Denis Thibeault
NRA - T&P

PUBLIC WORKS DEPARTMENT

GRAND CAYMAN, CAYMAN ISLANDS, B.W.I.

MASTER GROUND TRANSPORTATION PLAN

WILBUR SMITH ASSOCIATES

in association with

DAVID LASHLEY & PARTNERS

and

ROBERTSON WARD ASSOCIATES

1988

WILBUR
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ENGINEERS • ARCHITECTS • PLANNERS

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March 16, 1988

The Chairman, Steering Committee
Public Works Department
Cayman Islands
British West Indies

Dear Sir:

It is our pleasure to submit this final report, **Master Ground Transportation Plan**, prepared according to the terms of our Agreement. The report, including a technical appendix, has been bound in a single volume for convenience of use. The work is organized so as to address all the concerns of the Steering Committee. These include a detailed set of improvement projects and investment schedule, preliminary design plans, and identification of likely future road projects. It also includes council and advice concerning government transport policies and legislation as it affects ground transportation on Grand Cayman.

Road improvement projects recommended for construction in 1988-1992 have been divided into two groups, a set of immediate action projects designed to improve the existing road network, and new road segments to provide an alternative route to the congested West Bay Road. A traffic circulation scheme has been proposed for George Town, designed to efficiently circulate vehicle trips to and from the new North-South Arterial and Fort Street Extension. The one-way traffic scheme can be accomplished at a relatively low cost, but should not be implemented until the new arterial and connector roads are in place.

On behalf of David Lashley & Partners and Roberson Ward Associates, we acknowledge with thanks the close cooperation and assistance from Mr. Donovan Ebanks, Chief Engineer, and the staff of the Public Works Department. With the support of each member of the Steering Committee and their technical staff, this document was completed in a timely manner and should be of benefit to the quality of life experience in Grand Cayman for years to come.

Respectfully Submitted,

WILBUR SMITH ASSOCIATES

LE Maseng

Leif E. Maseng, P.E.
Study Director

ACKNOWLEDGEMENT

The Master Ground Transportation Plan was prepared under the direction of the MGTP Steering Committee appointed at the direction of the Cayman Islands Government, under the auspices of the Public Works Department. Members of the Committee were drawn from all branches of Government carrying major responsibilities regarding the provision of safe and convenient ground transportation facilities in Grand Cayman.

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INTRODUCTION

CHAPTER ONE

INTRODUCTION

The Cayman Islands, a British Dependent Territory, are located about 180 miles northwest of Jamaica and consist of three islands. Grand Cayman, the largest of the three, included 94 percent of the national population in 1987 (22,869 persons) The seat of national government is located in George Town, Grand Cayman.

The Islands came under British rule in 1670 and became a dependency of Jamaica that lasted until 1959. In 1962, when Jamaica became independent, the Cayman Islands remained a British Colony and a Governor was appointed.

The economic life is primarily based on two major activities, offshore financial services and tourism. The offshore company and banking laws were enacted during the 1960's, and are responsible for much of the economic growth experienced since then. More than 480 banks and trust companies, and 17,000 foreign companies were registered in the Islands. Only a small number of these, however, maintained individual local offices.

During the mid-1970's the Islands were discovered by the world tourism industry. This resulted in rapid development of hotels, retail shops and second homes located primarily in George Town and along the famous Seven Mile Beach to the north. By 1985, tourism contributed US $70 million per year to the economy and employed a quarter of the workforce. Thanks to tourism and banking, full employment has been achieved in Grand Cayman, and additional workers have been recruited from abroad.

Topographic features of Grand Cayman vary between the sand/marl shoreline along the western coastal area and the hard Bluff Limestone in the East End and Northside Areas. Average elevations along the western shore lie between 4 and 12 feet above mean sea level, with lower areas located primarily in mangrove swamp. Underlying most of the western half of the island is ironshore formation, a soft limestone material that is exposed in some areas and in others is covered by up to 20 feet of peat and/or marl.

Land development over the last 15-20 years has been concentrated along Seven Mile Beach and other areas near George Town. The result is an increasing scarcity of large land parcels suitable for residential/tourist oriented facilities in this vicinity. Because of this, developers have begun to dredge canals and small lakes adjacent to North Sound, and use the excavated material to reclaim lowlying areas for new development.

STUDY AREA

The Master Ground Transportation Plan (MGTP) analysis includes all of the Grand Cayman land area, approximately 69 square miles, and a 1987 population estimated to include over 24,000 persons including visitors. However, attention is directed primarily toward the urban centres of George Town, West Bay, and Bodden Town, as shown in Figure 1.

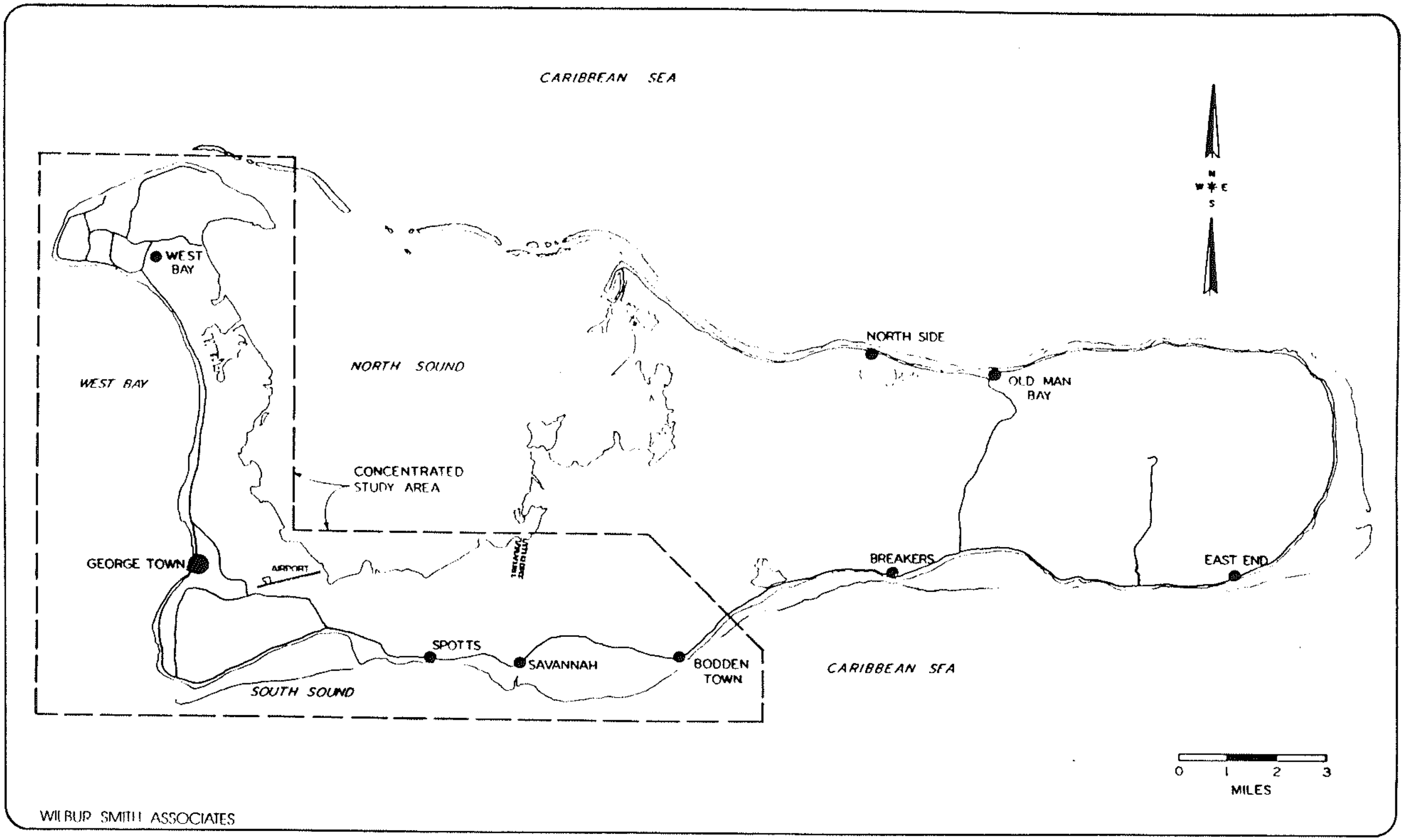
The benefit of a focus on the more populated area is twofold. It recognises that ground transportation consists of person-trips utilising a wide variety of personal and public vehicles, and the need for a network of public roads and streets designed to serve the transportation needs of the area. By concentrating on the more densely populated western portion of the Island it was possible to develop a system of relatively small geographic zones necessary for the traffic network analysis for trip generation.

A second purpose in targeting the more urban areas was that these are the primary source of traffic and parking problems that must be investigated. George Town, in particular, has recently experienced centre city traffic congestion and pedestrian inconvenience as business activity and tourist travel continues to grow.

The report that follows is intended to meet the requirements set out in the Terms of Reference for the Master Ground Transportation Plan Study. Objectives stated in the Terms of Reference included:

a. a detailed program of economically prioritized projects and a corresponding transport investment schedule for 1988-1992;

b. appropriate physical plans to allow timely land acquisitions necessary for these projects;



MGTP STUDY
GRAND CAYMAN BWI

FIGURE 1-1

STUDY AREA
MASTER GROUND
TRANSPORTATION PLAN

LEGEND

MAJOR ROADWAY

URBAN CENTRE

LIMITS OF STUDY AREA

c. a prospective program of road transport projects for years 1993-1997 with corresponding approximate investment schedule and primary justifying factors (i.e. reasons for consideration);

d. recommendations for the improvement of the operation, planning, and management of the road transport mode including specific recommendations to enable the annual updating of the five year investment program; and

e. recommendations for the improvement of Government transport policies, especially policies for effective transport coordination.

NATIONAL GOALS AND OBJECTIVES

To begin this analysis it was first necessary to ensure that the greater national interest was the guiding principle in the conduct of the Master Ground Transportation Plan Study. The provision of transport facilities is intended to serve the national interest by furthering national goals, objectives and policies. Transport is not an end in itself, and it does not have its own political constituency. Rather it should be directly and consciously linked to national economic, demographic and social policy.

A series of meetings were held with both governmental agencies and private groups to appraise them of the process of conducting a transportation study, and results that could be expected upon completion of the work. In all cases these sessions resulted in much general discussion and personal sharing of thoughts and concerns regarding future growth and development of Grand Cayman.

DEVELOPMENT/INFRASTRUCTURAL RELATIONSHIP

There is a direct relationship between the number of residents and visitors and the infrastructure investments (roads, water supply, sewerage, etc.) needed. Demand for transport is a function of population size, number of tourists, gross national product, trip making characteristics, and other demographic and economic features.

To design a road transport system that is based on needs, a forecast of demographic and economic conditions must be made. Such a forecast accepts and existing and established national policy and set of goals regarding future development. This was not the case in Grand Cayman at the onset of the Master Ground Transportation Study. The National Development Plan was in the process of being revised, and concerns about the rate of national growth were being expressed by both Government and the general public.

GROWTH ALTERNATIVES

As the issue of continued growth and development versus constrained growth has not been decided, the Government requested that the MGTP Study investigate transportation impacts relating to three possible growth rates. As a result of guidance from the Steering Committee, it was agreed that projections produced by the Department of Planning would be used for the period 1987 to 1992. Because development permits had already been granted and no major changes in Government policies were imminent, it was appropriate to anticipate a continuation of current growth rates for the next five years.

The MGTP Study based its population forecasts on the Planning Department's Linear Growth Projections which assumed a total population in 1985 of 21,332. This figure was projected by the Department to increase to 26,700 persons by the year 1992, or an annual increase of 3.6 percent in total population. This growth rate was subsequently defined as Growth Option B.

For the second five-year period, in order to comply with the Government's request, a low rate was defined as consisting of the natural increase of the indigenous population coupled with a proportional increase of expatriates (Option A). Similarly, a forecast of a high rate of development, based on a 10 percent average annual increase in work permits and thereby increasing the number of expatriates and dependents, was applied (Option C). The lower rate of growth in Option A resulted in a projected 1997 population of 28,700 persons. In contrast, the high growth rate of Option C projected total population to reach 36,300 persons in the same year.

ADOPTED GOALS AND POLICIES

A review of the Economic Development Plan, 1986/1990, and The Development Plan of 1977, provided the basis for judging likely future policy decisions and their effect on transportation planning. The 1977 goals or strategies had a strong growth and development orientation --encourage tourism, banking, manufacturing, etc. As evidenced by the growth and development between 1977 and 1987, these policies may be described as having succeeded.

A gradual shifting of attitude away from growth accentuation (1977) to one of controlled population increase is more apparent today. Concern has been expressed for environmental preservation, and emphasis on "Caymanian" opportunities, standard of living, and quality of life. This gradual shift in goals and policies was recognised in the Study.

In past years the Cayman Islands have viewed growth, both economic and demographic, as being quite beneficial in that income increases, lifestyles improve, etc. Beyond some intangible point, however, rapid growth brings excessive impacts that begin to affect the population in a negative manner. Congested roads are one obvious result as Government is unable to supply necessary infrastructure to accommodate the rate of development its actions have fostered.

TRANSPORT-SPECIFIC POLICY

Discussions with the Government and with those in the private sector also provided guidance on their policy and strategy matters. From these meetings the following conclusions were drawn:

Major Land Use Changes - Government undertook to notify the Consultant of any location changes to significant existing traffic generators envisaged within the planning period. It was concluded that the Port will remain where it is. The analysis was to consider any envisaged new schools, major hotels or condominiums, hospital relocation, etc, based upon information to be supplied by the Planning Department.

Mass Transportation - Discussions indicated that mass transportation would remain in the private sector. The private vehicle was assumed as the predominant form of transportation throughout the study period.

Road Network Improvements - A number of possible road network improvements in the study area were discussed during initial meetings with various agencies. It was understood that all options capable of improving traffic flow would be considered as possible solutions. These included traffic management procedures, intersection improvements, road widening, and alternative routings.

Parking Demand and Cost - The issues of parking space demand and parking policy were identified as important study elements. Government recognised that some form of parking regulation, possibly including the institution of parking charges, could be needed. The Study was also asked to comment on parking locations in terms of generalised need and access. The possible location of a new post office, with overhead multi-storey car park, was also reviewed.

Road Right-Of-Way - Historically new road construction on Grand Cayman was primarily in the form of land access roads. As a result, the owners of the affected land benefitted from the roads. Recognising this, the landowners generally provided the land for the roads without compensation. In order to provide for new and improved roads to serve the study area, Government must have the mechanisms whereby it can gain access to the necessary lands in order to serve public needs, even if this means compensating the landowners. Thus, the Study also considered strengthening of land acquisition procedures.

In addition, changing land use that accompanies development processes may preclude the provision of an adequate public road network. As in-filling occurs, the cost of a new road corridor becomes increasingly expensive. In order for the Government to address this problem, right-of-way must be preserved, even though it may not be required until some future date.

Governmental Policy Roles - In the past, Government intervention has occurred only in order to meet the needs and wishes of the people. Within this context of restrained

Government action and policy, this Study assumed that some types of increased Governmental action could be considered, for example:

* The feasibility of a George Town "pedestrian" area.

* The possibility of implementation of parking fees.

* Consideration of "staggered work hours".

Policies that tend to unnecessarily constrain or restrict were not considered in the Study. Items <u>not</u> analysed included:

* Vehicle ownership constraint or increased taxation.

* Vehicular use constraint, e.g., limited access to the centre of George Town.

* Governmental provision of mass transit.

PREVIOUS STUDIES

A number of studies of various aspects of Grand Cayman Transportation have been completed in the past and have been used as resource material for MGTP Study. Efforts to solve traffic related problems in the last decade began with attempts to relieve congestion in central George Town. Solutions include several schemes for one-way circulation of vehicles and identification of on-street parking areas.

More recently, studies have broadened this scope to recognise problem areas in Greater George Town and along West Bay Road. Although in each case studies were somewhat limited in scope, all recognised the need for additional data and statistics concerning both traffic and socioeconomic development in Grand Cayman. The most recent analysis, "Roadway Transportation Study", prepared by a group within the Department of Civil Engineering, University of Tennessee, December, 1986, was more comprehensive than others but was handicapped by the lack of a sufficient data base.

The MGTP Study, therefore, was organised in a manner that required data collection and analysis over the first half of the Study. This information was published in two interim reports. A Statement of National Goals and Objectives was followed by a report on the Existing Transport System. These were followed by a report on Preliminary Plans and Cost//Benefit Analysis, and a memorandum accompanying Right-of-Way Acquisition Plans. Each of these MGTP reports details all of the investigations and the analysis process that is summarised in this final report.

CHAPTER TWO

PLANNING ANALYSIS AND FORECAST

CHAPTER TWO

PLANNING ANALYSIS AND FORECAST

It should be recognised that, whilst land use planning in the Cayman Islands has been carried out in the past in varying degrees of detail, the general policy with regard to official development plans appears to have been one of flexibility in implementation. The designation of land by zones has not precluded development of individual properties in any zone provided that the primary use was not adversely affected or unless there were substantial objections from immediate neighbours.

CURRENT LAND USE

In response to needs of the MGTP Study, the Planning Department undertook an existing land use survey of Grand Cayman. Areas of similar activity were identified according to six predominant land use categories, including residential, commercial, industrial, agricultural, hotel and tourist related development, and institutional, crown and public open space. The distribution of the various land uses is shown on Figures 2-1, 2-2, and 2-3.

The three figures show the predominant use in each area, and reflect the single and multi-family uses coupled with tourism in the Seven Mile Beach/West Bay areas. They also indicate the gradual increase in the density of all uses within and around the centre of George Town, the mainly residential areas to the south and east, and the largely undeveloped eastern portion of the island characterised by single family residencies and "vacant" land.

TRAFFIC ZONES

In order to define more precisely all existing and future traffic and planning data identified during the course of this Study, the Island has been subdivided into 88 zones. Zone boundaries have been drawn so as to identify areas of similar land use and to facilitate traffic analysis of major trip generators. With a numbering system beginning in West Bay, the first 28 zones include the West Bay District and the Seven Mile Beach portion of the George Town District. Traffic zones 29 through 79 include all the remaining areas of the George Town

District, while zones 80-87 include the Bodden Town District. The remainder of the Island is identified by zone 88, as seen in Figures 2-4, 2-5 and 2-6.

CURRENT POPULATION

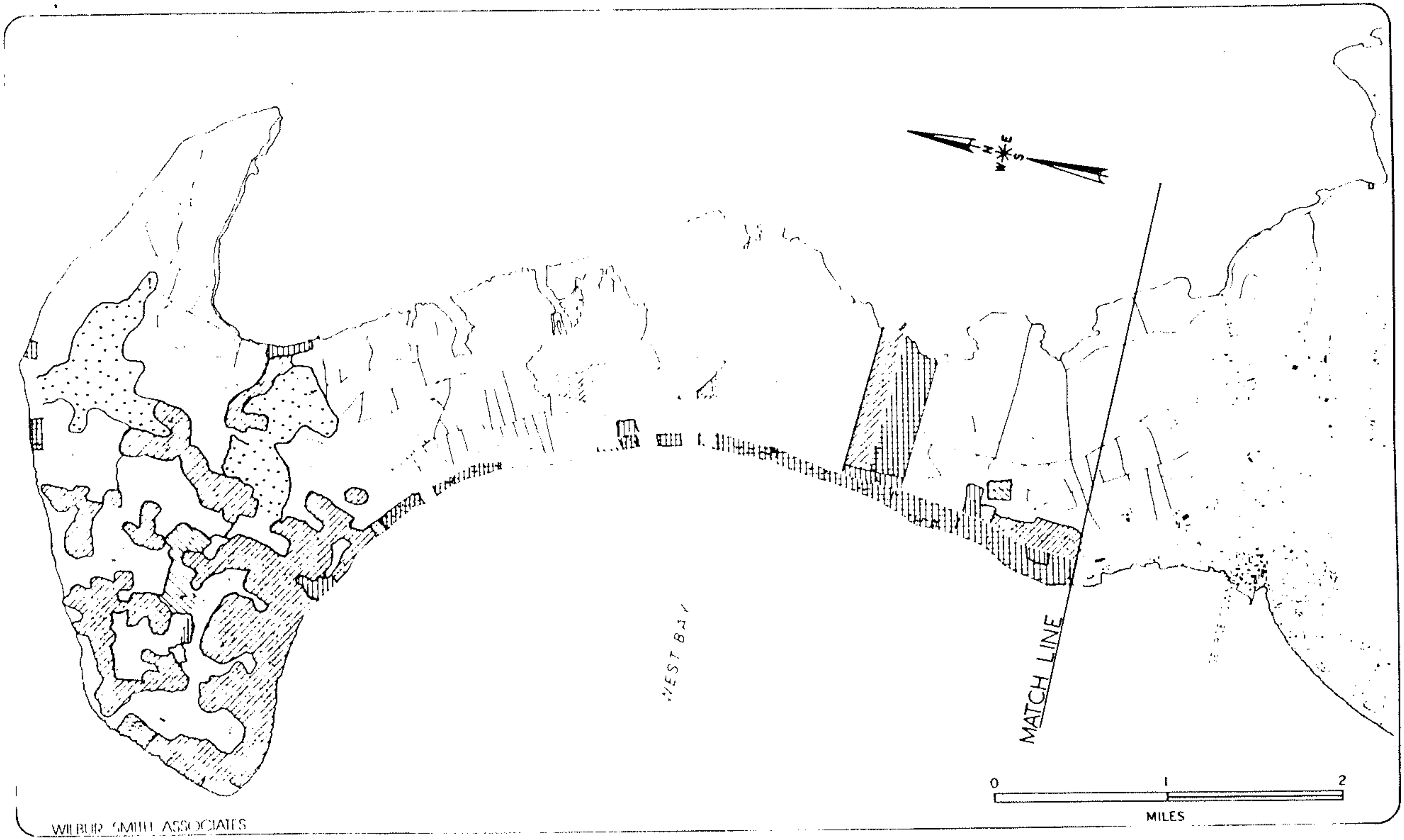
The 1986 Statistical Abstract of the Cayman Islands gives a provisional 1986 population estimate of 21,600. The Economic Development Plan, 1987, estimated 1987 population for the Cayman Islands at 22,869. Recently, the Government conducted a census on Cayman Brac and Little Cayman. Though this data is not yet available in printed form, it has been reported that 1,300 persons now live on those islands. The Economic Development Plan estimate of 22,869 persons was accepted by this study as the 1987 population of the Cayman Islands. Subtracting 1,300 for the Sister Islands population, the resulting 1987 Grand Cayman population was 21,569.

Population Distribution By Traffic Zones - During the early stages of the MGTP Study, need for updated and geocoded demographic database was realized. Subsequently the Planning Department undertook a windshield land use survey. The results of this survey were identified according to traffic zone (TZ), and used to quantify many of the parameters for the traffic analysis model.

Population by TZ was determined by using the Planning Department's number of single family (SF) and multi-family (MF) dwelling units per TZ and multiplying by an occupancy rate. These rates were derived from Water Authority survey data (1983) and from the Environmental Health Department's Sanitary Survey data (1987).

Tourist population for the peak season (March) was developed by identifying the number of hotel rooms per TZ, as reported by the Planning Department, and multiplying by occupancy rates (unit rental and persons per room). The result was an approximation of tourist population for each of the 88 traffic zones. It is important to note here that the MF units include condominiums rented on a short term basis.

