	520,200	50,000	570,200
	1999	2,312,000	327,533	50,000	2,689,533
	2000	6,936,000	462,400		7,398,400
	2001	1,156,000	77,067		1,233,067
R-4	1998	0	360,450	145,000	505,450
	1999	1,602,000	226,950	145,000	1,973,950
	2000	4,806,000	320,400		5,126,400
	2001	801,000	53,400		854,400
R-5	1998	0	1,062,900	105,000	1,167,900
	1999	3,543,000	590,500	105,000	4,238,500
	2000	10,629,000	708,600		11,337,600
	2001	7,086,000	472,400		7,558,400
R-6	1998	0	200,700	10,000	210,700
	1999	2,007,000	200,700	10,000	2,217,700
	2000	2,007,000	133,800		2,140,800
	2001	0	0		0
R-7	1998	0	211,050	5,000	216,050
	1999	2,814,000	257,950	5,000	3,076,950
	2000	1,407,000	93,800		1,500,800
	2001	0	0		0

Table 8.1.2(1) Economic Maintenance and Repair Cost (MEC$)

Year	R-1	R-2	R-3	R-4	R-5	R-6	R-7	Criteria
Improvement Option I								
2001	0.064	0.009	0.014	0.022	0.035	0.007	0.007	3cm-2%
2002	0.064	0.009	0.014	0.022	0.035	0.007	0.007	2%
2003	0.064	0.009	0.014	0.022	0.035	0.007	0.007	2%
2004	0.064	0.009	0.014	0.022	0.035	0.007	0.007	2%
2005	0.064	0.009	0.014	0.022	0.035	0.007	0.007	2%
2006	0.129	0.018	0.028	0.043	0.071	0.014	0.014	4%
2007	0.129	0.018	0.028	0.043	0.071	0.014	0.014	4%
2008	0.129	0.018	0.028	0.043	0.071	0.014	0.014	4%
2009	0.129	0.018	0.028	0.043	0.071	0.014	0.014	4%
2010	3.222	0.459	0.693	1.080	1.764	0.351	0.351	100%
2011	0.106	0.015	0.023	0.035	0.058	0.012	0.011	5cm-2%
2012	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2013	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2014	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2015	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2016	0.211	0.030	0.045	0.071	0.116	0.023	0.023	4%
2017	0.211	0.030	0.045	0.071	0.116	0.023	0.023	4%
2018	0.211	0.030	0.045	0.071	0.116	0.023	0.023	4%
2019	0.211	0.030	0.045	0.071	0.116	0.023	0.023	4%
2020	5.283	0.747	1.134	1.764	2.898	0.576	0.567	100%
2021	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2022	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2023	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2024	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
2025	0.106	0.015	0.023	0.035	0.058	0.012	0.011	2%
Improvement Option II								
2001	0.066	0.011	0.015	0.022	0.035	0.009	0.007	3cm-2%
2002	0.066	0.011	0.015	0.022	0.035	0.009	0.007	2%
2003	0.066	0.011	0.015	0.022	0.035	0.009	0.007	2%
2004	0.066	0.011	0.015	0.022	0.035	0.009	0.007	2%
2005	0.066	0.011	0.015	0.022	0.035	0.009	0.007	2%
2006	0.133	0.021	0.030	0.043	0.071	0.017	0.014	4%
2007	0.133	0.021	0.030	0.043	0.071	0.017	0.014	4%
2008	0.133	0.021	0.030	0.043	0.071	0.017	0.014	4%
2009	0.133	0.021	0.030	0.043	0.071	0.017	0.014	4%
2010	3.321	0.531	0.747	1.080	1.764	0.432	0.360	100%
2011	0.109	0.017	0.024	0.035	0.058	0.014	0.012	5cm-2%
2012	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2013	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2014	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2015	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2016	0.217	0.035	0.049	0.071	0.116	0.028	0.024	4%
2017	0.217	0.035	0.049	0.071	0.116	0.028	0.024	4%

Table 8.1.2(2) Economic Maintenance and Repair Cost (MEC$)