Occupancy Factors - A survey by the Water Authority (WA) determined occupancy values of 3.42 persons for SF units and 2.50 persons for MF units in their population estimates for the Seven Mile Beach Sewerage Scheme. These average values were determined by surveys sampling



MGTF STUDY
GRAND CAYMAN BWI

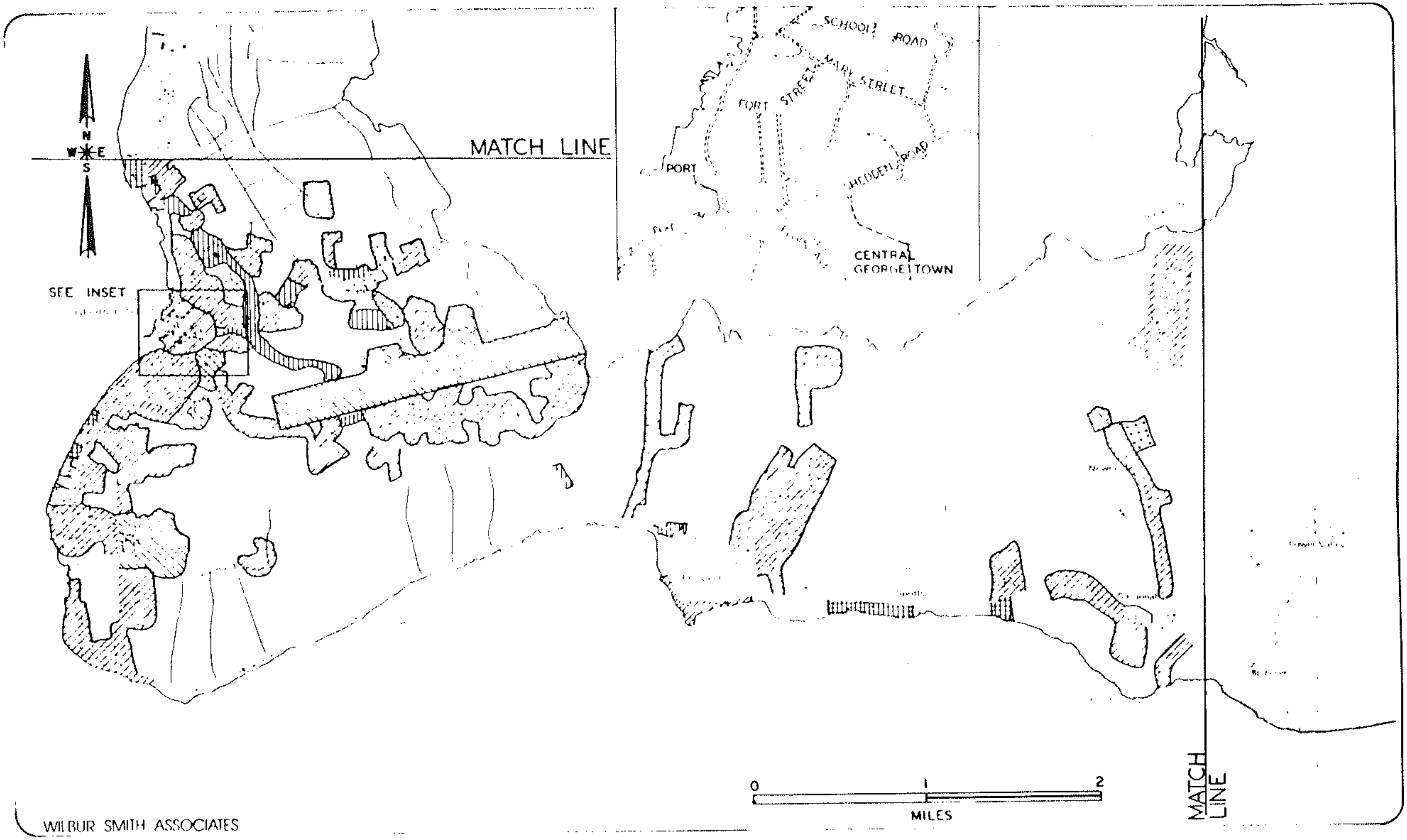
FIGURE 2-1

1987 LAND USE
WEST BAY

SHEET 1

LEGEND

RESIDENTIAL	AGRICULTURAL
COMMERCIAL	HOTELS / TOURIST RELATED DEV
INDUSTRIAL	INSTITUTIONAL, CROWN & PUBLIC OPEN SPACE (POS



WILBUR SMITH ASSOCIATES

MGTF STUDY
GRAND CAYMAN BWI

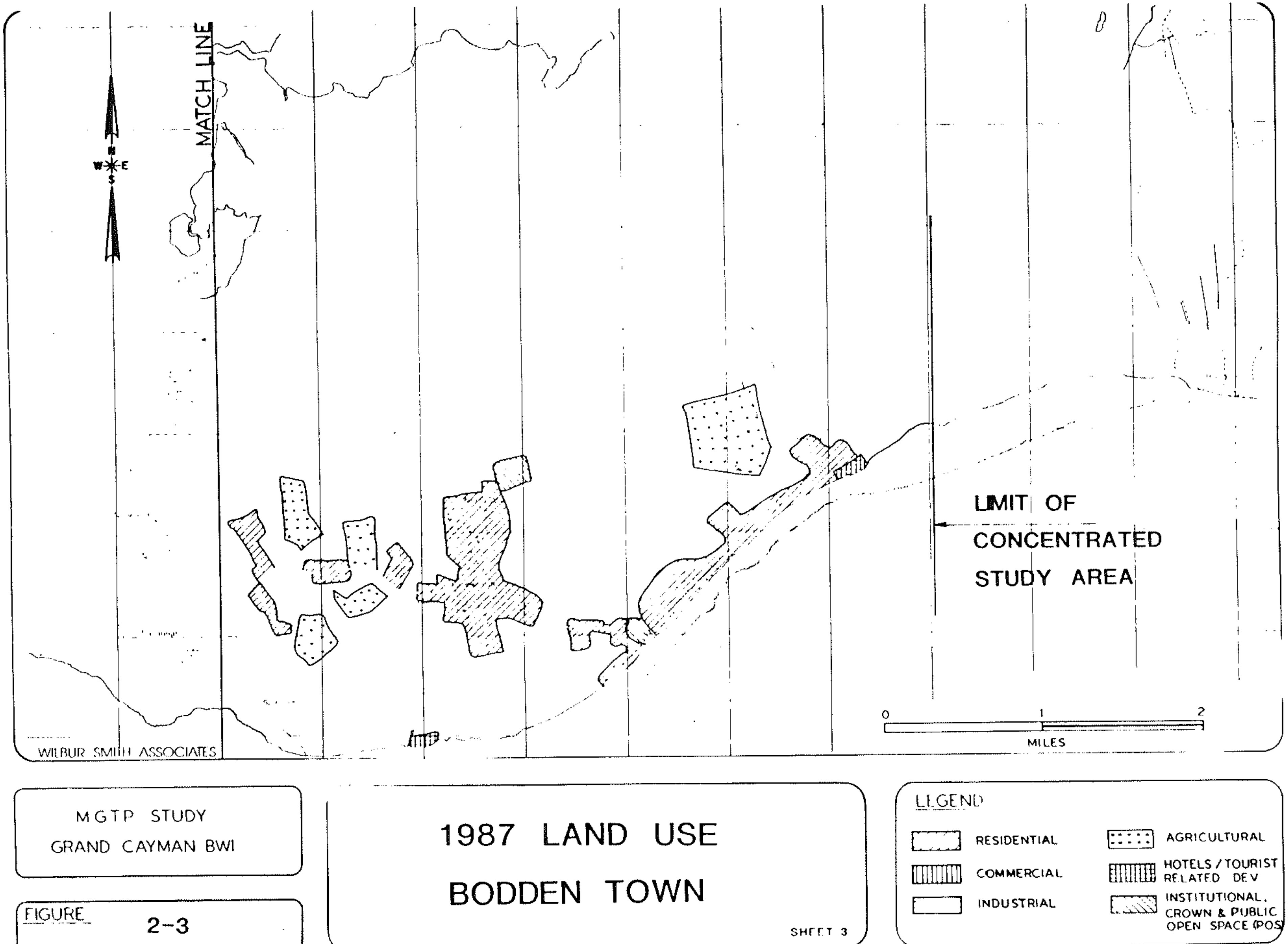
FIGURE 2-2

1987 LAND USE GEORGE TOWN

SHEET 2

LEGEND

- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- CENTRAL AREA
- AGRICULTURAL
- HOTELS / TOURIST RELATED DEV.
- INSTITUTIONAL, CROWN & PUBLIC OPEN SPACE (POS)

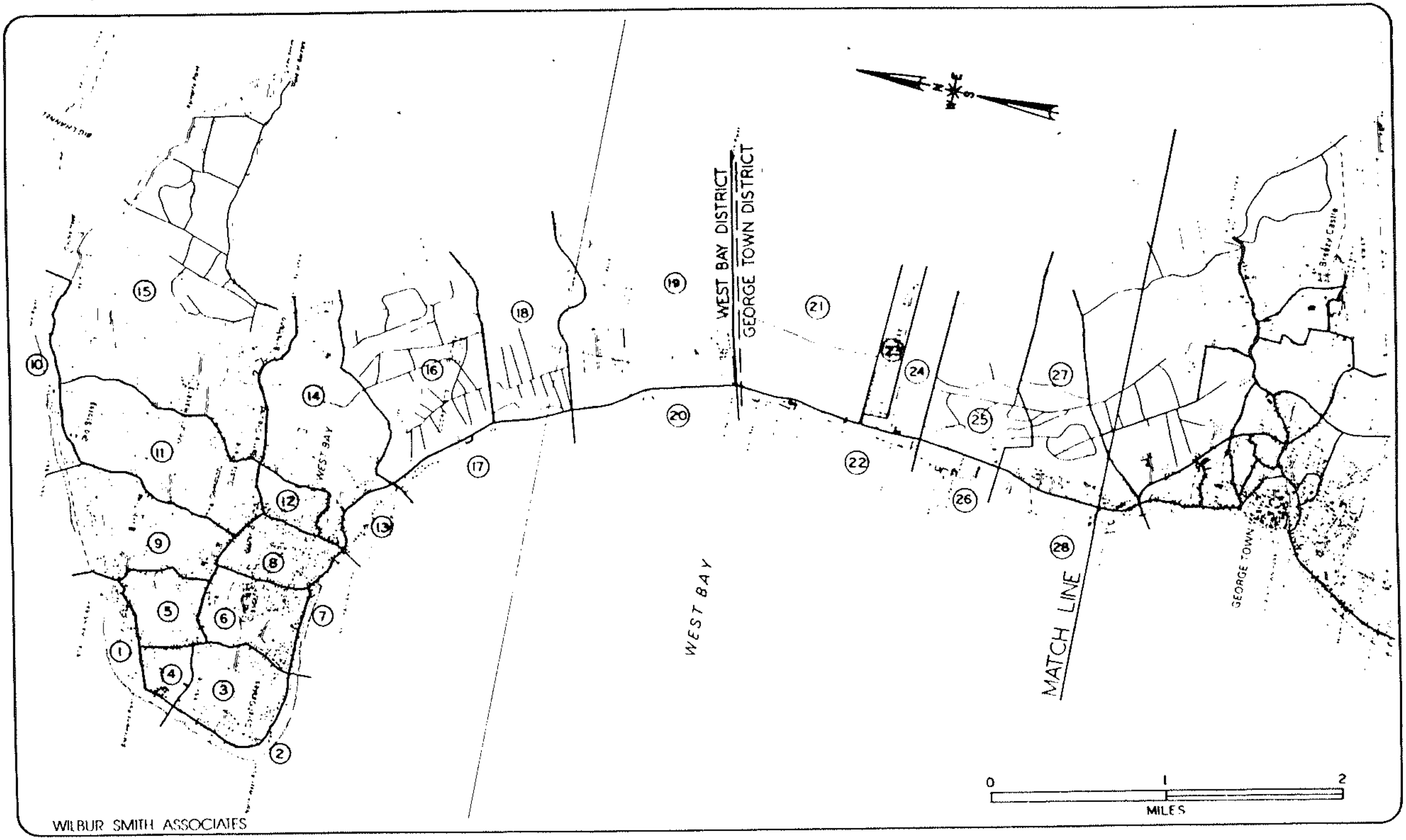


MGTP STUDY
GRAND CAYMAN BWI

FIGURE 2-3

1987 LAND USE
BODDEN TOWN

SHEET 3



MGTP STUDY
GRAND CAYMAN BWI

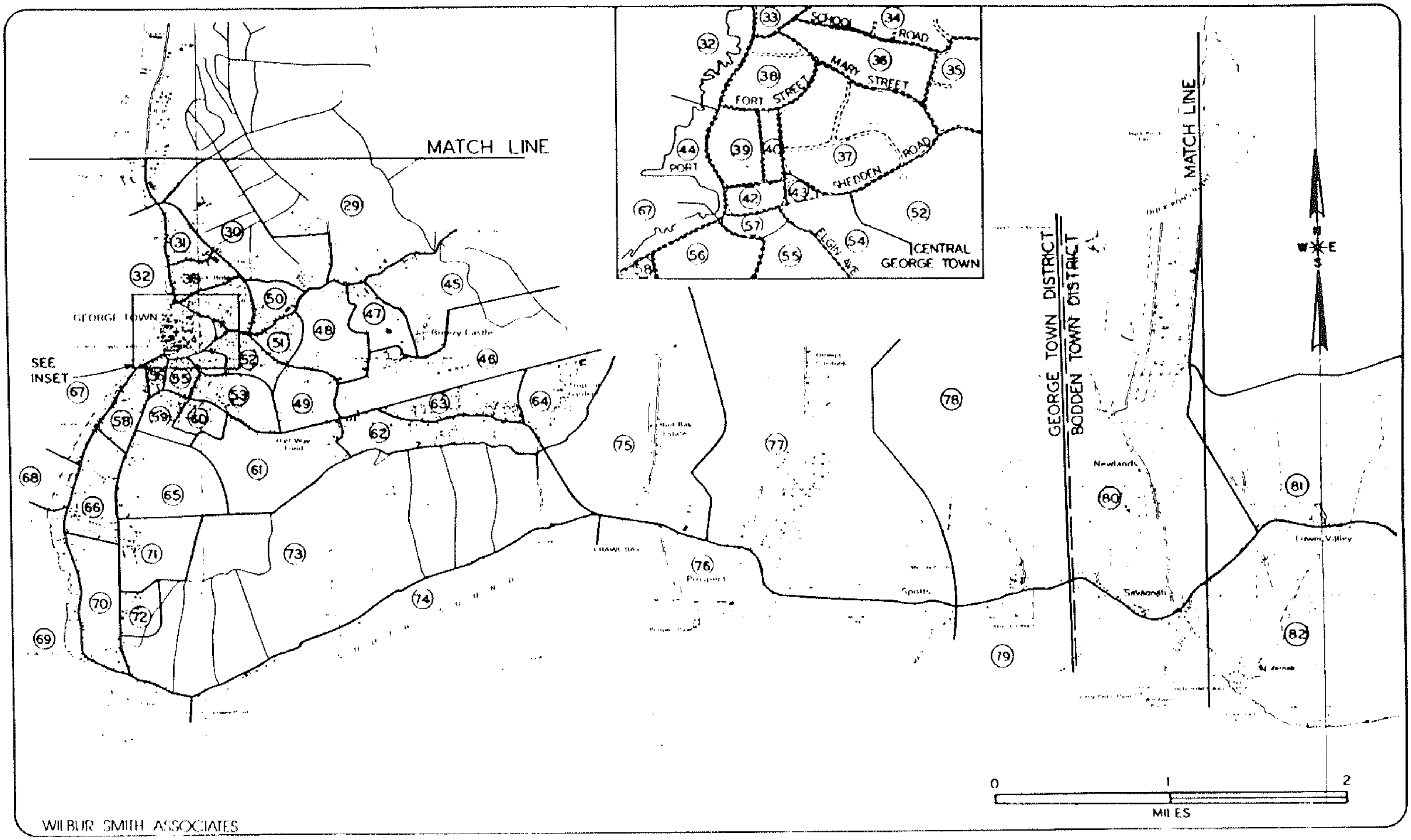
FIGURE 2-4

TRAFFIC ZONES
WEST BAY

SHEET 1

LEGEND

(26) TRAFFIC ZONE
ZONE BOUNDARY
ELECTION DISTRICT BOUNDARY



MGTP STUDY
GRAND CAYMAN BWI

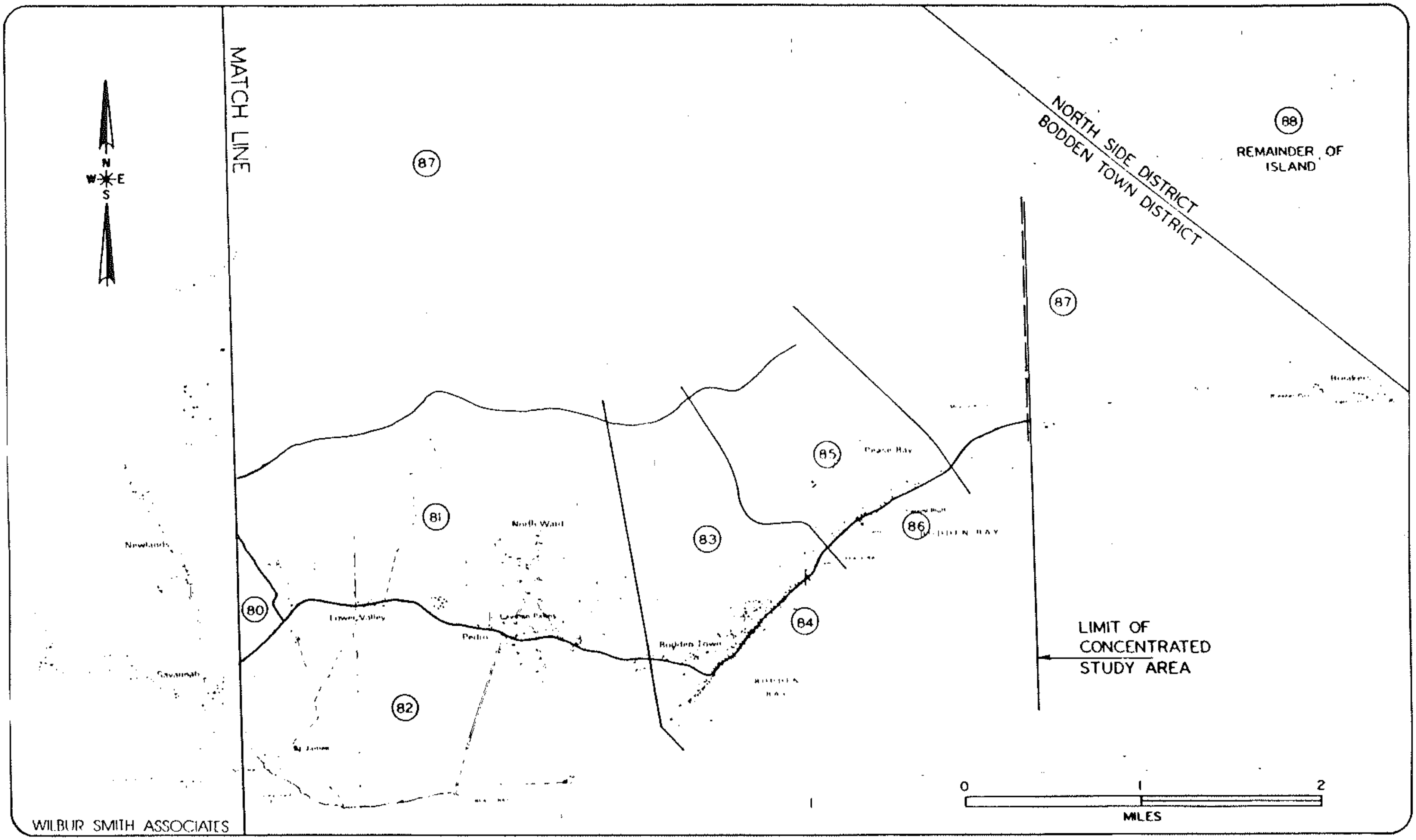
FIGURE 2-5

TRAFFIC ZONES GEORGE TOWN

SHEET 2

LEGEND

- (78) TRAFFIC ZONE
- ZONE BOUNDARY
- ELECTION DISTRICT BOUNDARY



MGTP STUDY
GRAND CAYMAN BWI

FIGURE 2-6

TRAFFIC ZONES BODDEN TOWN

SHEET 3

LEGEND

(82)	TRAFFIC ZONE
———	ZONE BOUNDARY
— — —	ELECTION DISTRICT BOUNDARY

69 homes in the West Bay Beach area in 1983. The area surveyed includes 127 SF units in TZ's 16 - 26, indicating a 54 percent sample, and thus are appropriate for the MGTP analysis of those zones.

Occupancy data produced by the the Environmental Health Department's (EHD) data from their Sanitary Survey, 1987, was also determined to be valid for use in this study. The EHD had compiled their data according to block and parcel number. This data was then collated according to zones 27-36, 45, 47, 52, 53, 55, 58, 59, 61-67, 70-72, 81, 83, 84, 87 and 88. Combined with the WA data, these factors represent a 31.2% sample of all SF units on Grand Cayman, exclusive of the West Bay area.

Single Family Units - Where data for a specific TZ had been analyzed, the calculated number of persons per household was used to estimate the population in single family dwelling units in that zone. Where information was not available for a specific TZ, the factor describing a zone with similar characteristics was used.

Multi Family Units - Water Authority values of 2.50 for MF units in the Seven Mile Beach area and 2.00 for MF units elsewhere were judged to be appropriate for the MGTP Study. Similar statistics developed during the EHD survey were discarded after discussions with their staff.

MGTP Population Estimate - With these values, the resulting total population for Grand Cayman was calculated to be 24,046. This includes an estimate of 1,633 tourists in the short term rented MF units. Subtracting tourists from the 24,046 estimate, the resulting Grand Cayman population is 22,413. Total population by traffic zone is shown in Table 2-1.

EMPLOYMENT

The Census of 1979 reported 7,539 people at work and 45 people sick, for a total of 7,584 jobs in that year. The Employment Survey of the Cayman Islands; November, 1985; reported a current demand for 10,034 jobs. This represents an increase of about 408 jobs per year. The system of job classification in the two reports was not consistent, therefore very few accurate comparisons could be made between the two sets of data. The 1985 report also stated that 1985 Grand Cayman employment was 9,601, indicating 433 jobs waiting to be filled.

TABLE 2-1
EXISTING POPULATION DISTRIBUTION AND PREDOMINANT LAND USE BY TRAFFIC ZONE

ZONE	LAND USE	1987 SF UNITS	1987 SF UNITS OCC RATE	1987 SF UNITS POPULATION	1987 MF UNITS	1987 MF UNITS OCC RATE	1987 MF UNITS POPULATION	1987 TOTAL UNITS	TOTAL POPULATION
1	SF	40	3.82	153	8	2.00	16	48	169
2	MF	13	3.82	50	58	2.00	116	71	166
3	SF	118	3.82	451	28	2.00	56	146	507
4	SF	31	3.82	118	0	2.00	0	31	118
5	SF	69	3.82	264	10	2.00	20	79	284
6	SF	116	3.82	443	26	2.00	52	142	495
7	SF	24	3.82	92	13	2.00	26	37	118
8	SF	123	3.82	470	44	2.00	88	167	558
9	SF	126	3.82	481	30	2.00	60	156	541
10	TU	9	3.82	34	62	2.00	124	71	158
11	SF	172	3.82	657	22	2.00	44	194	701
12	SF	49	3.82	187	6	2.00	12	55	199
13	SF	43	3.82	164	22	2.00	44	65	208
14	SL	84	3.82	321	2	2.00	4	86	325
15	SL	84	3.82	321	15	2.00	30	99	351
16	SL	1	3.42	3	0	2.50	0	1	3
17	MF	12	3.42	41	254	2.50	635	266	676
18	SL	1	3.42	3	0	2.50	0	1	3
19	MF	34	3.42	116	108	2.50	270	142	386
20	TU	1	3.42	3	97	2.50	243	98	246
21	SL	3	3.42	10	0	2.50	0	3	10
22	TU	11	3.42	38	252	2.50	630	263	668
23	SF	56	3.42	192	17	2.50	43	73	234
24	TU	1	3.42	3	53	2.50	133	54	136
25	RN	1	3.42	3	0	2.50	0	1	3
26	TU	9	3.42	31	134	2.50	335	143	366
27	SL	71	5.15	366	63	2.00	126	134	492
28	TU	8	2.50	20	388	2.00	776	396	796
29	IN	10	6.29	63	62	2.00	124	72	187
30	SF	116	3.33	386	117	2.00	234	233	620
31	SF	45	4.37	197	24	2.00	48	69	245
32	RE	9	1.50	14	6	2.00	12	15	26
33	SF	80	4.63	370	60	2.00	120	140	490
34	SF	28	3.28	92	12	2.00	24	40	116
35	SF	29	3.67	106	45	2.00	90	74	196
36	SF	43	4.74	204	42	2.00	84	85	288
37	OS	13	3.67	48	0	2.00	0	13	48
38	OS	5	3.67	18	4	2.00	8	9	26
39	RE	0	3.67	0	0	2.00	0	0	0
40	OS	0	3.67	0	0	2.00	0	0	0
41	PO	0	3.67	0	0	2.00	0	0	0
42	RE	0	3.67	0	0	2.00	0	0	0
43	RE	0	3.67	0	0	2.00	0	0	0
44	IO	0	3.67	0	0	2.00	0	0	0
45	SF	49	5.39	264	15	2.00	30	64	294
46	IN	1	5.39	5	0	2.00	0	1	5
47	IN	7	5.39	38	4	2.00	8	11	46
48	IN	4	3.67	15	2	2.00	4	6	19
49	RE	2	3.67	7	4	2.00	8	6	15
50	RE	24	3.67	88	6	2.00	12	30	100
51	SF	39	3.67	143	33	2.00	66	72	209
52	SF	59	3.96	234	36	2.00	72	95	306
53	SF	65	3.71	241	34	2.00	68	99	309

TABLE 2-1 (Con't.)
EXISTING POPULATION DISTRIBUTION AND PREDOMINANT LAND USE BY TRAFFIC ZONE

ZONE	LAND USE	1987 SF UNITS	1987 SF UNITS OCC RATE	1987 SF UNITS POPULATION	1987 MF UNITS	1987 MF UNITS OCC RATE	1987 MF UNITS POPULATION	1987 TOTAL UNITS	TOTAL POPULATION
54	OS	0	3.96	0	0	2.00	0	0	0
55	SF	46	4.33	199	16	2.00	32	62	231
56	SF	14	3.77	53	10	2.00	20	24	73
57	OS	3	3.77	11	2	2.00	4	5	15
58	SF	59	3.77	222	54	2.00	108	113	330
59	SF	42	4.12	173	32	2.00	64	74	237
60	IH	0	4.12	0	0	2.00	0	0	0
61	SL	26	4.12	107	17	2.00	34	43	141
62	SF	73	4.27	312	56	2.00	112	129	424
63	SF	100	3.95	395	28	2.00	56	128	451
64	SF	23	4.09	94	15	2.00	30	38	124
65	SF	170	3.82	649	79	2.00	158	249	807
66	SF	84	3.13	263	48	2.00	96	132	359
67	SF	14	2.60	36	9	2.00	18	23	54
68	TU	4	2.60	10	0	2.00	0	4	10
69	MF	44	2.60	114	67	2.00	134	111	248
70	SF	52	3.71	193	41	2.00	82	93	275
71	IS	2	3.47	7	12	2.00	24	14	31
72	SF	29	3.47	101	27	2.00	54	56	155
73	SL	62	3.67	228	0	2.00	0	62	228
74	MF	36	3.67	132	79	2.00	158	115	290
75	SL	45	3.67	165	24	2.00	48	69	213
76	MF	19	3.67	70	142	2.00	284	161	354
77	SL	120	3.67	440	18	2.00	36	138	476
78	SL	39	3.67	143	7	2.00	14	46	157
79	MF	16	3.67	59	33	2.00	66	49	125
80	SL	136	3.67	499	13	2.00	26	149	525
81	SL	193	3.67	708	19	2.00	38	212	746
82	SL	120	5.00	600	29	2.00	58	149	658
83	SL	110	3.00	330	41	2.00	82	151	412
84	SL	45	5.00	225	27	2.00	54	72	279
85	SL	35	3.50	123	4	2.00	8	39	131
86	SL	22	3.50	77	43	2.00	86	65	163
87	SL	17	3.88	66	7	2.00	14	24	80
88	SL	627	4.09	2564	108	2.00	216	735	2780
TOTALS		4365		16939	3325		7108	7690	24046

SOURCE; Planning Department and MGIP Study

Land Use Key

SF	SINGLE FAMILY UNITS	SL	SINGLE FAMILY LOW DENSITY	MF	MULTI FAMILY
TU	TOURISM OR RELATED	AG	AGRICULTURE	RB	RETAIL AND SERVICE TRADES
OS	OFFICES, BANKS	IC	CHURCH, CEMETERY	IS	SCHOOL, COLLEGE
IH	HOSPITAL, CLINIC	IO	OTHER	POS	PUBLIC OPEN SPACE
RN	RECREATION	IND	INDUSTRIAL		

Employment Distribution By Traffic Zone - Distribution of total employment among the 88 zones was determined by tabulating places of business shown on the Land use survey maps and applying a jobs per square foot factor to each building. To allow for some degree of differentiation between types of buildings, factors were developed for the categories of "retail" and "other".

Factors were developed through a survey of the actual number of employees in eight selected buildings in George Town. The Government Statistician reported the number of employees in six buildings (retail and office) as recorded during the Employment Survey, 1985. The number of employees by business was not requested nor reported to the Study team in order to ensure the confidentiality of this information. The other two samples were provided by the Honorable Member for Communications, Works and District Administration, Captain Charles Kirkconnell, for Kirkconnell Brother's Home Center and Kirk Plaza, two examples of retail stores. Retail jobs were established as 0.0050 per square foot, while a figure of 0.007 was set for all other employment except hotels.

Hotel jobs were determined separately by assuming a value of 1.0 jobs per hotel room. Construction and other mobile jobs were distributed evenly between TZ's 16 - 75, excluding TZ 41 (traffic island). It was these areas where the majority of construction was or will be undertaken.

The values as reported in the Employment Survey, 1985, for private sector construction (898), and for taxi drivers (294), were evenly distributed (20 per TZ) in TZ's 16 through 75, except TZ 41 which is a traffic island.

The resulting 1987 total employment for Grand Cayman is 11,171. This is 1,570 higher than the 1985 Employment Survey, representing an increase of 785 jobs per year. The distribution of employment by traffic zone is shown on Table 2-2.

TOURISM

Development of the tourist industry in recent years has resulted in its becoming a major revenue producer and employer. Although the rate of increase of tourist arrivals by air and

TABLE 2-2
EXISTING EMPLOYMENT BY TRAFFIC ZONE, 1987

ZONE	EMPLOYMENT RETAIL	EMPLOYMENT OTHER	INDUST.	TOTAL JOBS
1	19	0	0	19
2	0	0	0	0
3	0	0	0	0
4	36	0	0	36
5	19	5	0	24
6	89	0	0	89
7	36	0	0	36
8	56	0	0	56
9	52	12	0	64
10	0	84	0	84
11	35	0	0	35
12	7	0	0	7
13	36	0	0	36
14	44	0	0	44
15	68	0	0	68
16	0	18	0	18
17	0	18	0	18
18	0	18	0	18
19	102	42	9	153
20	0	55	0	55
21	114	28	0	142
22	0	394	0	394
23	0	18	0	18
24	0	355	0	355
25	78	18	0	96
26	0	121	0	121
27	121	79	0	200
28	3	325	0	327
29	40	18	137	195
30	195	18	18	232
31	292	90	0	382
32	148	40	0	189
33	107	19	0	126
34	47	37	0	84
35	119	40	68	227
36	74	37	0	111
37	242	516	0	758
38	247	259	0	507
39	485	626	0	1111
40	0	254	0	254
41	0	0	0	0
42	91	89	0	180
43	22	18	0	40
44	0	18	23	41
45	27	25	0	52
46	23	194	0	217
47	149	18	177	345
48	342	18	9	369
49	122	76	0	198

TABLE 2-2 (Cont.)
EXISTING EMPLOYMENT BY TRAFFIC ZONE, 1987

	EMPLOYMENT			TOTAL
ZONE	RETAIL	OTHER	INDUST.	JOBS
50	334	18	0	352
51	66	67	9	142
52	266	32	5	303
53	0	64	0	64
54	407	148	0	554
55	25	18	0	43
56	117	30	0	147
57	73	18	0	91
58	0	23	5	27
59	0	27	0	27
60	0	221	0	221
61	0	18	0	18
62	0	18	0	18
63	0	27	0	27
64	0	20	0	20
65	14	24	0	37
66	91	64	18	173
67	0	32	0	32
68	0	56	9	66
69	5	23	0	27
70	16	18	0	35
71	0	132	0	132
72	0	18	0	18
73	0	18	0	18
74	0	18	0	18
75	9	18	0	27
76	9	5	0	14
77	13	0	0	13
78	0	0	0	0
79	0	0	0	0
80	27	7	0	34
81	0	61	0	61
82	38	0	0	38
83	25	18	0	43
84	28	0	0	28
85	27	0	0	27
86	0	7	0	7
87	0	0	0	0
88	34	80	23	137
TOTALS	5,310	5,352	510	11,171

Source: Planning Department, and MGTP Study by sea has varied dramatically in certain years, the overall growth rate is amongst the highest in the Caribbean region. The latest data available indicate that a 8.2 percent increase was registered between 1985 and 1986.

<u>Historical Growth</u> - Table 2-3 indicates the growth of all tourist arrivals by air and by sea over the last decade. Observations and conclusions that may be made on the tourist trends must recognise that tourist arrivals by air may be affected by availability of accommodation. Thus they may reflect the opening of <u>new</u> hotels. As a result, substantial increase in any one annual air arrival statistic may not be significant without reference to particular circumstances. It is assumed that virtually all arrivals by sea represent visitors who depart on the same day.

TABLE 2-3

TOURIST ARRIVALS, 1972-1986

	ARRIVALS BY AIR		ARRIVALS BY SEA			
Year	Persons	Percent Change	Number of Ships	Persons	Percent Change	TOTAL ARRIVALS
1976	64,875	19.8	66	40,618	80.9	105,493
1977	67,197	3.6	77	42,426	4.5	109,623
1978	77,402	15.2	70	45,052	6.2	122,454
1979	100,587	29.9	98	59,030	31.0	159,617
1980	120,241	19.5	116	60,869	3.1	181,110
1981	124,598	3.6	126	78,013	28.2	202,611
1982	121,214	-2.7	179	158,285	102.9	279,499
1983	130,763	7.9	221	177,215	12.0	307,978
1984	148,485	13.6	250	203,583	14.9	352,068
1985	145,072	-2.3	319	258,674	27.1	403,746
1986	166,082	14.5	316	270,949	4.7	437,031

Source: Department of Tourism, and MGTP Study.

<u>Peak Arrivals and Occupancy Rates</u> - Of the total tourist arrivals by air in 1986 (166,082), the peak month of March accounted for 19,867 or 11.96 percent, followed closely by the month of December and 16,800 arrivals (10.11 percent). Tourist arrivals for February 1986 were 15,411, and these 3 months (February, March and December) have consistently produced the peak demands in recent years, Table 2-4.

TABLE 2-4
TOURIST ARRIVAL AND OCCUPANCY RELATIONSHIP, 1986

Month	AIR ARRIVALS Number	AIR ARRIVALS % of Year	PERCENT OCCUPANCY Hotels	PERCENT OCCUPANCY Apartments
January	13,532	8.15	68.1	65.6
February	15,411	9.28	77.9	78.9
March	19,867	11.96	78.5	78.3
April	12,491	7.52	64.3	56.4
May	12,937	7.79	61.3	44.4
June	13,650	8.22	65.3	41.6
July	13,863	8.35	64.7	41.3
August	14,914	8.98	66.9	43.9
September	8,410	5.06	53.7	20.8
October	10,984	6.61	56.0	32.5
November	13,223	7.96	71.3	53.4
December	16,800	10.11	69.3	55.7
Total	166,082	100.00	66.5	52.0

Source: Statistical Abstract June 1987, and
Department of Tourism.

By omitting the normally "slack" months of September and October, the average for the remaining 7 months is very consistent, varying from 12,491 in April to 14,914 in August, or an average over the 7 months of 13,516 per month. These "out-of-season" arrivals are more consistent and higher than in many other similar Caribbean destinations.

<u>Choice of Tourist Accommodation, 1986</u> - The choice of accommodation for 1986 was assessed in the 1987 Statistical Abstract. It was found that 51.5 percent of all tourists preferred hotels, while 29.5 percent chose apartment accommodations. The remaining 19 percent were accommodated in private homes.

These ratios have not varied significantly over the past five years. On the assumption that very few hotel visitors arrive by sea, the stated relationships can be translated to actual numbers of visitors according to housing categories. Hotels attracted an estimated 85,500 tourists in 1986, while about 49,000 others sought apartment housing. Private homes attracted approximately 31,600 visitors.

By assuming March, 1986, as the peak month for hotels and apartments and that the previously stated relationships remain reasonably constant during the "high season", visitors to hotels were estimated at about 10,200 persons. Tourists in apartments numbered about 5,900, while almost 3,800 persons visited private houses.

Statistics on length of stay in 1986 indicate an average 4.0 days for hotels and 6.9 days for apartments. Over the past five years, hotels averaged 3.26 days and apartments averaged 6.6 days.

By applying the 1986 lengths of stay to the March 1986 tourist arrivals, the following rounded numbers of visitors can be assumed to have been present on any one day in the peak month:

Hotels: 4.0(10,200)/31 = 1,300
Apartments: 6.9(5,900)/31 = 1,300
Private Homes: 7.0(3,800)/31 = 900

No statistical data on length of stay in private homes is available for analysis. Therefore it is assumed that each visit had a duration of seven days.

Visitors and Cruise Ship Arrivals, 1986 - Cruise ship arrivals, shown previously in Table 2-3, include 270,949 passengers landing in 1986. Increases in arrivals have varied dramatically, averaging 32 percent p.a. between 1982 and 1986. The average number of passengers per vessel in 1986 was 857, but certain larger vessels frequently disembark in excess of 1400 persons, and in some cases 1700 persons. Since up to 4 or 5 vessels may arrive on the same day, the minimum number disembarking was estimated as 857 x 4 = 3428 passengers. Assuming that any one such cruise ship may be of larger capacity, peak day arrivals may have reached 3750 to 4000 persons.

The majority of cruise ship passengers disembark between 8.00 a.m. and 10.00 a.m. Their returns to ship were dissipated over a longer period with most actual departures occurring between 4.00 p.m. and 6.00 p.m.

EDUCATION

The location and size of educational establishments can generate considerable traffic demands, and occupy substantial land areas in themselves. Table 2-5 indicates the enrollment in Government and private schools for 1985/86 reached just over 4,000 students. Of these, about 70 percent were attending Government schools.

TABLE 2-5

SCHOOL ATTENDANCE, 1985/1986

SCHOOL	BOYS	GIRLS	TOTAL STUDENTS	ADMINISTRATOR/ TEACHERS*	TRAFFIC ZONE
Govt. Primaries					
George Town	209	205	414	21	34
West Bay	136	114	250	13	9
Savannah	89	62	151	8	80
Bodden Town	51	33	84	4	83
North Side	25	27	52	3	88
East End	38	36	74	4	88
Sub-total	548	477	1,025	53	
Govt. Secondaries					
Middle School	402	413	815	41	71
High School	490	502	992	50	71
Sub-total	892	915	1,807	91	
Private Schools					
Cayman Prep	140	128	268	13	71
Wesleyan Christian	43	55	98	5	6
Edmar SDA	33	41	74	4	65
Triple "C"	96	125	221	20	53
Our Lady of Perp Help	143	149	292	15	71
Truth For Youth	121	141	262	13	56
Sub-total	576	639	1,215	70	
TOTAL	2,016	2,031	4,047	214	

Source: Chief Education Officer

* One teacher per 25 students and two administrators per 100 students.

PLANNING FORECASTS

For the purpose of future projections, it has been necessary to investigate as far as possible likely trends in the nature and extent of future growth and land use. Consequently, projections to 1992 and 1997 are based wherever possible on known or published data and actual proposed developments. Where such information is lacking or nonexistent, an assessment has been made of changes likely to occur in so far as they affect the Transportation Plan. It is not the intention nor the mandate of the Study to prepare a new Physical Development Plan for Grand Cayman. All assumptions will need to be reviewed regularly, and certainly at the 1992 mid-term date.

Known Projects, 1987 - An examination has been made of current Government projects (as set out in the EDP 1986-1990). It has also been necessary to identify major private developments that are approved (in full or outline) together with those on which construction has already commenced. Both Government and private projects have been identified by traffic zone, and in the case of private retail/commercial, or apartment projects, the floor space or number of units has been established.

Future Projects - Because of the lack of precise future planning and projected land use, it has been necessary to assess each area with regard to future potential, and in order to design the transportation systems on likely population and employment statistics. All Government projects listed in the Economic Development Plan 1986-1990 which affect transport needs have been scheduled on an annual basis. All private sector town planning approvals (other than those identified as already commenced) have been noted by type and by zone. Future development schemes within each traffic zone have been indicated according to type and number of units on Figures 2-7, 2-8 and 2-9.

Summary of All Projects 1987-1992 and 1993-1997 - In order to assess and estimate future demands for transportation, a full schedule of all projects has been prepared on a traffic zone basis, and for the two 5-year periods of the Study. It should be noted that single residences are not included, neither is the erection of residences which may occur on approved subdivisions. However, all projects approved prior to 1987 which have become active during the year to date are included, as are all multi-family units larger than a duplex. All projects now underway in the private sector are also included, on the assumption that they will be completed in full. It is known that certain projects scheduled to be commenced by Government are not yet underway, but it has been assumed that they will be completed in the respective 5-year time periods.

The total number of hotel rooms includes the 526 rooms already opened in 1987 but not included in the 1986 statistics. The number for apartments/condominiums reflects units only, and not the number of rooms envisaged. No detailed projections can be made for private sector developments other than possible expansion in the high growth zones, particularly in the Seven Mile Beach area.

FUTURE POPULATION PROJECTIONS

Population projections for the Cayman Islands were made for the first and second five year periods covered by the MGTP Study. These projections were based on information supplied by the Planning Department. A single projection was prepared for the first period (1987-1992), while three growth rates were indicated for the second period (1992-1997). All projections were linear and were based on macro population trends taken from the Statistical Abstract and the 1986-1990 Economic Development Plan.

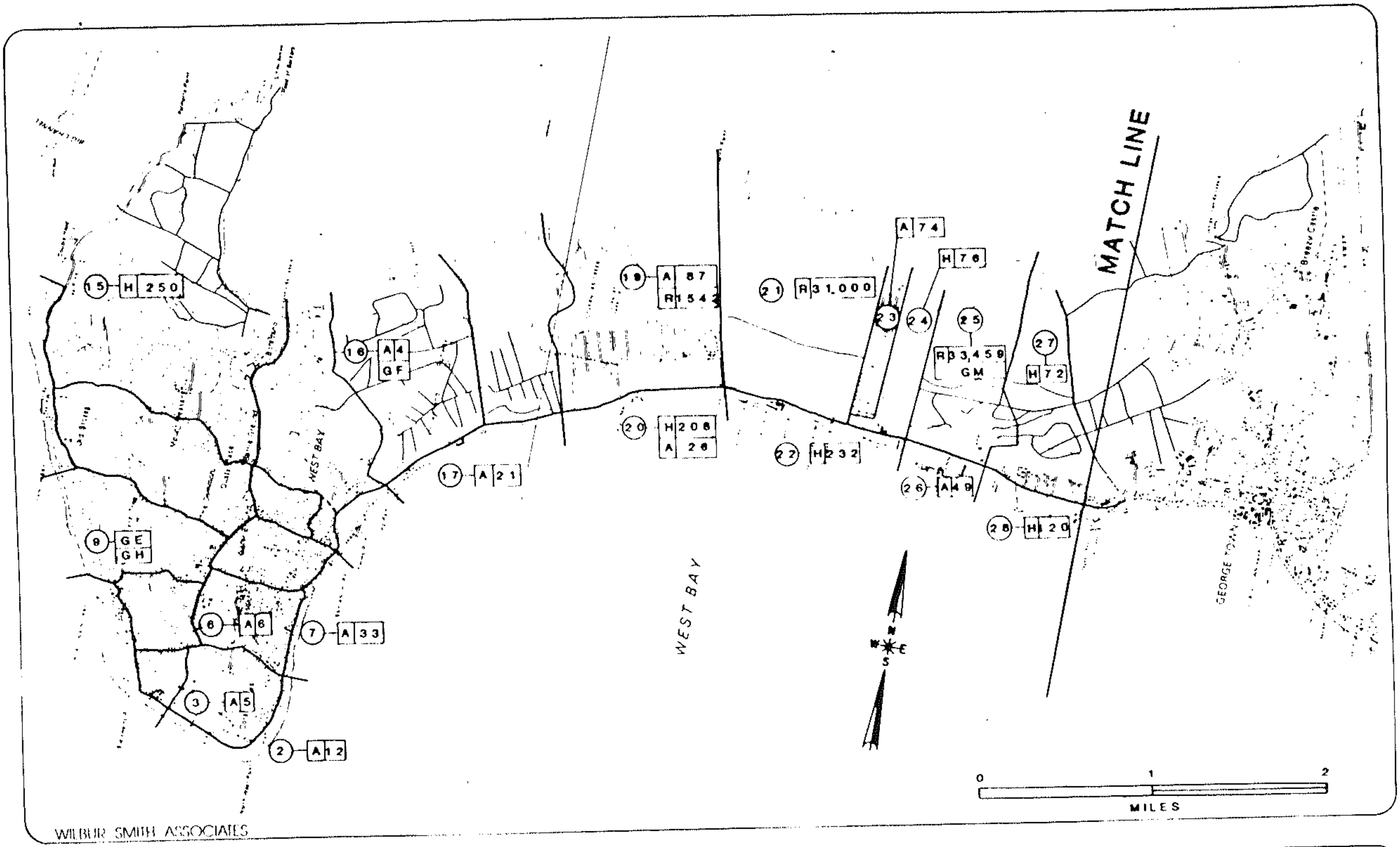
Discussions with Cable and Wireless (West Indies) Ltd., (C&W) revealed that they prepared annual forecasts of demand for telephone service. In essence this is a forecast of future population levels. Projections of business, residential and governmental tenancies and connections are done by 2,5,10,15 and 20 year periods for 49 geographic zones of Grand Cayman called "Cabinets". This information was made available for use by the MGTP Study team, and forms the basis for allocation of future population to each of the MGTP traffic zones.

Population Forecasts, 1992 and 1997 - Population forecasts were calculated for each traffic zone according to number of households and occupants and appropriate occupancy rates. The resulting 1992 and 1997 "B" forecasts are 27,551 and 33,965 persons respectively, as noted in Table 2-6. The restrained growth ("A") forecast for 1997 totaled 30,164 persons in the 88 zones on Grand Cayman , while the high growth "C" projection reached 37,765 in the same zone.

EMPLOYMENT PROJECTIONS

As with population forecasts, Cable and Wireless, provided a basis for the MGTP forecast of employment data to each traffic zone.

Employment to Population Relationship - A trend in the relationship of employment to population in the Cayman Islands for the years 1970, 1979 and 1985 were projected to 1997 in order to establish a forecast of total employment for 1997. The trend of an increasing ratio of employment to population was projected to increase to 53.9% in 1992 and 57.7% in 1997, based on the projection in the 1986-1990 Economic Development Plan of a 58.1% ratio by the year 2000.