Year	R-1	R-2	R-3	R-4	R-5	R-6	R-7	Criteria
2018	0.217	0.035	0.049	0.071	0.116	0.028	0.024	4%
2019	0.217	0.035	0.049	0.071	0.116	0.028	0.024	4%
2020	5.436	0.873	1.215	1.764	2.898	0.711	0.594	100%
2021	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2022	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2023	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2024	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
2025	0.109	0.017	0.024	0.035	0.058	0.014	0.012	2%
Improvement Option III								
2001	0.071	0.017	0.023	0.022	0.038	0.010	0.009	3cm-2%
2002	0.071	0.017	0.023	0.022	0.038	0.010	0.009	2%
2003	0.071	0.017	0.023	0.022	0.038	0.010	0.009	2%
2004	0.071	0.017	0.023	0.022	0.038	0.010	0.009	2%
2005	0.071	0.017	0.023	0.022	0.038	0.010	0.009	2%
2006	0.142	0.035	0.045	0.043	0.076	0.020	0.019	4%
2007	0.142	0.035	0.045	0.043	0.076	0.020	0.019	4%
2008	0.142	0.035	0.045	0.043	0.076	0.020	0.019	4%
2009	0.142	0.035	0.045	0.043	0.076	0.020	0.019	4%
2010	3.546	0.864	1.125	1.080	1.908	0.495	0.468	100%
2011	0.116	0.020	0.037	0.035	0.062	0.016	0.015	5cm-2%
2012	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2013	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2014	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2015	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2016	0.233	0.041	0.073	0.071	0.125	0.033	0.031	4%
2017	0.233	0.041	0.073	0.071	0.125	0.033	0.031	4%
2018	0.233	0.041	0.073	0.071	0.125	0.033	0.031	4%
2019	0.233	0.041	0.073	0.071	0.125	0.033	0.031	4%
2020	5.814	1.017	1.836	1.764	3.123	0.819	0.765	100%
2021	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2022	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2023	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2024	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%
2025	0.116	0.020	0.037	0.035	0.062	0.016	0.015	2%

8.2 PRELIMINARY ECONOMIC ANALYSIS

In this preliminary analysis, the estimated rough project costs of construction, including engineering and land acquisition, and maintenance are used with the determined basic direct benefits of each road in order to select roads and improvement options with high economic viability for the Feasibility Study.

8.2.1 Analysis Procedure

The road improvement project is expected to generate direct benefits, which can be evaluated on a monetary basis, and indirect benefits which are assessed under the project socioeconomic impact as presented in Chapter 13. Benefits of the project are measured through the comparison of the two cases of "with project" and "without project".

The three economic parameters of benefit/cost ratio (B/C), economic internal rate of return (EIRR) and net present value (NPV) are used in this economic analysis to produce factors used in the established prioritization ranking for the project roads. Costs and benefits are divided, as shown below, into direct costs and benefits which are evaluated on a monetary basis and indirect costs and benefits which are assessed under the project's socioeconomic impact.

In the economic analysis of road projects, the main benefit is normally gained from savings in vehicle operating costs. For existing traffic on existing roads, the improved roads result in lower fuel and tire consumption as well as vehicle maintenance requirements in addition to savings in traveled distance and time.

The distance-related benefits are based on savings in the traveled distance (dL, EC$/pcu-km) and time-related benefits on savings in travel time (dT, EC$/pcu-hr), for all vehicles on the road network for the road improvement options of each of the seven project roads and for the case of improving all the project roads.

The implementation schedule applied in this analysis is presented in Table 8.2.1 in which a period of 12 months is required for the detailed design and 24 months for the construction activities of the whole project roads. As this analysis is tentatively applied to determine mainly the prioritization ranking of the project roads, the construction of all the roads is assumed to start after the tendering stage with different construction periods depending on the length of each road.

Table 8.2.1 Overall Tentative Implementation Schedule

Task	1st year	2nd year	3rd year	4th year
Selection of Consultant				
Detailed Design				
Land Acquisition				
Tendering				
Construction				

8.2.2 Direct Benefits

The direct benefits of the project are those measured in monetary values and composed of savings in different costs, however, in this preliminary analysis only the two main types of benefits are considered, which are:

- Savings in Vehicle Operating Cost
- Savings in Travel Time Cost

These two items basically provide the major component of the direct benefits in the economic analysis. The methodology of estimation and results of vehicle operating cost and travel time value based on the local conditions and data collected in Grenada are presented in Chapter 13. Table 8.2.2 gives a summary for the two components of distance-related and time-related VOC as well as the pcu base average time cost which is estimated based on the average GNP/capita and the household income statistics in the country.