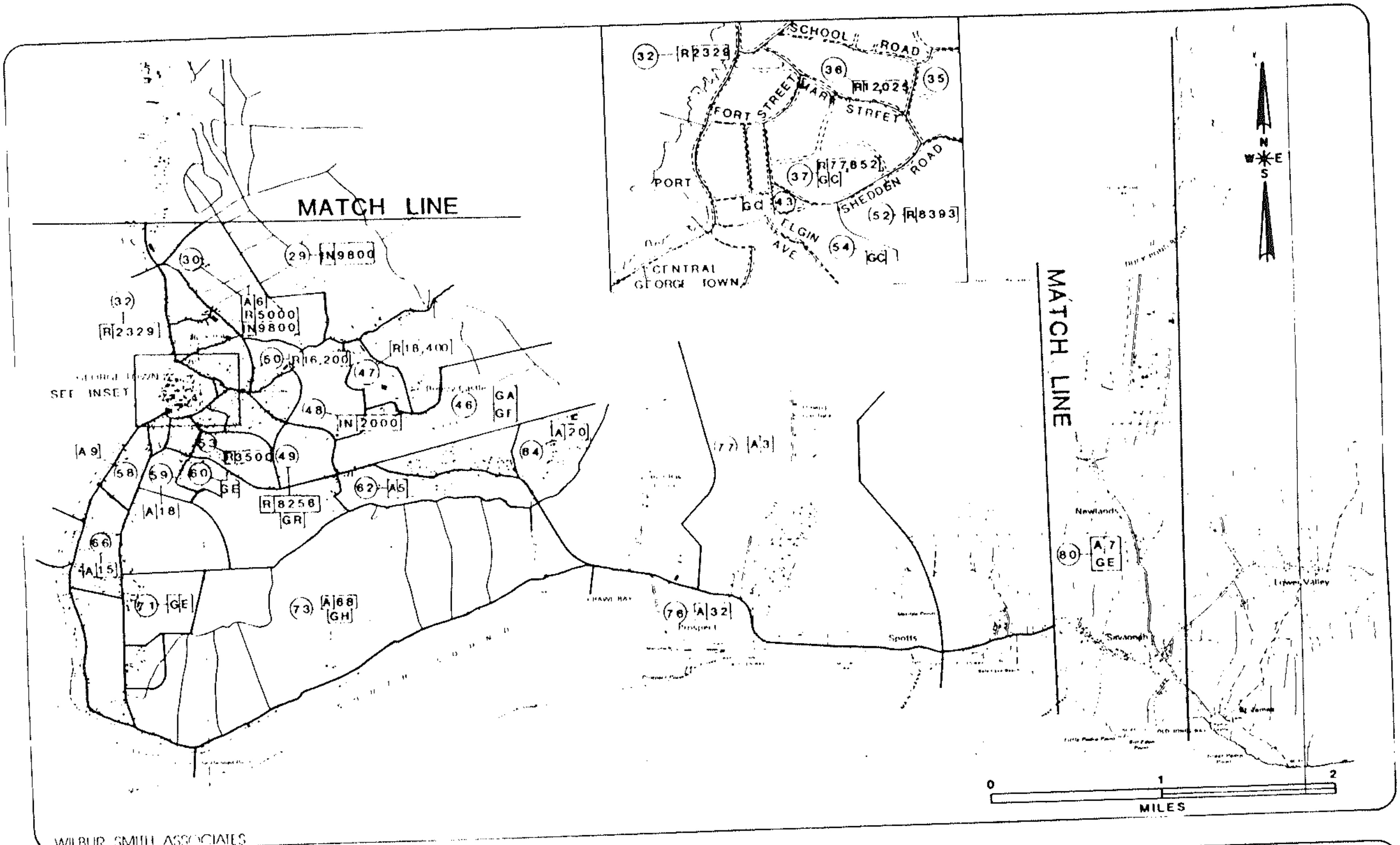
MGTP STUDY
GRAND CAYMAN BWI

FIGURE 2-7

FUTURE DEVELOPMENT SCHEMES WEST BAY

SHEET 1

LEGEND
H HOTEL(S) (ROOMS)
A APARTMENTS OR CONDOMINIUMS (UNITS)
R RETAIL/COMMERCIAL (AREA IN SQ. FT.)
IN INDUSTRIAL (AREA IN SQ FT)
G GOVERNMENT PROJECTS
GE : EDUCATION GH : HEALTH
GF : FIRE GM : MUSEUM
(16) TRAFFIC ZONE NUMBER



WILBUR SMITH ASSOCIATES

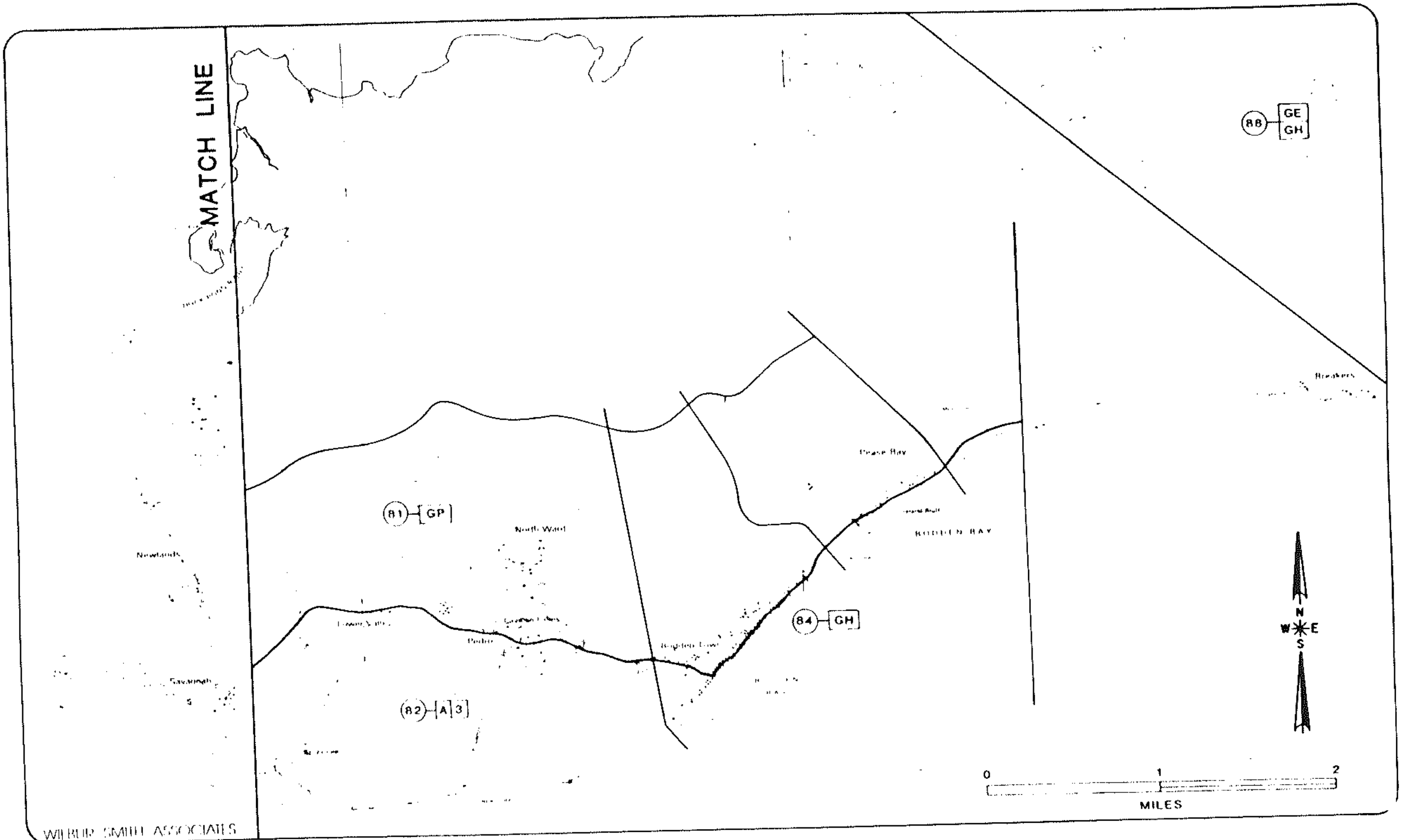
MGTP STUDY
GRAND CAYMAN BWI

FIGURE 2-8

FUTURE DEVELOPMENT SCHEMES
GEORGE TOWN

SHEET 2

LEGEND
- H HOTEL(S) (ROOMS)
- A APARTMENT OR CONDOMINIUM (UNITS)
- R RETAIL/COMMERCIAL (SQ.FT.)
- IN INDUSTRIAL (SQ.FT.)
- G GOVERNMENT PROJECTS
  - GE : EDUCATION GH : HEALTH GF : FIRE
  - GC : POST OFFICE/COMMUNICATIONS
  - GA : AIRPORT GR : AGRICULTURE/MARKETING
- (16) TRAFFIC ZONE NUMBER



MGTP STUDY
GRAND CAYMAN BWI

FIGURE 2-9

FUTURE DEVELOPMENT SCHEMES BODDEN TOWN

SHEET 3

LEGEND
A APARTMENTS OR CONDOMINIUMS (UNITS)
G GOVERNMENT PROJECTS
GE : EDUCATION GH : HEALTH
GP : POLICE/PRISON
(82) TRAFFIC ZONE NUMBER

TABLE 2-6
FUTURE POPULATION AND DISTRIBUTION BY TRAFFIC ZONE

ZONE	LAND USE	1987 TOTAL UNITS	1987 TOTAL POP	C & W CABINET No.	C & W R.O.G. %	1992 TOTAL UNITS	1992 OCC RATE	1992 TOTAL POP	1997 TOTAL UNITS	1997 OCC RATE	1997 'A' POP	1997 'B' POP	1997 'C' POP
1	SF	48	169	wb7	4.95	56	2.75	154	68	2.7	163	183	204
2	MF	71	166	wb7	4.95	110	2.75	304	130	2.7	312	351	391
3	SF	146	507	wb7	4.95	186	2.75	511	237	2.7	568	639	711
4	SF	31	118	wb7	4.95	39	2.75	109	50	2.7	121	136	151
5	SF	79	284	wb 6	2.78	91	2.75	249	104	2.7	249	281	312
6	SF	142	495	wb2	5.64	177	2.75	486	226	2.7	541	610	678
7	SF	37	118	wb2	5.64	49	2.75	134	64	2.7	154	173	192
8	SF	167	558	wb2	5.64	220	2.75	604	289	2.7	693	780	868
9	SF	156	541	wb4	7.33	222	2.75	611	266	2.7	639	719	800
10	TU	71	158	wb8	4.33	88	2.75	241	108	2.7	260	293	326
11	SF	194	701	wb5	5.07	228	2.75	628	318	2.7	763	859	955
12	SF	55	199	wb1	1.60	60	2.75	164	64	2.7	155	174	194
13	SF	65	208	wb1,wb3	3.65	73	2.75	200	93	2.7	223	251	279
14	SL	86	325	wb3	5.69	113	2.75	312	150	2.7	359	404	449
15	SL	99	351	wb5	5.07	137	2.75	376	202	2.7	485	546	607
16	SL	1	3	sm1	14.16	22	2.75	60	54	2.7	129	145	161
17	MF	266	676	sm2	11.92	347	2.75	955	460	2.7	1104	1243	1382
18	SL	1	3	sm2	11.92	22	2.75	60	123	2.7	295	332	370
19	MF	142	386	sm2,sm3	8.02	279	2.75	767	357	2.7	856	964	1072
20	TU	98	246	sm2,sm3	8.02	124	2.75	341	162	2.7	388	437	486
21	SL	3	10	sm3	4.11	24	2.75	65	104	2.7	251	282	314
22	TU	263	668	sm3,sm4	7.32	299	2.75	823	353	2.7	847	953	1060
23	SF	73	234	sm4	10.53	120	2.75	331	169	2.7	404	455	506
24	TU	54	136	gt17	19.64	87	2.75	240	124	2.7	298	336	374
25	RN	1	3	gt16	8.97	5	2.75	12	32	2.7	78	87	97
26	TU	143	366	gt16	8.97	245	2.75	673	278	2.7	666	750	833
27	SL	134	492	gt15,gt16,g	6.22	161	2.75	443	185	2.7	444	500	555
28	TU	396	796	gt15,gt16,g	6.22	475	2.75	1308	544	2.7	1305	1469	1633
29	IN	72	187	gt9	1.59	63	2.75	173	109	2.7	262	295	328
30	SF	233	620	gt14	4.73	314	2.75	862	390	2.7	935	1053	1170
31	SF	69	245	gt7	4.01	84	2.75	231	102	2.7	245	276	307
32	RE	15	26	gt21	5.02	19	2.75	53	24	2.7	59	66	73
33	SF	140	490	gt21	5.02	179	2.75	492	148	2.7	356	401	446
34	SF	40	116	gt7	4.01	49	2.75	134	94	2.7	226	255	283
35	SF	74	196	gt8	5.92	99	2.75	271	132	2.7	315	355	395
36	SF	85	288	gt7	4.01	103	2.75	285	126	2.7	302	340	378
37	OS	13	48	gt26	0.00	8	2.75	22	8	2.7	19	22	24
38	OS	9	26	gt20	7.96	13	2.75	36	19	2.7	46	52	58
39	RE	0	0	gt2	0.00	0	2.75	0	0	2.7	0	0	0
40	OS	0	0	gt2	0.00	0	2.75	0	0	2.7	0	0	0
41	PO	0	0	N/A	0.00	0	2.75	0	0	2.7	0	0	0
42	RE	0	0	gt1	3.71	0	2.75	0	0	2.7	0	0	0
43	RE	0	0	N/A	0.00	0	2.75	0	0	2.7	0	0	0
44	IO	0	0	gt2	0.00	0	2.75	0	0	2.7	0	0	0
45	SF	64	294	gt22	6.50	78	2.75	214	95	2.7	228	257	286
46	IN	1	5	gt22	6.50	0	2.75	1	-0	2.7	-0	-0	-0
47	IN	11	46	gt22	6.50	11	2.75	30	6	2.7	14	15	17
48	IN	6	19	gt9,gt10,gt	4.49	7	2.75	21	9	2.7	22	25	28
49	RE	6	15	gt10,gt11	4.15	7	2.75	20	9	2.7	22	24	27
50	RE	30	100	gt9,gt14	3.16	35	2.75	96	61	2.7	146	165	183
51	SF	72	209	gt9,gt10	3.49	85	2.75	235	101	2.7	243	274	305
52	SF	95	306	gt10,gt24	3.68	114	2.75	313	136	2.7	327	368	409
53	SF	99	309	gt11,gt24	2.44	112	2.75	307	126	2.7	302	340	378

TABLE 2-6 (Con't.)
FUTURE POPULATION AND DISTRIBUTION BY TRAFFIC ZONE

ZONE	LAND USE	1987 TOTAL UNITS	1987 TOTAL POP	C & W CABINET No.	C & W R.O.G. i %	1992 TOTAL UNITS	1992 OCC RATE	1992 TOTAL POP	1997 TOTAL UNITS	1997 OCC RATE	1997 'A' POP	1997 'B' POP	1997 'C' POP
54	OS	0	0	gt1	3.71	0	2.75	0	0	2.7	0	0	0
55	SF	62	231	gt1,gt24	2.84	71	2.75	196	82	2.7	197	221	246
56	SF	24	73	gt1,gt4,gt1	3.21	38	2.75	105	58	2.7	139	156	174
57	OS	5	15	gt1	3.71	4	2.75	11	2	2.7	5	6	7
58	SF	113	330	gt4,gt19	2.97	131	2.75	360	156	2.7	375	422	469
59	SF	74	237	gt19	3.96	90	2.75	247	109	2.7	262	295	328
60	IH	0	0	gt11,gt19	3.44	0	2.75	0	20	2.7	48	54	60
61	SL	43	141	gt11	2.91	120	2.75	329	177	2.7	425	479	532
62	SF	129	424	gt12	2.34	145	2.75	398	163	2.7	390	439	488
63	SF	128	451	gt12	2.34	144	2.75	395	161	2.7	387	436	484
64	SF	38	124	gt13	8.13	56	2.75	154	83	2.7	199	224	249
65	SF	249	807	gt19	3.96	302	2.75	832	367	2.7	880	991	1102
66	SF	132	359	gt4,gt5	3.11	154	2.75	423	179	2.7	430	484	539
67	SF	23	54	gt4	1.97	25	2.75	70	33	2.7	79	89	99
68	TU	4	10	gt4	1.97	4	2.75	12	4	2.7	9	10	12
69	MF	111	248	gt5	4.26	157	2.75	431	183	2.7	440	495	551
70	SF	93	275	gt5	4.26	135	2.75	370	161	2.7	386	435	484
71	IS	14	31	gt6	6.18	19	2.75	52	26	2.7	61	69	77
72	SF	56	155	gt6	6.18	76	2.75	208	102	2.7	245	275	306
73	SL	62	228	gt25	3.97	145	2.75	400	192	2.7	459	517	575
74	MF	115	290	gt25	3.97	140	2.75	384	170	2.7	407	458	510
75	SL	69	213	gt23	2.35	92	2.75	254	127	2.7	305	343	381
76	MF	161	354	gt23	2.35	181	2.75	497	203	2.7	487	548	610
77	SL	138	476	gt23	2.35	180	2.75	495	204	2.7	489	551	613
78	SL	46	157	bt6	5.40	60	2.75	165	78	2.7	187	210	234
79	MF	49	125	bt6	5.40	64	2.75	175	83	2.7	199	224	249
80	SL	149	525	bt6	5.40	194	2.75	533	252	2.7	605	681	757
81	SL	212	746	bt4,bt5	10.04	342	2.75	941	462	2.7	1108	1247	1387
82	SL	149	658	bt4,bt5	10.04	240	2.75	661	288	2.7	690	777	864
83	SL	151	412	bt1,bt2	7.36	170	2.75	469	207	2.7	497	559	622
84	SF	72	279	bt1,bt2	7.36	83	2.75	227	96	2.7	231	260	290
85	SL	39	131	bt3	7.27	55	2.75	152	79	2.7	189	212	236
86	SF	65	163	bt3	7.27	62	2.75	171	81	2.7	195	219	244
87	SL	24	80	bt3	7.27	34	2.75	94	73	2.7	176	198	220
88	SL	735	2780	ns+ee	6.69	866	2.75	2382	905	2.7	2169	2442	2715
Totals		7690	24046			10019		27551	12580		30164	33965	37765

NOTES: FOR YEARS 1992 AND 1997 THE ESTIMATED SHORT TERM TOURIST RENTALS ARE 2151 AND 2765 RESPECTIVELY.

LAND USE KEY

SF	SINGLE FAMILY UNITS	IC	CHURCH, CEMETERY
SL	SINGLE FAMILY LOW DEN	IS	SCHOOL, COLLEGE
MF	MULTI FAMILY	IH	HOSPITAL, CLINIC
TU	TOURISM OR RELATED	IO	OTHER
AG	AGRICULTURE	POS	PUBLIC OPEN SPACE
RE	RETAIL & SERVICE TRAD	RN	RECREATION
OS	OFFICES, BANKS	IND	INDUSTRIAL

Future Employment by Zone - Future employment for each traffic zone in the study area is shown on Table 2-7. Retail employment is expected to increase 69 percent between 1987 and 1997, reaching a total of almost 9,000 jobs when applying the "B" growth rate. Total employment is expected to increase by 61 percent is the same period. A restrained rate of growth ("A") results in a 43 percent increase in all jobs over the 10 year period, while the rapid "C" rate increases jobs by 79 percent.

TOURISM PROJECTIONS

Future tourist arrivals by air have been projected on the basis of past trends. A straight line trend for the period 1976 to 1986 was projected to 1992 and 1997. The resultant forecast of arrivals by air, compared to Department of Tourism projection, are set out in Table 2-8. The comparison indicates that the trend forecast is much more conservative, and may more accurately reflect the ability of Grand Cayman to provide facilities and staff for tourist accommodations.

Cruise boat arrivals for the period 1976 to 1986 average a phenomenal increase of 56.7 percent per year. By incorporating the 1987 estimate of 277,464 arrivals with the 1976-1986 trend, a slightly modified annual growth rate is established. This trend forms the basis for the forecast of cruise ship passenger arrivals shown in Table 2-9. The forecast of cruise passenger arrivals in 1997 is 535,500 persons, an increase of 93 percent over the 1987 estimate of 277,500. Though seemingly an extravagant forecast, the growth reflects short-term requests for berthing facilities, and long-term plans to add anchorage points in George Town Harbour.

EDUCATION

The number of students attending eight government primary and secondary schools and six private schools on Grand Cayman were obtained from the Education Department, Cayman Islands Government. Each school was identified in its respective traffic zone according to student enrollment.

TABLE 2-7
FUTURE EMPLOYMENT AND DISTRIBUTION BY TRAFFIC ZONE

ZONE	C & W CABINET No.	C & W ROG i%	1992 TOTAL JOBS	1992 RE-TAIL	1992 OTHER	1992 INDUST	PROJECTION 'A' 1997 TOTAL JOBS	1997 RE-TAIL	1997 OTHER	1997 INDUST	PROJECTION 'B' 1997 TOTAL JOBS	1997 RE-TAIL	1997 OTHER	1997 INDUST	PROJECTION 'C' 1997 TOTAL JOBS	1997 RE-TAIL	1997 OTHER	1997 INDUST
1	wb7	8.45	24	24	0	0	29	29	0	0	33	33	0	0	37	37	0	0
2	wb7	8.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	wb7	8.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	wb7	8.45	47	47	0	0	57	57	0	0	64	64	0	0	72	72	0	0
5	wb 6	4.94	26	21	5	0	27	22	5	0	30	24	6	0	34	27	6	0
6	wb2	18.47	180	180	0	0	338	338	0	0	380	380	0	0	423	423	0	0
7	wb2	18.47	74	74	0	0	139	139	0	0	156	156	0	0	173	173	0	0
8	wb2	18.47	113	113	0	0	212	212	0	0	238	238	0	0	265	265	0	0
9	wb4	5.92	74	60	14	0	79	65	15	0	89	73	17	0	99	81	18	0
10	wb8	14.87	145	0	145	0	234	0	234	0	264	0	264	0	293	0	293	0
11	wb5	6.58	42	42	0	0	46	46	0	0	52	52	0	0	58	58	0	0
12	wb1	4.94	8	8	0	0	8	8	0	0	9	9	0	0	10	10	0	0
13	wb1,wb3	6.70	43	43	0	0	48	48	0	0	54	54	0	0	60	60	0	0
14	wb3	8.45	57	57	0	0	69	69	0	0	78	78	0	0	87	87	0	0
15	wb5	6.58	81	81	0	0	90	90	0	0	102	102	0	0	113	113	0	0
16	sm1	8.45	24	0	24	0	29	0	29	0	32	0	32	0	36	0	36	0
17	sm2	6.96	22	0	22	0	25	0	25	0	28	0	28	0	31	0	31	0
18	sm2	6.96	22	0	22	0	25	0	25	0	28	0	28	0	31	0	31	0
19	sm2,sm3	6.68	183	122	50	11	204	136	56	12	230	153	63	14	255	170	70	15
20	sm2,sm3	6.68	65	0	65	0	73	0	73	0	82	0	82	0	91	0	91	0
21	sm3	6.40	168	135	33	0	185	148	37	0	208	166	41	0	231	185	46	0
22	sm3,sm4	9.12	529	0	529	0	659	0	659	0	742	0	742	0	825	0	825	0
23	sm4	11.84	28	0	28	0	39	0	39	0	44	0	44	0	49	0	49	0
24	gt17	8.45	462	0	462	0	558	0	558	0	629	0	629	0	699	0	699	0
25	gt16	5.02	107	87	20	0	110	89	21	0	124	101	23	0	138	112	26	0
26	gt16	5.02	134	0	134	0	138	0	138	0	155	0	155	0	173	0	173	0
27	gt15,gt	3.80	209	126	83	0	203	123	80	0	229	138	91	0	254	154	101	0
28	gt15,gt	3.80	342	3	339	0	332	3	330	0	374	3	371	0	416	3	413	0
29	gt9	10.76	282	59	26	197	379	79	35	265	427	89	40	299	475	98	44	332
30	gt14	4.87	255	215	20	20	260	219	20	20	293	247	23	23	326	275	26	26
31	gt7	3.82	400	306	94	0	389	297	92	0	438	334	103	0	487	372	115	0
32	gt21	12.70	297	234	63	0	436	343	93	0	491	386	104	0	545	430	116	0
33	gt21	12.70	199	169	30	0	292	247	44	0	328	279	50	0	365	310	55	0
34	gt7	3.82	88	49	39	0	85	48	38	0	96	54	43	0	107	60	48	0
35	gt8	3.83	238	125	42	71	231	121	41	69	261	136	46	78	290	152	51	87
36	gt7	3.82	116	77	39	0	113	75	38	0	127	85	43	0	142	94	48	0
37	gt26	3.30	773	247	526	0	733	234	499	0	826	264	562	0	918	293	625	0
38	gt20	8.45	659	322	337	0	797	389	408	0	897	438	459	0	998	487	511	0
39	gt2	3.96	1170	510	659	0	1145	500	645	0	1289	563	727	0	1433	625	808	0
40	gt2	3.96	267	0	267	0	262	0	262	0	295	0	295	0	328	0	328	0
41	N/A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	gt1	8.06	230	116	114	0	273	138	135	0	308	155	152	0	342	173	169	0
43	N/A		35	19	16	0	28	15	13	0	32	17	14	0	35	19	16	0
44	gt2	3.96	43	0	19	24	42	0	19	23	48	0	21	26	53	0	23	29
45	gt22	12.30	81	41	39	0	116	59	57	0	131	67	64	0	145	74	71	0
46	gt22	12.30	335	35	300	0	483	51	432	0	544	57	487	0	605	64	541	0
47	gt22	12.30	534	231	28	275	769	333	41	396	866	375	46	446	963	417	51	495
48	gt9,gt1	10.28	522	483	26	13	686	635	34	17	773	716	38	19	859	796	42	21
49	gt10,gt	5.75	227	140	87	0	242	149	92	0	272	168	104	0	303	187	116	0

TABLE 2-7 (Con't.)
FUTURE EMPLOYMENT AND DISTRIBUTION BY TRAFFIC ZONE

ZONE	C & W CABINET No.	C & W ROG 1%	1992 TOTAL JOBS	1992 RE-TAIL	1992 OTHER	1992 INDUST	PROJECTION 'A' 1997 TOTAL JOBS	1997 RE-TAIL	1997 OTHER	1997 INDUST	PROJECTION 'B' 1997 TOTAL JOBS	1997 RE-TAIL	1997 OTHER	1997 INDUST	PROJECTION 'C' 1997 TOTAL JOBS	1997 RE-TAIL	1997 OTHER	1997 INDUST
50	gt9,gtl	7.82	444	421	23	0	522	495	27	0	588	557	30	0	653	619	34	0
51	gt9,gtl	9.27	192	89	91	12	241	111	114	15	271	125	129	17	302	139	143	19
52	gt10,gt	8.12	388	341	41	6	462	406	49	7	520	457	55	8	578	508	61	9
53	gt11,gt	6.08	74	0	74	0	80	0	80	0	90	0	90	0	101	0	101	0
54	gtl	8.06	708	520	189	0	841	617	224	0	947	695	252	0	1053	773	281	0
55	gtl,gt2	8.26	56	32	23	0	67	39	28	0	75	44	32	0	84	48	35	0
56	gtl,gt4	5.44	167	133	34	0	175	139	36	0	197	157	40	0	219	174	45	0
57	gtl	8.06	116	93	23	0	138	110	28	0	155	124	31	0	173	138	35	0
58	gt4,gtl	4.13	29	0	24	5	29	0	24	5	32	0	27	5	36	0	30	6
59	gt19	6.96	33	0	33	0	37	0	37	0	42	0	42	0	47	0	47	0
60	gt11,gt	5.34	249	0	249	0	260	0	260	0	293	0	293	0	325	0	325	0
61	gt11	3.71	19	0	19	0	18	0	18	0	21	0	21	0	23	0	23	0
62	gt12	10.76	26	0	26	0	35	0	35	0	40	0	40	0	44	0	44	0
63	gt12	10.76	39	0	39	0	53	0	53	0	60	0	60	0	66	0	66	0
64	gt13	8.45	26	0	26	0	31	0	31	0	35	0	35	0	39	0	39	0
65	gt19	6.96	45	17	29	0	51	19	32	0	58	21	36	0	64	23	41	0
66	gt4,gt5	4.88	190	100	70	20	195	102	72	20	219	115	81	23	244	128	90	26
67	gt4	1.30	29	0	29	0	25	0	25	0	29	0	29	0	32	0	32	0
68	gt4	1.30	61	0	52	8	52	0	45	7	59	0	51	8	65	0	56	9
69	gt5	8.45	36	6	30	0	43	7	36	0	48	8	40	0	54	9	45	0
70	gt5	8.45	45	21	24	0	54	26	29	0	61	29	32	0	68	32	36	0
71	gt6	1.92	126	0	126	0	112	0	112	0	126	0	126	0	140	0	140	0
72	gt6	1.92	17	0	17	0	15	0	15	0	17	0	17	0	19	0	19	0
73	gt25	8.45	24	0	24	0	29	0	29	0	32	0	32	0	36	0	36	0
74	gt25	8.45	24	0	24	0	29	0	29	0	32	0	32	0	36	0	36	0
75	gt23	8.45	36	12	24	0	43	14	29	0	48	16	32	0	54	18	36	0
76	gt23	8.45	18	12	6	0	21	14	7	0	24	16	8	0	27	18	9	0
77	gt23	8.45	17	17	0	0	21	21	0	0	23	23	0	0	26	26	0	0
78	bt6	8.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	bt6	8.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	bt6	8.45	44	35	9	0	53	42	11	0	60	47	13	0	67	52	14	0
81	bt4,bt5	7.44	76	0	76	0	87	0	87	0	98	0	98	0	109	0	109	0
82	bt4,bt5	7.44	47	47	0	0	54	54	0	0	61	61	0	0	68	68	0	0
83	btl,bt2	11.30	64	37	27	0	88	51	37	0	99	57	42	0	110	64	46	0
84	btl,bt2	11.30	42	42	0	0	58	58	0	0	65	65	0	0	73	73	0	0
85	bt3	8.45	34	34	0	0	42	42	0	0	47	47	0	0	52	52	0	0
86	bt3	8.45	9	0	9	0	11	0	11	0	13	0	13	0	14	0	14	0
87	bt3	8.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88	ns+ee	7.28	168	41	99	28	193	48	113	32	217	54	127	36	241	60	142	40
TOTALS			13679	6651	6337	691	15985	7971	7125	890	18000	8975	8022	1002	20014	9979	8920	1115

NOTES: CABLE AND WIRELESS' REPORTED RATES OF GROWTH FOR BUSINESS TENANCIES WERE APPLIED TO 1987 EMPLOYMENT TO PROJECT 1992 AND 1997 EMPLOYMENT.

TABLE 2-8

FORECASTS OF TOURIST ARRIVALS BY AIR

	PASSENGERS	
	10 YEAR TREND	DEPT. OF TOURISM
1986	166,082	
1987	174,700	220,000(±)
1988	184,700	240,000(±)
1989	194,600	-
1990	204,500	-
1991	214,400	-
1992	224,400	-
1997	274,000	-

Source: Department of Tourism, and MGTP Study

TABLE 2-9

FORECAST OF CRUISE PASSENGER ARRIVALS

YEAR	PASSENGERS	CHANGE (Percent)
1987	277,464	2.4
1988	305,500	10.1
1989	331,000	8.3
1990	356,600	7.7
1991	382,200	7.2
1992	407,700	6.7
1997	535,500	40.1

Source: Department of Tourism, and MGTP Study

Projected enrollment for 1997 was also provided by the Department. Recent trends in enrollment show an annual rate of growth for the 10 year period of 4.40 percent. According to the Statistical Abstract, 1986, the average annual increase in students in all schools on all islands since 1970 is 3.05 percent, slowing somewhat since 1982. If was therefore appropriate to use the forecast as the "B" rate of growth since it reflects continuing trends experienced over recent years.

Student enrollment in Grand Cayman is expected to increase by 1,834, or 27 percent, by 1992. With the "B" population increase between 1992 and 1997, student enrollment is projected to rise to 5,915 in all schools. More students are attending school in zone 71 (Walkers Road) than in any other zone, Table 2-10.

TABLE 2-10

SCHOOL ENROLLMENT FORECASTS

		STUDENTS				
	TRAFFIC			1997 Growth Rates		
SCHOOL	ZONE	1987	1992	A	B	C
GOVT. PRIMARIES						
West Bay	9	250	358	413	465	517
George Town	34	214	432	577	650	723
Savannah	80	151	233	280	315	350
Bodden Town	83	84	125	147	165	183
North Side/East End	88	126	229	294	330	366
GOVT. SECONDARIES						
Middle School	71	815	883	844	950	1056
High School	71	992	1096	1066	1200	1334
PRIVATE SCHOOLS						
Wesleyan Christian	6	98	174	222	250	278
Triple "C"	53	221	306	346	390	434
Truth For Youth	56	262	326	346	390	434
Edmar SDA	65	74	142	187	210	233
Perp. Help/C.I. Prep	71	560	580	559	600	667
TOTALS		3847	4881	5253	5915	6577

Source: Chief Education Officer and MGTP Study

CHAPTER THREE

TRAFFIC FORECASTING AND CAPACITY ANALYSIS

CHAPTER THREE

TRAFFIC FORECASTING AND CAPACITY ANALYSIS

Transportation planning, as the phrase implies, requires a technical look into the future. In order to plan for the future transport needs of Grand Cayman it was first necessary to forecast the amount of travel and changes in trip characteristics that were likely to occur. These forecasts reflected development trends identified in the planning analysis, and were the most important factors in developing the capital improvement program.

ESTIMATING FUTURE TRAFFIC

The forecasting process is complex in that it requires a thorough study of socioeconomic trends within the Study Area. In addition it is necessary to examine internal forces, primarily government policy, and external factors which have an impact on transportation needs, before traffic forecasting can be accomplished. These local and regional aspects have been examined in Grand Cayman and have been described in earlier chapters of the MGTP Study.

For this study, mathematical models were developed to simulate existing traffic patterns and to forecast future trips on the existing road network. The same process was used later in the study to forecast travel on both new and improved road links. This process has been accepted worldwide as one of the most reliable and comprehensive procedures for use in transportation planning. Details of models dealing with trip production, attraction, and distribution, household size and model development are included in Appendix E.

In order to identify deficiencies in the existing road network under future traffic conditions, it was first necessary to forecast the extent of that traffic and then to compare those figures with the capacity of the roadway over which that number of vehicles was expected to pass. Forecasts of future vehicle trips on the existing 1987 road network were made for 1992 and 1997. These projections were based on trip generation rates identified for the forecasts of population and development expected in each of those target years.

Traffic In 1992 - West Bay Road served the highest volume of average weekday traffic in 1987, and was expected to continue that condition in the future. The road segment between Holiday Inn and Merrens Shopping Complex was expected to carry between 17,000 and 30,000 vehicles in 1992, with volumes increasing rapidly with proximity to George Town.

Eastern Avenue was also expected to serve a high traffic volume in future years. Just over 14,000 vehicles were projected for the segment of Eastern Avenue adjacent to Kirkconnells Home Center. Other roads with comparatively high traffic forecasts include North Church Street (19,500), Cardinall Avenue Extension (17,400) and Shedden Road east of Elizabethan Square (15,000).

Traffic in 1997 - Three forecasts of traffic for 1997 were prepared in order to measure the impact of development policies that may be implemented by the Cayman Government. These included a straight line forecast of growth that most reflected the 1980-1986 trend, designated the "B" development trend. In addition, an "A" rate was prepared to show the effects of policy severely restricting island development between 1992 and 1997. A third growth rate "C", assumed a continuation of the parabolic curve describing Cayman's rapid development over the past several years. Only the straight line ("B") forecast is discussed in this analysis.

Although traffic increased at varying rates at most locations, the relationship between road segments did not change. West Bay Road was predicted to carry 23,200 vehicles at the Holiday Inn, and 36,600 opposite Merrens. North Church Street and Cardinall Avenue again were expected to experience the highest traffic flow in George Town, with volumes of 21,800 and 22,500 respectively. Eastern Avenue, 19,200 and Crewe Road, 17,800 also were projected to carry relatively high traffic volumes.

CAPACITY NEEDS

The assignments of future traffic assumed that no improvements would be made to the existing road network. It was also assumed that traffic growth would not be restrained by the possible lack of capacity of any road segment to serve the need of future traffic. That procedure established the likely level of future travel demands. When compared with the actual capacity of each road segment to carry traffic, locations where road improvements were needed in order to achieve the required capacity became apparent.

1992 Deficiencies - Much of West Bay Road is currently providing a level-of-service (LOS) below that deemed most appropriate for Grand Cayman, (LOS "C"). By the year 1992, that condition was expected to extend from its southern end at Eastern Avenue to the Holiday Inn, a distance of about 2.4 miles, as shown in Figures 3-1 and 3-2. A further deficiency is likely to exist at the northern end of West Bay Road, at Church Street in West Bay.

In the George Town area, North Church Street, Harbour Drive, and part of South Church Street are currently operating below LOS "C" and are expected to deteriorate in LOS by 1992. In the same category are segments of Fort Street, Edward Street, Cardinall Avenue, Shedden Road, and Mary Street, as seen in Figure 3-3. Elgin Avenue and segments of Crewe Road are expected to exceed practical capacity by 1992, as is the northern half of Eastern Avenue.

1997 Deficiencies - A number of roads that had sufficient capacity to serve 1992 traffic needs are expected to become deficient by 1997. Capacity problems evident on more southern segments of West Bay Road by 1992 are expected to extend further northward about 1.5 miles to near Victoria House, Figure 3-4. On South Church Street the deficiency extends southward from Boilers Road for about one mile, in addition to that part of the road found deficient by 1992, as noted in Figure 3-5.

Segments of Crewe Road and Smith Road, both with existing capacity to serve 1992 traffic forecasts, are expected to become deficient by 1997. Similarly in George Town, segments of Fort Street and Mary Street are not expected to be able to serve forecasted traffic volume with an acceptable LOS, Figure 3-6.

In addition, several roads are likely to be within 10 percent of practical capacity in 1997. These include segments of South Church Street, Walkers Road, Hospital Road, Airport Road and Bodden Town Road. In George Town, roads nearly at capacity include parts of Shedden Road, Goring Road and the Eastern Avenue - North Sound Road Connector Road.

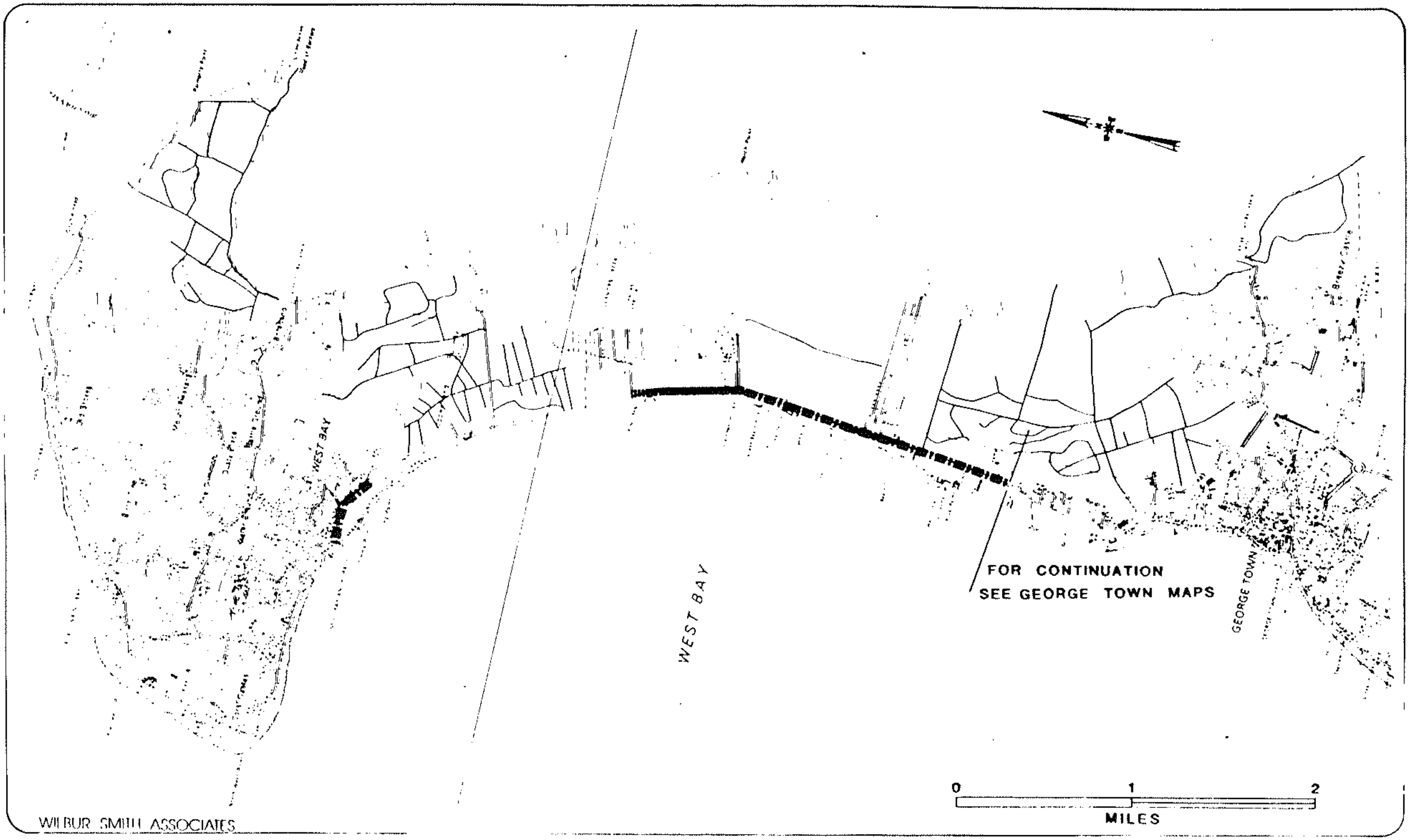


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FIGURE 3-1

1992 ROAD DEFICIENCIES
WEST BAY

LEGEND
VOLUME/CAPACITY (V/C) RATIOS
BELOW 0.9
BETWEEN 0.90 AND 0.99
1.00 AND UP

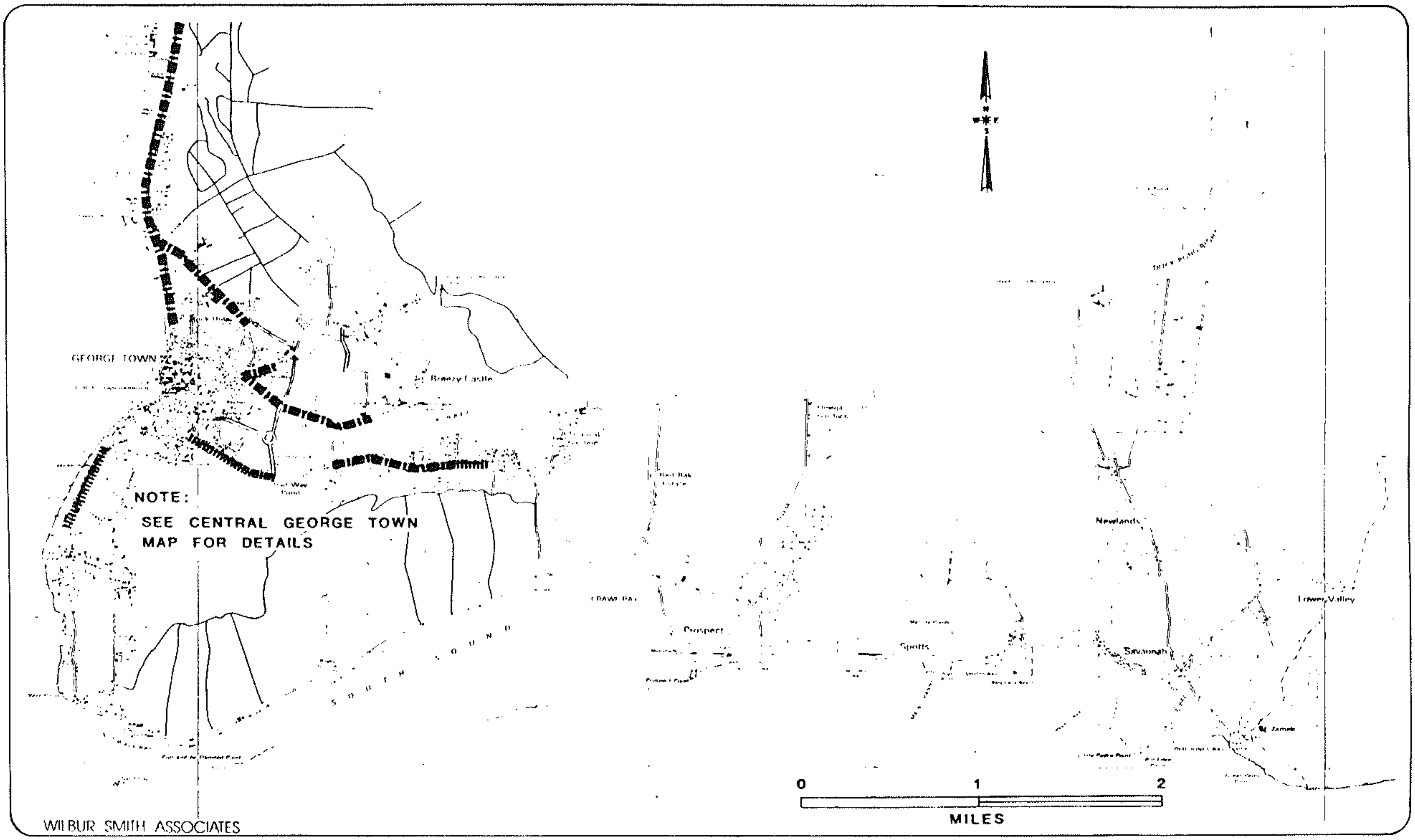

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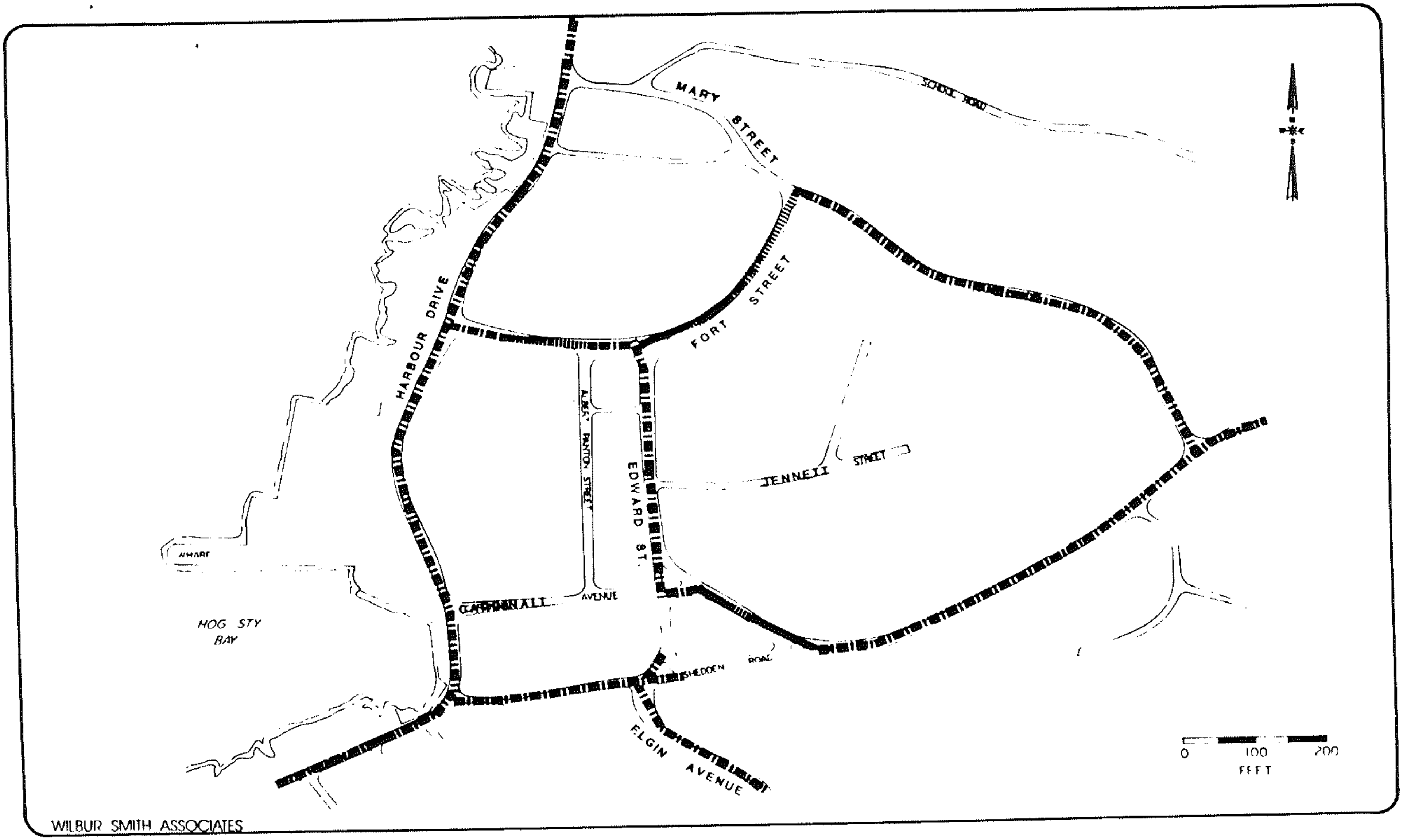
FIGURE 3-2

1992 ROAD DEFICIENCIES
SOUTH SOUND

LEGEND
VOLUME/CAPACITY (V/C) RATIOS

(thin line)	BELOW 0.9
(hatched line)	BETWEEN 0.90 AND 0.99
(dashed heavy line)	1.00 AND UP



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1992 ROAD DEFICIENCIES
CENTRAL GEORGE TOWN