Table 8.2.2 Summary of Vehicle Operating Cost and Travel Time Cost

a. Distance-Related VOC (EC$/pcu-km)	
Total Average	0.2629
b. Time-Related VOC (EC$/pcu-hr)	
Total Average	1.7414
c. Travel Time Economic Cost (EC$/pcu-hr)	
Average	2.9197

8.2.3 Preliminary Results

The results of this economic analysis are preliminary and approximate parameters based on tentatively developed average benefit values which are used in this stage as indicators for the purpose of the prioritization ranking of project roads to select roads for feasibility studies. Table 8.2.3 presents the estimated parameters for the three improvement options while the detailed estimations are included in Appendix 8. In this analysis, a residual value of 50% was considered in the estimation based on the assumption that the life span of roads and bridges from the engineering point of view is 50 years.

Table 8.2.3 Preliminary Economic Parameters

Road	Parameter	Option I	Option II	Option III
R-1	Total Cost (MEC$)	14.372	28.464	48.749
	B/C	1.68	2.01	1.94
	EIRR %	21.77	23.99	22.82
	NPV	12,739,408	34,465,678	52,620,427
R-2	Total Cost (MEC$)	1.533	3.0488	5.8932
	B/C	0.73	0.43	0.43
	EIRR %	7.51	3.09	3.45
	NPV	-376,160	-2,298,999	-4,382,183
R-3	Total Cost (MEC$)	3.121	6.475	11.891
	B/C	0.23	0.18	0.16
	EIRR %	-1.48	0.65	1.47
	NPV	-3,183,449	-6,508,407	-11,866,231
R-4	Total Cost (MEC$)	2.917	3.594	8.460
	B/C	0.30	0.69	0.54
	EIRR %	1.51	8.15	6.34
	NPV	-2,933,574	-1,522,835	-4,757,345
R-5	Total Cost (MEC$)	8.415	9.699	24.3024
	B/C	0.20	0.44	0.24
	EIRR %	1.27	4.88	2.03
	NPV	-8,619,256	-6,560,661	-21,374,038
R-6	Total Cost (MEC$)	1.510	3.313	4.569
	B/C	0.37	0.26	0.11
	EIRR %	2.72	1.41	1.07
	NPV	-1,297,481	-3,156,459	-5,167,896
R-7	Total Cost (MEC$)	1.3974	1.9788	4.7938
	B/C	0.02	0.14	0.09
	EIRR %	-7.60	-3.33	-2.88
	NPV	-1,902,429	-2,273,434	-5,541,402

Note: Option I : Minimum Improvement Option
Option II : Rehabilitation Option
Option III : High Standard Improvement Option
[ ] : Highest EIRR Option

8.3 PRELIMINARY ENVIRONMENTAL EVALUATION

The evaluation of environmental issues was divided into four distinct areas as follows:

- Right-of-Way Acquisition
- Natural Environment
- Socioeconomic Environment
- Women in Development

8.3.1 ROW Acquisition

When acquisition of Right-of-Way (ROW) is necessary due to proposed improvements to the roadway such as widening then there may be potential environmental impacts. Negative impact may occur when the land is occupied and people must be resettled to another location. R-1, R-3, R-4 and R-5 all have a little potential for ROW acquisition. R-2, R-6 and R-7 have no potential for ROW acquisition.

8.3.2 Natural Environment

Evaluation of the natural environment considered the potential impact from a variety of areas including soil erosion, hydrology, air pollution, noise and vibration pollution, ecosystems, materials, flooding, and waste disposal. The above areas of potential impact can be divided between those that impact during the construction phase and those that impact when the roads are completed. R-1, R-2, R-3, R-4, R-5, R-6 and R-7 are all affected a little in some way by the referenced natural environmental areas.

8.3.3 Social Environment

The potential socioeconomic environmental impact must be viewed in a comprehensive manner. A number of areas were reviewed to make an assessment of the potential impacts. The areas included land use, employment and income, traffic, and archaeological and historical sites. Based on an evaluation of the above socioeconomic environmental issues R-6 and R-7 were negatively, R-2 and R-3 were affected a little and R-1, R-4 and R-5 were positively affected.

8.3.4 Women In Development (WID)

It is apparent that while women account for fifty per cent of the population of Grenada, they have not been able to make meaningful contributions to economic development programs in the country. This project has a Women in Development component which gives a higher priority ranking to the roads which can provide facilities to support the WID issue. Accordingly, and based on the population covered and other women social aspects investigated through the initial environmental survey, R-1 and R-4 were ranked as highest priority, R-2 and R-5 as middle priority and R-3, R-6 and R-7 as lowest priority.