LEGEND
VOLUME/CAPACITY (V/C) RATIOS
BELOW 0.90
BETWEEN 0.90 AND 0.99
1.00 AND UP

FIGURE 3-3

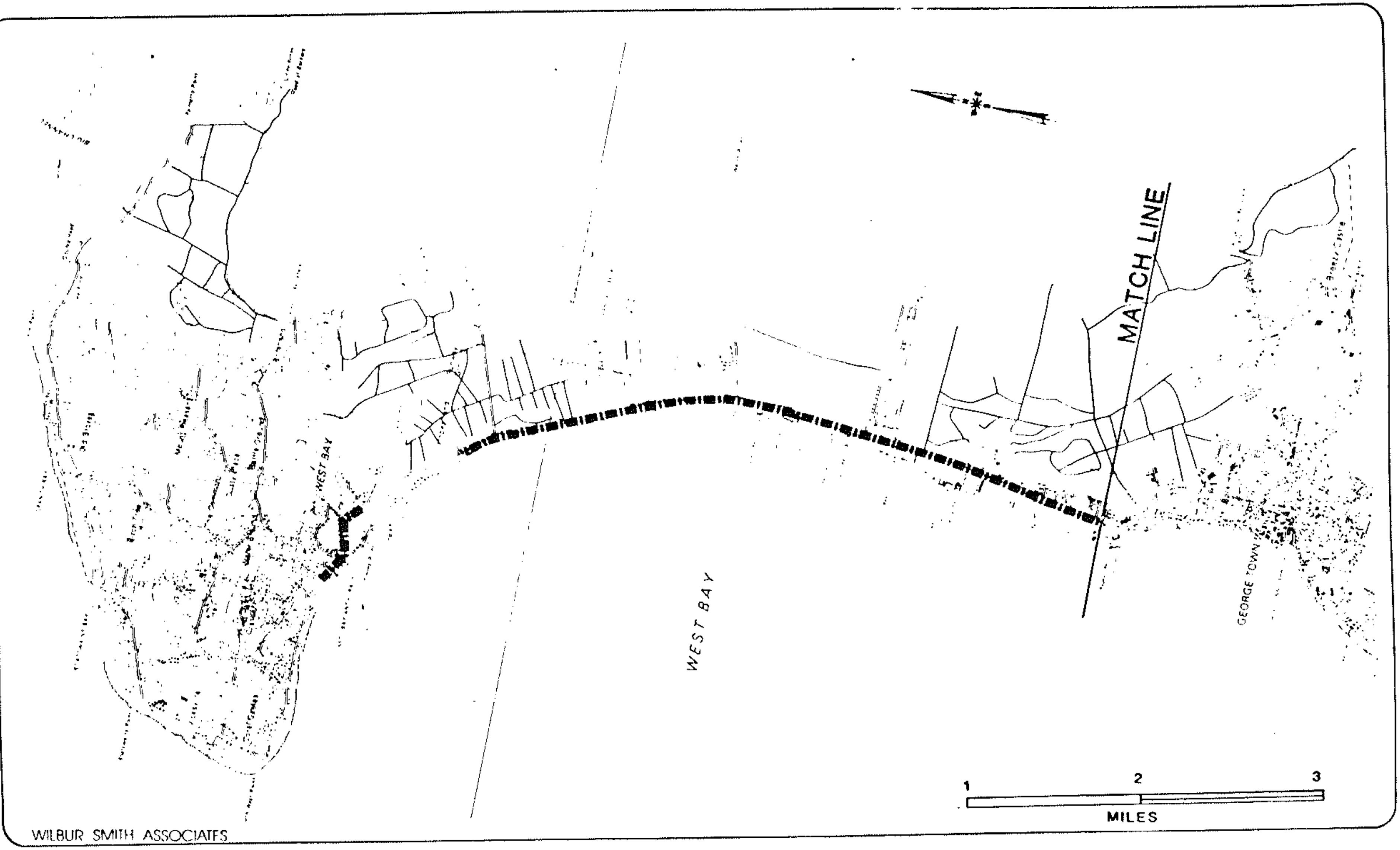

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FIGURE 3-4

1997 ROAD DEFICIENCIES

WEST BAY

LEGEND

VOLUME CAPACITY (V/C) RATIO

- BELOW 0.90
- BETWEEN 0.90 AND 0.99
- 1.00 AND UP

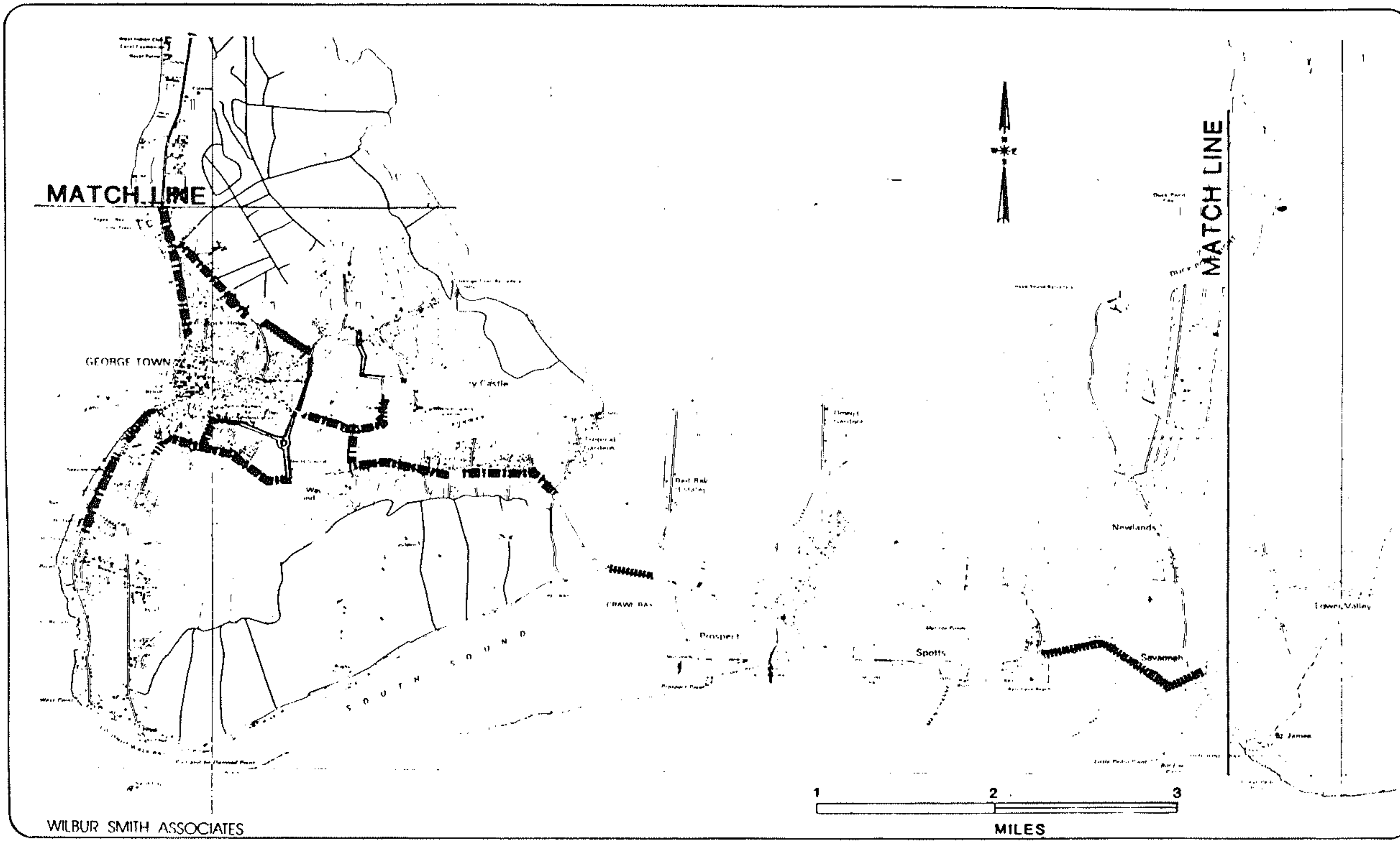

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FIGURE 3-5

1997 ROAD DEFICIENCIES

SOUTH SOUND

LEGEND:

VOLUME CAPACITY (V/C) RATIO

- BELOW 0.90
- BETWEEN 0.90 AND 0.99
- 1.00 AND UP

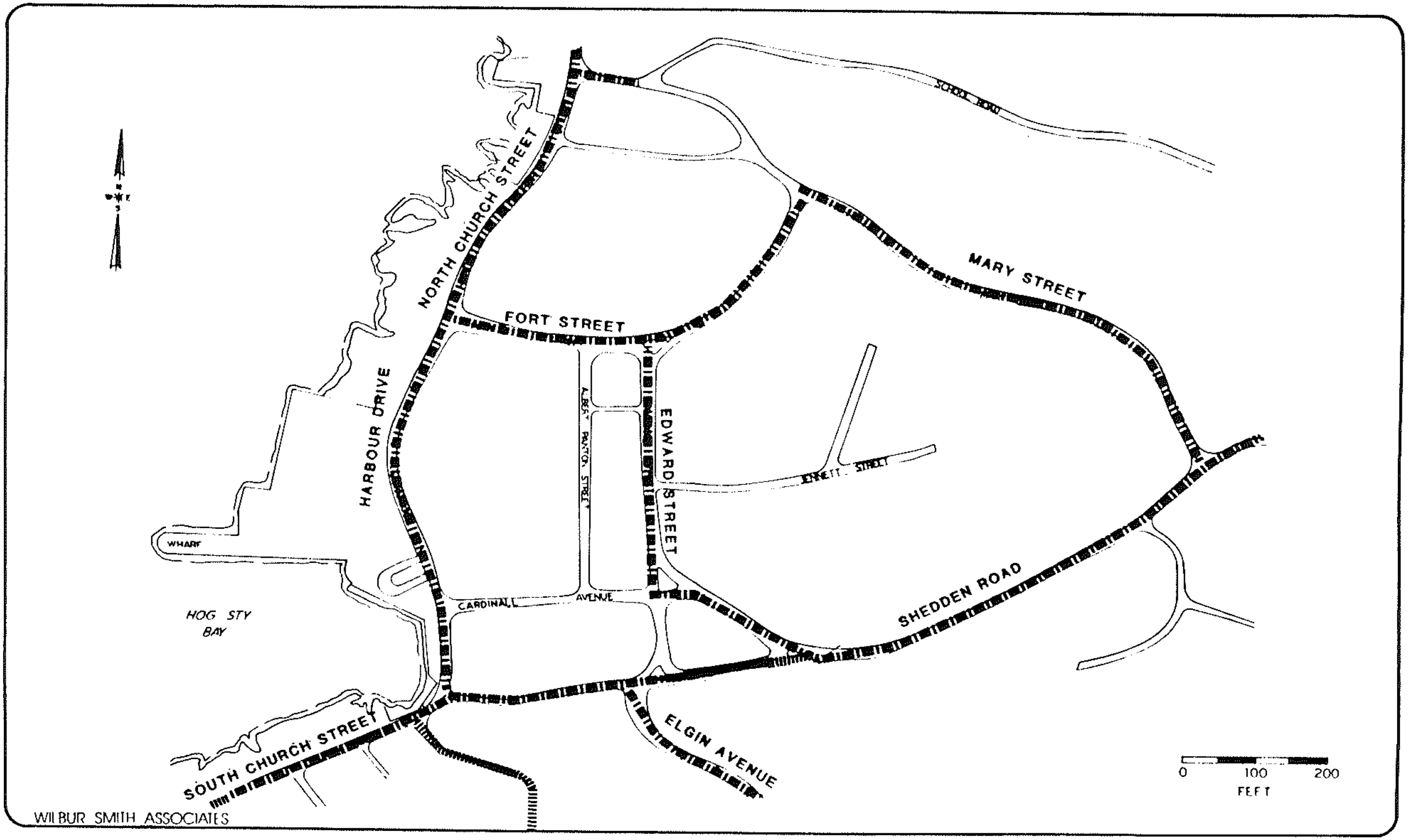

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FIGURE 3-6

1997 ROAD DEFICIENCIES
CENTRAL GEORGE TOWN

LEGEND
VOLUME CAPACITY (V/C) RATIO
- BELOW 0.90
- BETWEEN 0.90 AND 0.99
- 1.00 AND UP

CHAPTER FOUR

ALTERNATIVES ANALYSIS

CHAPTER FOUR

ALTERNATIVES ANALYSIS

Preceding analyses have established growth forecasts judged to be appropriate for Grand Cayman population, employment, tourism and education. These forecasts were then used to project future vehicle trips on the existing road network, and to identify road segments not able to handle the projected traffic level at an acceptable level-of-service. This chapter identifies alternative solutions available with which to solve the anticipated future road congestion on the Island.

PLANNING CONSTRAINTS

Future traffic congestion is expected to occur primarily along the Seven Mile Beach peninsula and in central George Town. Each of these areas has absorbed a large proportion of recent development that has occurred on the Island, and together the two will likely include more than 90 percent of the new growth expected over the next 10 years.

Seven Mile Beach Area - Several factors along the peninsula control the possible location of new or widened roads. West Bay Road is located on a 50 foot right-of-way throughout its entire length. Adjacent structures, primarily along the southern half of the route, are located immediately along the property line or set back only a short distance. All frontage property has at least one point of access to the road, and most business lots have two or more entrances. Disruption of West Bay Road traffic flow due to right turning vehicles and to entering traffic is frequent and often involves a full stop.

Alternatives along new alignment have two major constraints. The Hyatt Hotel/Britannia development, including the hotel, several golf courses, and condominium developments extends across the entire peninsula from West Bay Road to North Sound. The development was required to allocate a north-south road corridor through the property before construction approval was granted. It would be extremely costly to place a new route alignment at any other location than that route chosen by the developer, a corridor within 250 feet of West Bay Road.

With the Bypass proposal occupying North Sound Way right-of-way, it would become necessary to re-connect North Sound Road with the central city. Radial Segment 9-3 would carry the route eastward along new alignment from School Road. New intersections are effected at Eastern Avenue and the Outer Bypass as the route continues a short way further to join existing North Sound Road alignment.

Of the four new radial connector alternatives, segments 9-1 and 9-3 produce the most effective traffic operations pattern. Although new right-of-way would involve taking several residences and business locations, they were judged to be the preferable new radial routes into downtown George Town.

Central Business District - Central George Town presently has a reasonable network of roads. The traffic problem relates more to narrow rights-of-way that accommodate these streets. To acquire the additional R/W needed to allow road widening it would be necessary to reduce sidewalk width and, in many instances, disrupt the flow of patrons into and out of adjacent business and office establishments.

A more acceptable approach would be to convert many of the streets to one-way operations, thus doubling the capacity of each road to handle directional traffic. In addition, intersection improvements at selected locations and pedestrian control at crosswalks are necessary to make the system function to its' fullest capacity.

Greater George Town Area - Alternatives to relieve congestion on both North and South Church Streets had to be identified. Both roads penetrate older sections of the community and thus are constrained by narrow, winding right-of-way and buildings immediately adjacent to property lines. To widen existing roads was judged as too harsh a course, environmentally, to be acceptable.

A more viable solution was to improve existing roads to the east of George Town in order to attract trips that do not have a mid-town destination. Upgrading of Eastern Avenue and North Sound Way was a logical extension of this concept (see Figure 4-3).

Though presently serving only a minor traffic need, North South Way provides the logical extension of the new arterial route between George Town and West Bay. With minor improvements the existing route would serve ten-year traffic needs as an Outer Bypass east of George Town. In a similar manner Eastern Avenue would function as an Inner Bypass provided certain intersection improvements and an extension to Smith Road were accomplished.

Other likely improvements to the road network in this area would include relocation of North Sound Road and a new road link between North Sound Road (Outer Bypass) and the Airport road at Dorcy Drive. A proposal to improve the inner-city road system would connect the east end of Jennett Street to both Mary Street and Shedden Road.

SOUTH SOUND CORRIDOR

This corridor is primarily served by Crewe Road and South Sound Road to the west and by Red Bay/Bodden Town Road to the east. Capacity constraints occur on each of these routes and it is anticipated that 1997 traffic volumes will overload short sections of both Crewe Road and Red Bay Road.

Crewe Road/Red Bay Road Improvement - Alternatives considered included the widening and partial realignments of Crewe Road and Red Bay Road. The development along Crewe Road is, however, such that comprehensive improvement of sight lines, horizontal curvature or junction deficiencies would cause considerable property damage.

New Route 13-0 - This route would create a second major east-west arterial road. The section of the route to the south and west of Crewe Road would cross undeveloped swamp land and the road to the east would bisect a slowly developing urban area. It is considered that the construction of a road along the route designated as 13-0 would enhance the development potential of the adjacent areas. It would also serve as a conduit for traffic resulting from further development of the eastern portion of the island.

New Route 14-0, 13-1, 13-2 - As an alternative to alignment 13-0, this route bisects the swamp land south of Crewe Road before joining South Sound Road near its junction with Red Bay Road. The route would then incorporate the improved section of Bodden Town Road to Spotts where it would become part of a new route proposed to bypass Savannah. Ground conditions for these routes would be comparable with the section of 13-0 previously discussed i.e., swamp to the west of the lime rock/marl strata at ground level to the east.

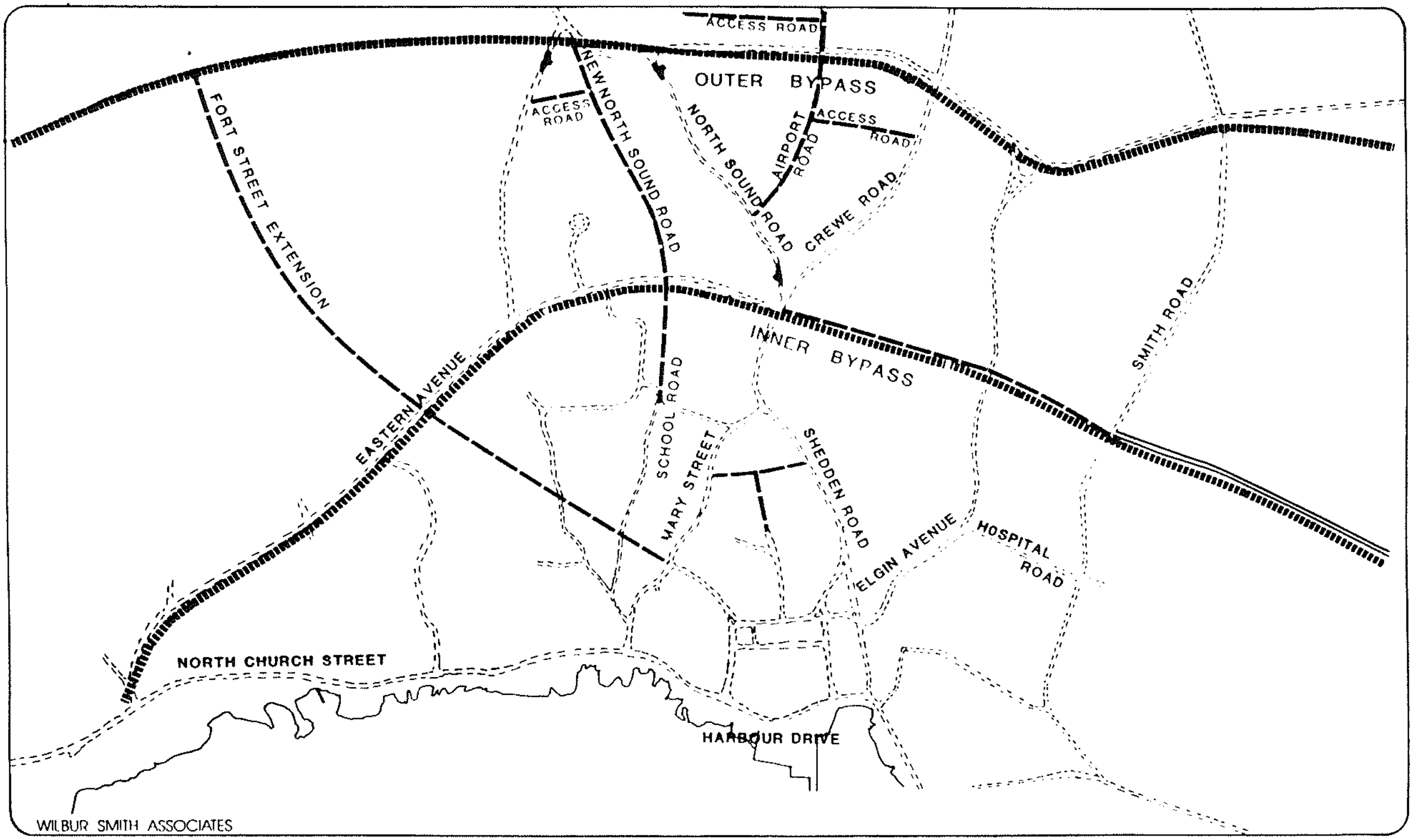

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FIGURE 4-3

INNER AND OUTER RING ROAD

BODDEN TOWN CORRIDOR

This transportation corridor is presently traversed by the single road which passes through the centre of Bodden Town. Traffic on this route is not heavy and the anticipated 1997 vehicle/capacity ratios are below 1.0. There is, however, a need to improve a number of sections along this route to create safer and more amenable conditions for the various categories of road user. Alternatives considered are shown in Figure 4-4.

Shamrock Drive/Church Street - Improvements to this existing road section should be considered whether or not Bodden Town is bypassed. Upgrading may be limited by the property constraints along each side of the road.

East-West Arterial - This is an extension of Segment 13-0 discussed previously. An advantage of the route would be to open new areas to development. It would provide a fast/efficient route connecting Bodden Town with the airport, sea port and the commercial centre of George Town. Construction costs per mile along this route would be lowered by the favourable sub grade conditions.

Route 16-0/16-1 - A possible bypass of Bodden Town would follow the eastern segments of the proposed East-West Arterial to North Ward, and then along new alignment to a point on the existing Bodden Town Road near Savannah.

Bodden Town Bypass - This limited Bodden Town bypass specifically addresses the need to reduce traffic flows in the existing urban area. It does not however, provide for the development of the hinterland to the same degree that route 13-0 does.

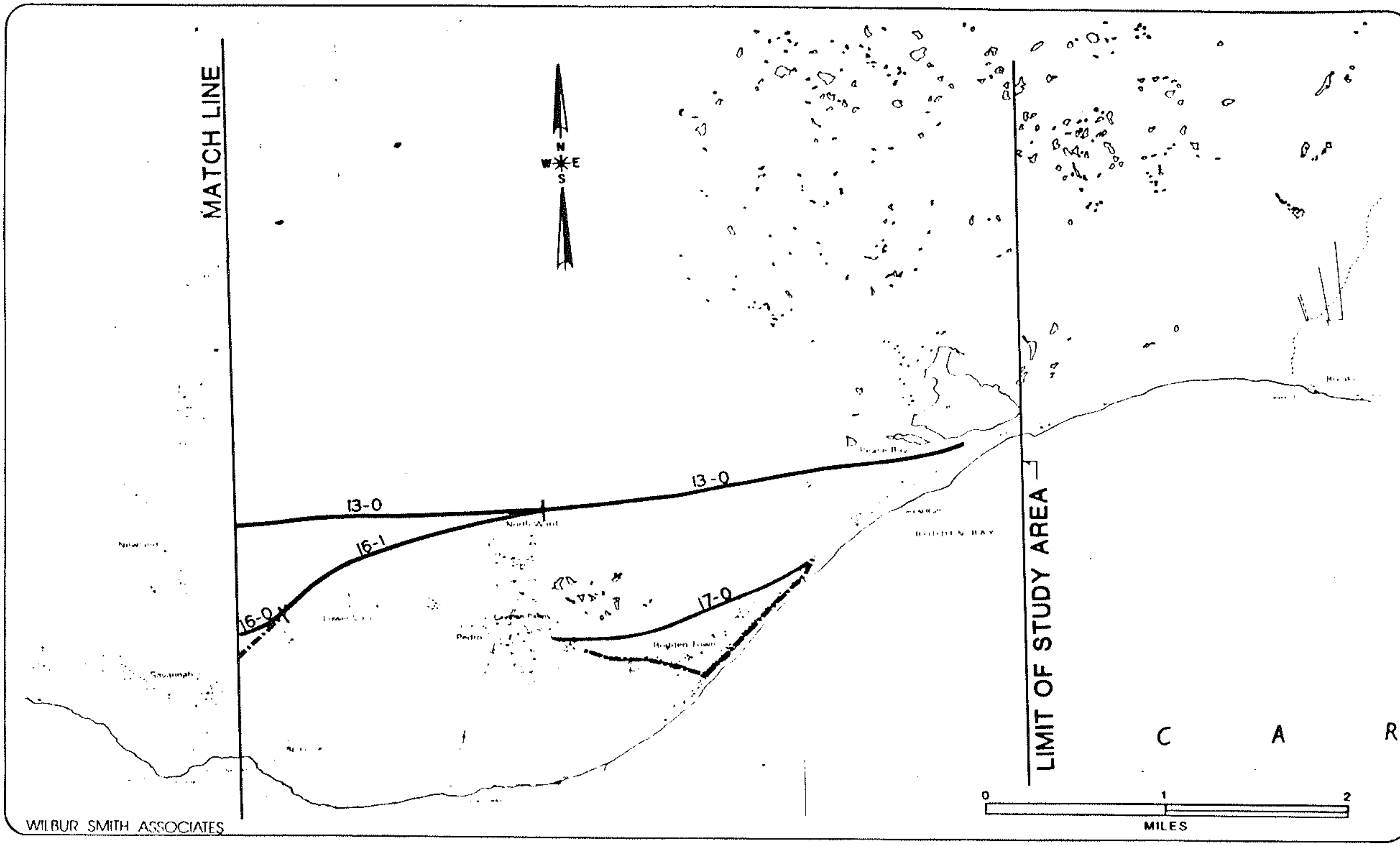

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FIGURE 4-4

ALTERNATIVE ROUTES
BODDEN TOWN

LEGEND

13-2	NEW ROUTE ALTERNATIVE
	UPGRADING ALTERNATIVE
	LINK

CHAPTER FIVE

ECONOMIC CONSIDERATIONS

CHAPTER FIVE
ECONOMIC CONSIDERATIONS

This chapter has been divided into five sections. Section 1 covers the economic evaluation of the Phase 1 and 2 recommendations. Section 2 discusses the input requirements for the MGTP traffic model, a prerequisite to the proper economic evaluation of road projects. Section 3 analyses the administrative process which is currently followed in the development of the annual road program, highlighting the criteria upon which decisions are based. Section 4 presents alternative sources of financing for the recommended road projects. Section 5 contains a recommended short-term (1988-1992) investment plan covering Phase 1 and other related projects. There are also two appendices backing up Chapter Five; Appendix A: Economic Costs; and B: Benefit/Cost Tables, Phases 1 and 2.

SECTION ONE

BENEFIT/COST ANALYSIS

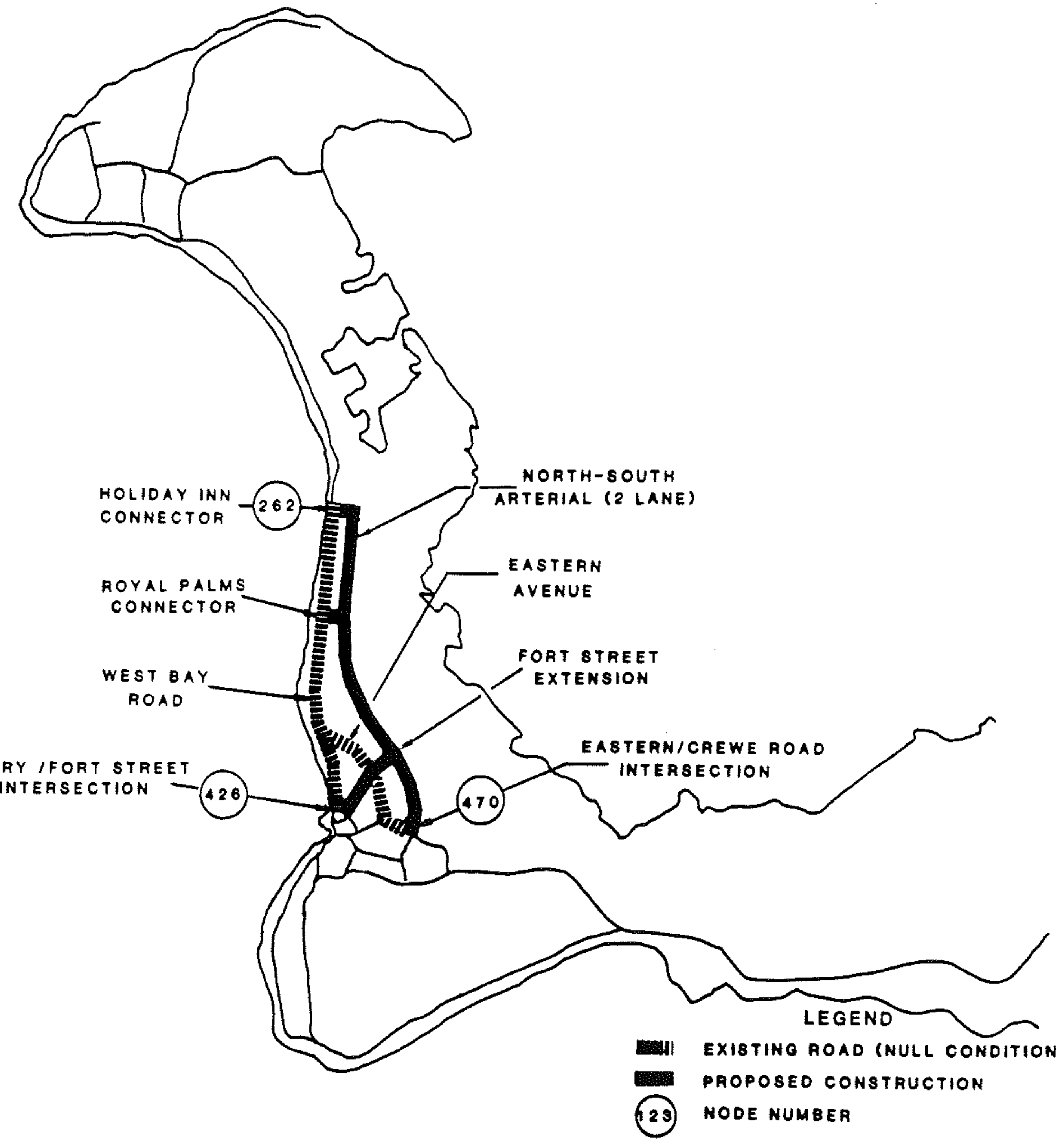
This section covers the benefit-cost analysis of the road construction projects identified as approporiate solutions to existing traffic problems on the road network. The analyses are based on user cost factors which are shown in Appendix A, plus traffic forecast elsewhere in the report.

During the development of Phases 1 and 2, seven likely road construction alternatives were tested. None of these preliminary alternatives is specifically recommended in this chapter per se, although portions of the same road segments may appear as part of the recommended projects.

ALTERNATIVES RECOMMENDED FOR ANALYSIS

Phase 1 - The alignment for the 1992 Phase 1 road improvments (referred to hereafter as Phase 1) is shown as by Figure 5-1. This two-lane North-South arterial would roughly parallel West Bay Road, starting on the north at Node 262 (Holiday Inn Connector) and running south to Node 470 (Crewe Road). There would also be a two-lane George Town Connector which would branch off at Node 501 (Fort Street Extension) ending at Node 426 (Mary Street-Fort Street intersection). A part of the North-South Arterial, also appears in Phase 2 where a particular section is recommended for four-laning. The null or existing road with which the proposed road is compared is shown by a dashed line. Basic length and ADT data for this null alignment is shown by Table 5-1 and for the improved (Phase 1) version by Table 5-2.

Additional clarification is required with regard to Table 5-1 (Phase 1-1, Null Alignment) and similar tables which follow. The only actual ADT data shown are under the first column headed 1987, as indicated by the footnote. The other 1987 ADT column (plus the other two columns) were estimated by a traffic model. A close scrutiny of these forecast data will show that in most improved alignment cases, the model has generated traffic. This is logical, because an improved (less-congested) route can be expected to attract traffic from competing roads. However, the economic analysis requires that the same traffic be loaded on both null and improved alignments, with the difference in VOC on the two alignments then as the princi-



EXISTING AND PROPOSED ROADS
PHASE ONE, 1987-1992

FIGURE 5-1

TABLE 5-1

PHASE 1 NULL ALIGNMENT
(NORTH-SOUTH ARTERIAL, 2-LANE)
SEGMENT LENGTH AND TRAFFIC

LINK END POINTS	LENGTH[1] (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1987[2]	1987[3]	1992[3]	2017[3]
262-264	0.33	13,505	3,031	4,507	11,887
264-266	0.40	15,755	5,368	7,491	18,106
266-268	0.23	16,211	5,836	8,120	19,540
268-270	0.35	17,319	7,017	9,995	24,885
270-272	0.48	18,727	5,643	8,038	20,013
272-274	0.49	20,148	5,364	7,656	19,116
274-276	0.13	22,975	7,951	11,185	27,355
276-278	0.15	9,138	2,034	3,533	11,028
278-280	0.14	8,327	1,492	2,815	9,430
280-288	0.14	8,327	1,492	2,815	9,430
288-290	0.10	10,769	5,888	7,993	18,518
290-476	0.17	11,375	5,792	7,890	18,380
476-478	0.09	7,622	5,612	6,944	13,604
478-482	0.25	7,606	5,782	7,133	13,888
482-486	0.11	12,318	9,382	9,993	13,048
486-470	0.22	11,048	8,114	8,459	10,184
276-282	0.21	13,949	6,033	7,826	16,791
282-284	0.15	13,998	6,110	8,220	18,770
284-420	0.20	16,969	7,992	9,854	19,164
420-422	0.03	4,226	6,145	7,496	14,251
422-424	0.06	2,208	4,055	5,135	10,535
424-426	0.03	2,208	4,055	5,135	10,535
Total	4.46				

(1) All 2-lane.
(2) Actual.
(3) Estimated With Phase 1-1 improved alignment assumed to be in place.

TABLE 5-2

PHASE 1 IMPROVED ALIGNMENT (NORTH-SOUTH ARTERIAL, 2-LANE) SEGMENT LENGTH AND TRAFFIC

LINK END POINTS	LENGTH (3) (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1992	2017
262-271 (1)	1.01	13,292	25,922
270-271 (2)	0.12	4,411	9,781
271-500	0.61	17,160	34,945
500-501	0.61	17,160	34,945
501-474	0.52	12,596	27,001
474-472	0.11	12,316	25,606
472-530	0.17	12,186	26,066
530-470	0.16	14,395	28,340
501-290	0.47	6,873	10,728
290-503	0.20	8,776	14,416
503-504	0.07	7,194	12,684
504-426	0.06	7,522	13,212
Total	4.11		

(1) Includes North Connector Road to null alignment (length-0.16).

(2) South Connector Road to null alignment.

(3) All 2-lane.

pal annual benefit of the new construction. Since two different alignments were involved (and not just an improvement of the null alignment) it was necessary to run an annual analysis of a principal segment of the new road alignment and then compare it to a similar analysis of a major segment of the old road. In order to do this, the ADT predicted by the model was adjusted to ensure that comparable annual vehicle miles were used in the analysis of both alignments.

Figure 5-2 indicates the basic link node system used. These nodes designate boundaries between traffic analysis zones.

Phase 2 - This 7.38 mile-long alternative (to be opened in 1997), is planned in four sections, described below.

2-1 = North-South Arterial (2-lane) This road would run from Node 504 (Botabano Road) south to Node 514 (Holiday Inn Connector).

2-2 = North-South Arterial (4-lane) This alternative would four-lane that portion of the Phase 1 project from Node 271 (Royal Palms Connector) south to Node 501 (Fort Street Extension).

2-3 = South Sound Arterial This two-lane road would run from Node 317 (Smith Road) to 347 (Walkers Road).

2-4 = East-West Arterial This two-lane road would run between Nodes 600 (South Sound Arterial) and 602 (Crewe Road near Lions' Centre).

The null alignments are shown by the dashed lines on Figure 5-3. Table 5-3 shows basic length and ADT data on both the null and improved alignments for Phase 2-1 as does Table 5-4 for Phase 2-2, Table 5-5 for Phase 2-3 and Table 5-6 for Phase 2-4.

BASIC ESTIMATION PROCESS

The economic evaluation requires that the null or existing road be compared to the improved road, and that the advantages to the user of the improvement (if any) be quantified in a theoretically defensible manner over time. These quantified advantages must then exceed the costs for the project to be economically feasible. In this study, the HIAP (Highway Invest-

TABLE 5-3

PHASE 2-1 NULL/IMPROVED ALIGNMENTS (NORTH-SOUTH ARTERIAL) SEGMENT LENGTH AND TRAFFIC

PART 1 - NULL ALIGNMENT

LINK END POINTS	LENGTH(1) (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1987(2)	1987(3)	1997(3)	2022(3)
204-214	0.30	1,265	1,737	2,522	4,485
214-212	0.10	3,507	395	663	1,333
212-210	0.19	3,721	565	790	1,353
210-252	0.20	3,996	565	792	1,360
252-254	0.38	8,328	4,078	7,473	15,961
254-256	0.60	9,368	4,372	7,787	16,325
256-258	0.23	10,637	5,629	9,805	20,245
258-260	0.77	10,654	5,620	9,730	20,005
260-262	0.60	12,681	3,324	3,963	5,561
TOTAL	3.37				

PART 2 - IMPROVED ALIGNMENT

LINK END POINTS	LENGTH(1) (Miles)	AVERAGE DAILY TRAFFICE (ADT) 1987	1987	1997(3)	2022(3)
504-506	0.30	----	----	6,669	12,529
506-508	0.55	----	----	7,800	14,360
508-510	0.53	----	----	8,103	15,346
510-512	0.75	----	----	8,751	17,546
512-514	0.94	----	----	18,345	40,185
TOTAL	3.07				

(1) All 2-lane.
(2) Actual.
(3) With Phase 2-1, Improved Alignment assumed to be in place.

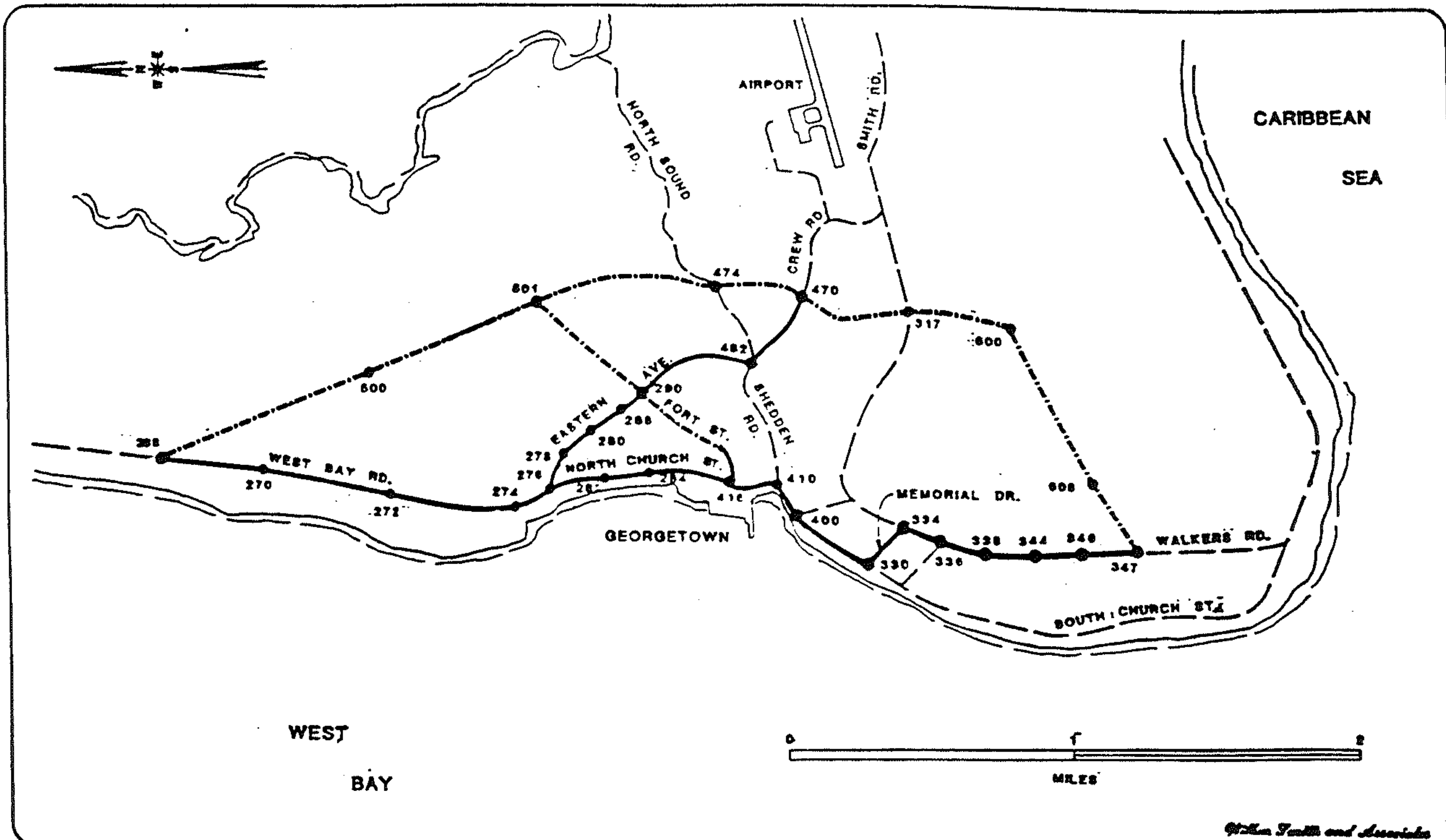


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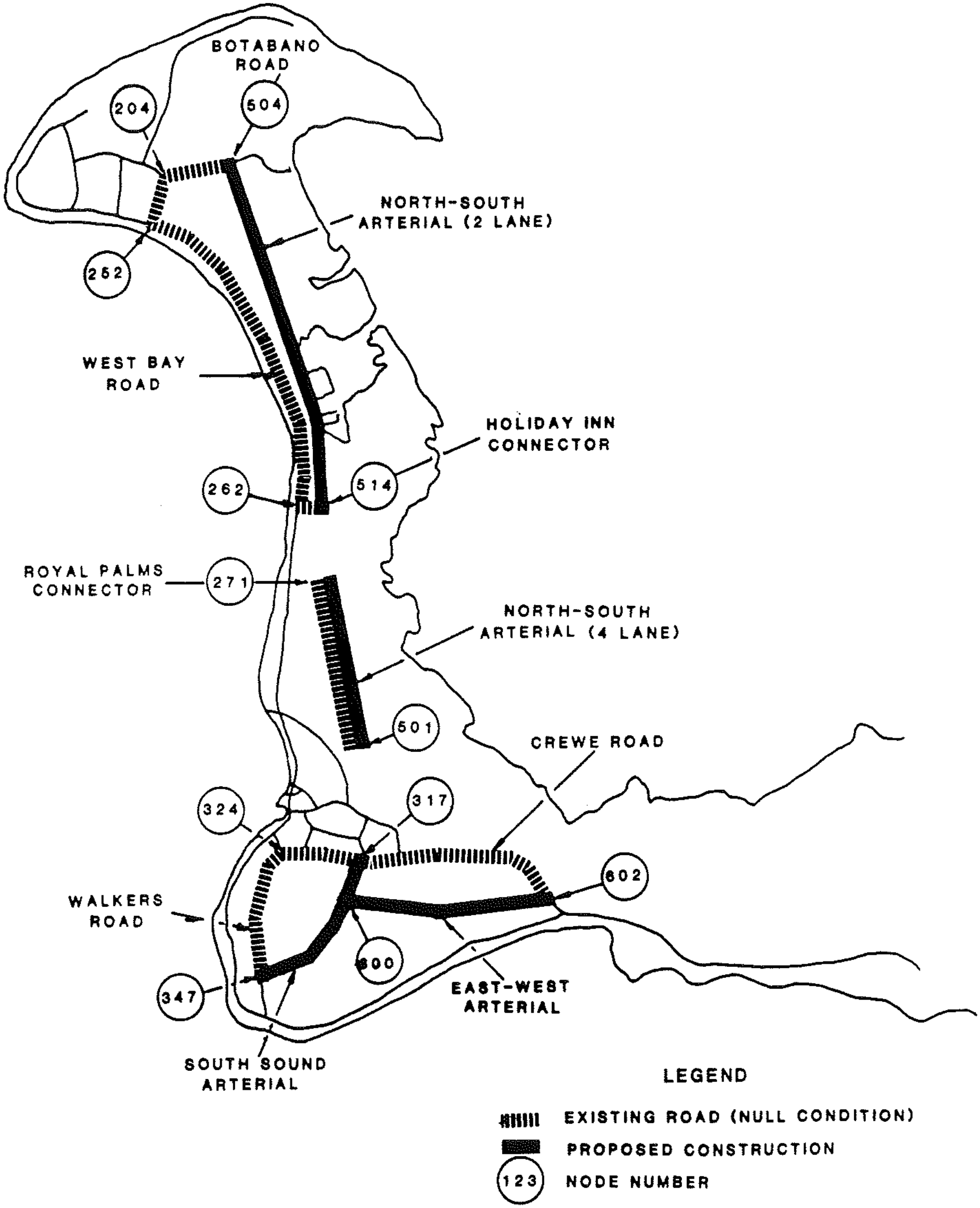
FIGURE
5-2

HIAP MODEL
KEY PLAN

LEGEND
LINK (EXISTING)
LINK (PROPOSED)
NODE
OTHER PRINCIPAL ROADS



EXISTING AND PROPOSED ROADS
PHASE TWO, 1993-1997

FIGURE 5-3

TABLE 5-4

PHASE 2-2 NULL/IMPROVED ALIGNMENTS
(NORTH-SOUTH ARTERIAL)
SEGMENT LENGTH AND TRAFFIC

PART 1 - NULL ALIGNMENT - 2-LANE

LINK END POINTS	LENGTH (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1992	1997	2022
271-501	1.2	17,956	22,584	45,724

PART 2 - IMPROVED ALIGNMENT - 4-LANE

LINK END POINTS	LENGTH (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1992	1997	2022
271-501	1.2	17,956	24,254	55,744

TABLE 5-5

PHASE 2-3 NULL/IMPROVED ALIGNMENTS (EAST/WEST ARTERIAL) SEGMENT LENGTH AND TRAFFIC

PART 1 - NULL ALIGNMENT

LINK END POINTS	LENGTH[1] (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1987[2]	1987[3]	1997[3]	2022[3]
317-316	0.2	6,888	3,290	5,929	12,527
316-314	0.2	6,727	3,044	5,243	10,741
314-362	0.55	11,877	5,503	8,098	14,586
362-364	0.39	10,127	3,839	6,144	11,907
364-366	0.35	9,876	3,648	5,767	11,065
366-602	0.14	9,876	3,648	5,767	11,065
TOTAL	1.83				

PART 2 - IMPROVED ALIGNMENT

LINK END POINTS	LENGTH[1] (Miles)	AVERAGE DAILY TRAFFICE (ADT) 1987[2]	1987[3]	1997[3]	2022[3]
600-601	0.79	----	----	10,878	18,391
601-602	0.78	----	----	9,719	18,391
TOTAL	1.57				

(1) All 2-lane.
(2) Actual.
(3) With Phase 2-3 Improved Alignment assumed to be in place.

TABLE 5-6

PHASE 2-4 NULL/IMPROVED ALIGNMENTS (SOUTH SOUND ARTERIAL) SEGMENT LENGTH AND TRAFFIC

PART 1 - NULL ALIGNMENT

LINK END POINTS	LENGTH[1] (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1987[2]	1987[3]	1997[3]	2022[3]
317-318	0.20	10,846	7,339	10,495	18,385
318-320	0.27	11,115	7,338	10,320	17,775
320-322	0.16	9,184	4,786	7,070	12,780
322-324	0.10	9,210	3,367	5,417	9,867
324-332	0.08	11,994	5,573	7,568	12,556
332-334	0.10	11,150	4,916	6,705	11,178
334-336	0.16	8,998	4,070	5,500	9,075
336-338	0.15	9,112	4,248	5,715	9,383
338-344	0.27	6,389	2,516	3,173	4,816
344-346	0.19	6,729	3,323	4,294	6,722
346-347	0.12	4,355	4,419	5,805	9,270
TOTAL	1.80				

PART 2 - IMPROVED ALIGNMENT

LINK END POINTS	LENGTH[1] (Miles)	AVERAGE DAILY TRAFFIC (ADT) 1987	1987	1997[3]	2022[3]
317-600	0.28	----	----	13,801	24,871
600-347	1.26	----	----	6,075	10,328
TOTAL	1.54				

(1) All 2-lane.
(2) Actual.
(3) With Phase 2-4 Improved Alignment assumed to be in place.

ment Analysis Package) computer model of the Federal Highway Administration of the U.S. Department of Transportation has been selected as the most suitable. The consultant has had considerable experience with this FHWA model, since Wilbur Smith Associates carried out the original field test and modification of it in 1978/79.

HIAP MODEL

The HIAP model uses programs based on microeconomics to analyse the economic feasibility of individual road sections. Inputs required include a wide range of data. In HIAP terminology, these include link identification, road area type, population area class, terrain class, highway type, number of lanes, surface type, surface rating and vehicle operation cost (VOC) plus ADT. From these data, the model calculates the volume/capacity ratio for each link. From that ratio it develops average vehicle running speeds, which are in turn used to determine vehicle operating costs. The difference in vehicle operating costs between the null and improved links times the ADT times 365 times the segment length constitutes the basic annual benefits expected from a link improvement.

The model is also capable of calculating the benefits expected from the road improvement from reduced passenger and truck cargo inventory time as well as from reductions in the frequency of accidents. Benefits from reduced time cost were not included in the results of this analysis.

OTHER MODEL INPUTS

The development of the VOC required for the HIAP model is covered in detail in Appendix 5-A to this report. The results are summarised in Table 5-7. Other costs (also covered in Appendix 5-A) are summarised below.

Truck Cargo Inventory - The average cost of cargo inventory time for a light truck was estimated at CI $0.00019/minute and for heavy trucks, CI $0.0014/minute. Half of all truck trips were considered to be empty.

Accident Costs - Property damage costs were estimated at CI $2,500 each, with injuries at CI $18,000 and fatalities at CI $80,000 each.

TABLE 5-7

SUMMARY-STUDY VEHICLE VOC

	COST PER MILE (CI$)					
	PASSENGER CAR			TRUCKS		BUS
MPH	Private	Rental	Taxi	Light	Heavy	
5	0.36	0.28	2.06	1.57	2.14	2.09
10	0.32	0.25	1.15	0.87	1.27	1.16
15	0.28	0.22	0.83	0.62	1.03	0.83
20	0.25	0.20	0.66	0.49	0.86	0.66
25	0.24	0.19	0.55	0.41	0.76	0.55
30	0.23	0.18	0.49	0.36	0.69	0.49
35	0.23	0.19	0.44	0.32	0.64	0.44
40	0.25	0.19	0.41	0.30	0.62	0.40
45	0.26	0.21	0.38	0.28	0.59	0.38
50	0.29	0.23	0.37	0.27	0.59	0.36

Source: Table A-17, MGTP Study

Average Hourly Wage Rates - The rate per monthly paid employee was estimate at CI $10.38 per hour, with weekly paid employees at CI $5.17 per hour. In calculating time savings, only 40 percent of the total would be included, and then only for work trips which were estimated as 18 percent of total type.

Average Passengers per Vehicle - The average number of persons per vehicle was estimated at private/rental cars - 1.61, taxis - 1.85, light trucks - 1.68, heavy trucks - 1.32 and buses - 5.37. In calculating passenger time benefits, the driver would be deducted for all except private/rental cars.

Idling Costs - Hourly idling cost (without wages) were estimated (in CI $) as: private cars - 0.67, rental cars - 0.52, taxis - 0.69, light trucks - 0.58, heavy trucks - 1.27 and buses - 0.69.

Road Maintenance - Annual maintenance costs were estimated at CI $20,000 per mile for both null and improved roads, with the null version also requiring resurfacing every seven years at a cost of CI $220,000 per mile.

TRAFFIC

The ADT's for the various null and improved links were indicated earlier in this chapter. Forecasts include normal and diverted traffic, a very conservative approach. Traffic was projected on a linear basis.

CONSTRUCTION PERIOD

Construction periods assumed for Phases 1 and 2 were as follows:

CONSTRUCTION IMPLEMENTED BY YEAR

Calendar Year	Percent Phase 1	Phase 2
1990	25	--
1991	50	--
1992	25	--
1995	--	25
1996	--	50
1997	--	25

CONSTRUCTION COSTS

The costs of right-of-way and construction and residual value of study links are shown by Table 5-8. The total economic cost for Phase 1 is estimated at CI $12.7 million and for Phase 2 - CI$ 21.4 million. It is pointed out that the right-of-way which will be acquired will be wide enough (125 ft.) for a four-lane road throughout, although all of the 11.7 miles recommended is initially planned as two-lane except for one four-lane stretch (Phase 2-2) which is only 1.2 miles long. While this approach is commendable in that it ensures room for later expansion, it also biases the initial analysis against the new two-lane segments. For example, total land costs for Phase 2 roads would be CI $8.66 million for the 125 ft. wide right-of-way. For a 50 ft. R-O-W (adequate for a 2-lane road), costs would only be 40 percent as much, at CI $3.5 million. Residual values shown are the cost of earthworks, drainage and purchased land.

TABLE 5-8

ECONOMIC COSTS
PHASES 1 AND 2

PHASE	LINK NO.	COST BY PHASE R-O-W	Construction (CI $ 000)	Total	RESIDUAL VALUE (3)
One (1)	1-1	3,893.0	8,728.6	12,711.6	10,414.6
Two	2-1	4,287.0	6,451.5	10,738.5	9,040.7
	2-2	(2)	1,759.0	1,759.0	1,296.0
	2-3	338.0	2,632.5	2,970.5	2,277.7
	2-4	3,994.0	1,960.8	5,954.8	5,438.8
Second Phase Total		8,619.0	12,803.8	21,422.8	18,053.2
Overall Total		12,602.0	21,532.4	34,134.4	28,467.8

(1) All items on this line are phase totals.
(2) This cost would have been incurred when the 125-ft. right-of-way was acquired for Phase 1-1, since Phase 2-2 is a 4-lane version of 1.2 miles of Phase 1-1.
(3) Value of purchased land plus earthworks and drainage.

LEAST COST SOLUTION

As indicated earlier, the HIAP model compares the results of VOC (or other) criteria times the annual traffic for both null and improved alignments, with the difference in cost between the two constituting the principal benefits of the improved version. This analysis can be carried out on a link-by-link basis, or on a total project basis. Where the alignment of the improved version is different from that of the null version (as is the case in this study) the total project approach is most logical.

Regardless of which approach is used, the results should be the same. When the annualised benefits (which are actually reductions in cost) are extrapolated throughout the 25-year analysis period, the least cost solution should be the one with the highest benefits.

PRODUCTIVITY MEASURES

The HIAP model also produces economic productivity measures, which provide the final differentiation between alternatives.

<u>Benefit/Cost (B/C) Ratio</u> - The present value of project benefits divided by the present value of costs. In order for the project to be economically feasible the ratio should be at least 1:1.

<u>Net Present Value (NPV)</u> - The present value of project benefits minus the present value of project costs. A feasible project should have a positive NPV.

<u>Internal Rate of Return (IRR)</u> - That discount rate at which the net present value of project benefits equals the net present value of project costs. A feasible project has an IRR at least as great as the discount rate.

As a general rule, the three measures will prove to be consistent, i.e., if one is favourable, all three are favourable. In selection between projects, the NPV is usually recognised as the most dependable measure, since the other two criteria have inherent defects. For example, the B/C Ratio is blind to distributional impacts and generally overestimates the effects of operating costs, while the IRR can produce ambiguous results.[1] However, each case must be judged on its own merits, particularly when the criteria are inconsistent.

DISCOUNT RATE/PERIOD

The discount rate used in a project evaluation should be a measure of the opportunity cost of the capital resource over time. For public projects, such as the present road improvement, the rate should be at least equal to the interest rate available on long-term government bonds. Beyond this floor, it should also represent a weighted average of the opportunity cost associated with each capital source involved in the project.[2] In the present case, a discount rate of 12 percent has been used.

The discount period should be equal to the estimated useful life of the project. As indicated earlier, the period used here is 25 years.

PRELIMINARY EVALUATION

Some seven alternatives were considered during the preliminary evaluation. These alternatives do not appear in the final analysis except in those cases where they form part of a Phase improvement. Also during the preliminary evaluation, it became apparent that the present West Bay Road could not be improved sufficiently to carry projected traffic volumes beyond 1997. This led to the recommendation which require new road alignments.

BENEFITS CONSIDERED

Only VOC savings are considered in the analysis described herein. This is a very conservative approach, and is in accordance with IDB preferences.

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1 R. de Neufvill and J.H. Stafford, _Systems Analysis for Engineers and Managers_, McGray-Hill Book Co., NY, NY, 1987, p.180.

2 _Ibid_.

RESULTS OF EVALUATION

It is axiomatic in the economic evaluation of a road project that the evaluation period is the same length as the expected life of the facility which is being analysed. With paved roads, this period is generally assumed to be 20-25 years. However, it is also recognised that the longer the repayment period, the greater the total outlay. Accordingly, the B/C evaluation was carried out first for 25 years. If the project proved to be economically feasible over that period, it was then tested at 15 and 20 years. The results are shown on Table 5-9. This technique actually provides a very rigorous sensitivity test. The computer tables upon which this is based are included as Appendix B, which is entitled "Benefit/Cost Analysis Tables".

Phase 1: North-South Arterial - This high volume facility showed a B/C Ratio of 1: 3.57, an NPV of CI $22.14 million and an IRR of 38.7 percent for the 15 year period, increasing to a B/C Ratio of 1 = 4.62, an NPV of CI $31.34 million and an IRR of 39.1 percent at 25 years. This is a highly viable component.

Phase 2-1: North-South Arterial Extension to Botabano Road - 2 Lane - This segment was the first portion of Phase 2 which was evaluated It showed up poorly in the first analysis, and was reevaluated as a double check. Its final B/C Ratio was 1; 0.58; its NPV was CI $1.7 million and its IRR was 7.2 percent In order to be economically feasible, it would have to had a B/C Ratio greater than one; a positive NPV and an IRR higher than the 12 percent discount rate.

Phase 2-2: North-South Arterial Widening - 4 Lane - This Phase 2 component shows high viability, with a 20-year reading of B/C Ratio - 1: 3.52, NPV: CI $1.8 million and IRR 34.4 percent.

Phase 2-3: East-West Arterial - This Phase 2 segment has a B/C Ratio of 1: 0.66, an NPV of CI-$391,900 and an IRR of 7.7 percent. While making a slightly better showing than Phase 2-1, it was still not economically feasible.

Phase 2-4: South Sound Arterial - This Phase 2 link had a B/C Ratio of 1: 0.29, an NPV of CI-$1,588,700 and an IRR of 3.2 percent. It made the poorest showing of any of the four Phase 2 segments and was not economically feasible.

TABLE 5-9

RESULTS OF B/C ANALYSIS
PHASES 1 AND 2

PROJECT	Years For Repayment	B/C Ratio	Net Present Value (CI$000)	Internal Rate Of Return (Percent)
	EVALUATION CRITERIA			
Phase 1-1 = North-South Arterial (2-Lane)	15	3.57	22,144.4	38.7
	20	4.16	27,279.0	39.0
	25	4.62	31,344.9	39.1
Phase 2-1 = North-South Arterial (2 Lane)	25	0.58	-1,678.6	7.2
Phase 2-2 = North-South Arterial (4-Lane)	15	3.02	1,391.9	33.9
	20	3.52	1,791.9	34.4
	25	4.05	2,124.2	34.6
Phase 2-3 = East-West Arterial (2-Lane)	25	0.66	-391.9	7.7
Phase 2-4 = South Sound Arterial (2-Lane)	25	0.29	-1,588.7	3.2

Note: See Apendix 5-B for backup computer Tables.

Source: Wilbur Smith Associates

SUMMARY

The analysis indicates clearly that all of the Phase 1 segments plus the Phase 2-2 segment of Phase 2 proved to be economically feasible. However, it is pointed out that Phase 2-2 had an advantage in the evaluation because its right-of-way was previously purchased as part of the Phase 1 construction, with the result that there was no land cost for Phase 2-2.

Segments 2-1, 2-3 and 2-4 of Phase 2 were found to be not economically feasible. In order of declining viability, the sequence of these segments would be: (1) Phase 2-3, (2) Phase 2-1 and (3) Phase 2-4. As pointed out previously, these segments (along with the others) were handicapped in the analysis because they were carrying the cost of a 125 ft. wide right-of-way, when present plans are only for the construction of two-lane roads on the right-of-way land acquired. However, this approach does ensure that four-lane rights-of-way will be available, when needed.

A further analysis was made of the three Phase 2 segments previously found not to be economically possible. This investigation was to determine if improved Benefit/Costs results could be realized if land acquisition needs on three Phase 2 projects were reduced to that required for a two-lane road (50 foot width). This exercise was not sufficient to prove economic viability.

PHASE NUMBER	B/C RATIO	NPV (CI $000)	IRR No.
2-1	0.75	-791.6	9.1
2-3	0.67	-372.2	7.8
2-4	0.43	-805.9	5.0

In order for these segments to have been economically feasible, the B/C Ratio would have had to be greater than 1:1, the NPV would have had to be positive and the IRR would have had to be larger than the discount rate of 12 percent. A separate test was not made of the effects of the inclusion of time benefits, because a decision was made earlier in the study not to include them.

However, the principal question at hand was the economic feasibility of the Phase I projects. Each of those improvements was found to very beneficial to vehicle operators in Grand Cayman.

SECTION TWO

TRAFFIC MODEL INPUT

The MGTP model, which is installed on a computer in PWD, is capable of forecasting traffic for the Grand Cayman road network. However, in order to do this, it must have certain general data input, and these data must be for specified traffic analysis zones. The range of these data is significant, as follows:

1. Population
2. Dwelling Units
3. Total Employment
4. Retail Employment
5. School Attendance

Most of the data indicated above are presently collected by the Cayman Islands Government, in one form or another, as evidenced by entries in the Statistical Abstract,[3] subsequently referred to as the Abstract. However, there are two principal difficulties connected with trying to use these data with the MGTP Traffic Model. First, the base areas from which they are collected have boundaries different than those of the traffic zones. Second, the frequency of collection of the data is less than is required.

In view of the above, it appears that special arrangements will be necessary to obtain data for the model. The following considers the manner in which each class of basic data was obtained for initial use with the MGTP Traffic Model, and indicates where additional actions are necessary.

POPULATION

The last Island census was taken in 1979, with previous censes taken in 1960 and 1970. The best indication of changes in stable population appears to be the number of work permits granted, because the indigenous population is growing at a relatively constant rate. There are also foreigners who have residential permits, but not work permits. This information is also available in the Immigration Department.

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[3] Government Statistics Unit, Department of Finance and Development, Cayman Islands, *Statistical Abstract of the Cayman Islands - 1986*, June 1987.

Recommendation: That PWD arrange with The Immigration Department to obtain necessary data on work and residency permits issued, on a recurring annual basis.

The large number of tourists which visit the Islands annually also have a heavy impact on traffic, particularly in George Town where roughly half of the population lives. For example, in 1986, the Islands hosted 437,000 tourists, 62 percent arriving by cruise ship, the remainder by air. These arrival data are available from the Department of Tourism on a monthly basis.

Recommendation: That PWD arrange with the Immigration Department, to obtain necessary tourist arrival data on a recurring annual basis.

Births and deaths are irrefutable evidence of population changes. Such data are collected by the Registration of Births, Deaths and Marriages.

Recommendation: That PWD arrange with the Registrar of Births, Deaths and Marriages to obtain necessary data on a recurring annual basis.

DWELLING UNITS

The Central Planning Authority (CPA) has the authority to approve all construction which is proposed in the Islands. However, a certain proportion of the construction permits which are issued are not implemented, i.e., no building takes place. As a result, it was necessary for The Planning Department in June, 1987, to conduct a survey to determine where building had actually occurred. This survey updated the most recent aerial photo map (1985) to 1987, identifying new construction since the map was made.

Recommendation:
That the Planning Department continually update the land use maps to show actual construction, and that PWD arrange to get the results on an annual basis.

EMPLOYMENT

The Government Statistics Unit carried out an employment survey of the Islands in November 1985. However, in order to protect proprietary information the results were closely held and could not be released to the MGTP Study.

Recommendation:
That employment by Traffic Zone be compiled directly from subsequent surveys, and that such totals be made available to PWD staff on an annual basis.

SCHOOL ENROLLMENT

The Education Department maintains a thorough coverage of the number of pupils in various types of schools.

Recommendation: That PWD arrange with the Education Department to obtain necessary school attendance data on a recurring annual basis.

SECTION THREE

TRANSPORT INVESTMENT CRITERIA

This section of the chapter analyses the criteria which are presently used in making decisions on road investments. First, the process presently used in assembling an annual road construction programme is analysed, and decision points established. The criteria upon which decisions are made at each of these points are then determined, and (where appropriate) recommendations are made for improvement. These recommendations consider the impact of the MGTP.

DECISION PROCESS

The most recent example of the decision process for Cayman road investments is the actions taken in 1986 which led to the adoption of PWD's Annual Work Programme, Figure 5-4. Actions on this chart are keyed to Table 5-10, which summarises the action taken at each point. While there is no assurance that the process shown will be followed in the future, it is both logical and current.

Actions are divided into five areas:

1. Project Formulation
2. Project Selection
3. Project Design and Approval
4. Annual Work Programme Preparation
5. Construction Inspection

Presently there are 35 actions required, 15 of which are the responsibility of PWD. With this many actions involved, there is ample opportunity for delay if participants in the process do not handle their actions expeditiously. Some 19 of the actions involve decisions. The criteria upon which the decisions involved are based are covered in the following discussion.

ROAD PROJECT DECISION PROCESS

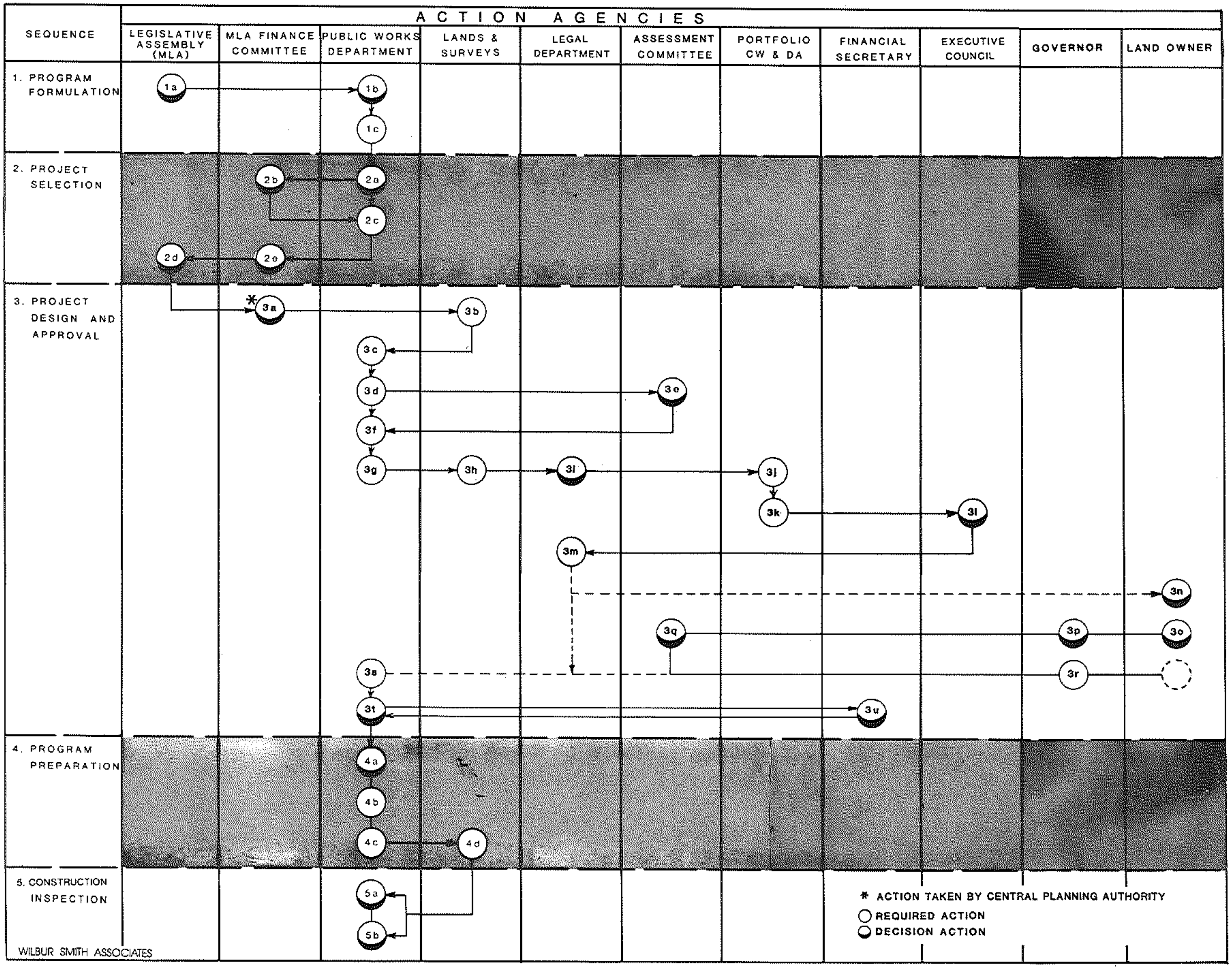


FIGURE 5-4

TABLE 5-10

ROAD PROJECT DECISION PROCESS

1. <u>Project Formulation</u>
* a. Each MLA provides list of road projects from his district to PWD.
* b. PWD adds other projects, based on technical considerations.
   c. PWD prepares technical description of each project.

2. <u>Project Selection</u>
* a. PWD identifies projects of possible national concern.
* b. MLA Finance Committee selects from these projects.
   c. The cost of national projects is deducted from funds available for road construction.
* d. MLA Finance Committee divides remaining funds up among districts.
* e. MLA's select projects for their district, consistent with funding allocated.

3. <u>Project Design and Approval</u>
* a. Central Planning Authority reviews projects.
   b. Department of Lands and Surveys conducts reconnaissance surveys of approved projects.
   c. PWD develops preliminary horizontal alignment from surveys.
   d. PWD forwards to Portfolio of CW and DA for political review and comment.
   e. PWD obtains alignment approval from Portfolio of CW and DA.
   f. PWD prepares project budget, based on approved horizontal alignments.
   g. PWD sends to Department of Lands and Survey for property acquisition, as necessary.
   h. Department of Lands and Survey prepares boundary plan and <u>Gazette</u> Notice, sends to Legal Department.
* i. Legal Department reviews Gazette Notice.
   j. Portfolio of CW & DA prepares submission for Executive Council consideration.
   k. Portfolio of CW & DA submits Gazette Notice to executive Council.
* l. Executive Council approves/disapproves submission.
   m. Clerk of Legal Department publishes Notice.
* n. Landowner does not object within 15 days; PWD proceeds.
* o. Landowner objects to the Governor, within 15 days.
* p. Governor refers the objection to the Assessment Committee.
* q. The Assessment Committee determines compensation.
   r. The Governor notifies the landowner.
   s. PWD completes final road project design.
* t. PWD develops final project cost estimate.
      (1) If below preliminary estimate, PWD can initiate construction.
      (2) If above preliminary estimate, PWD forwards to Financial Secretary.
* u. Financial Secretary reviews and approves, as appropriate.

4. <u>Annual Works Programme Preparation</u>
* a. PWD decides for each project
      (1) PWD construction, or
      (2) Contractor construction.
   b. PWD prepares annual schedule for project construction.
   c. PWD prepares construction schedule and programme for next 3 months.
   d. Lands and Surveys Department sets out construction control points.

5. <u>Construction Inspection</u>
* a. PWD inspects contractor-built projects.
* b. PWD also inspects PWD-built projects.

* Decision Points

<u>**Project Formulation**</u> - In this part of the process, the list of road projects which are to be considered for implementation is assembled. There are three steps, two of which require decisions.

<u>1a - Project List, MLA to PWD</u> - In this step, each Member of the Legislative Assembly selects road projects for his district, for forwarding to PWD. The principal source of these projects is the constituents of the MLA, but may also be originated by the member if a particular need is seen. The bases for project selection are principally parochial, emanating from an evaluation by the MLA of the actual needs of his district.

<u>1b - Addition of Technical Consideration Projects</u> - The addition of these projects to the MLA list by PWD is based upon estimates of the current physical needs of the road system. For example, roads which have already been paved must be resurfaced periodically to forestall deterioration. Further, a certain number of miles of improved roads may require reconstruction during any particular year. This step might also consider the implications of other road actions which are not specifically part of the annual road program. An example would be requests for connection to an existing (or planned) road by a developer, or acceptance of a developer's roads for subsequent maintenance.

<u>**Project Selection**</u> - As would be expected, most of the five steps in this portion of the process involve decisions.

<u>2a - Identification of National Concern Projects</u> - In identifying projects of this category, PWD considers the needs of future traffic, together with current and expected road conditions. For example, an important road might have sufficient capacity to carry forecast traffic, but the current condition might be such that it is expected to deteriorate to an unacceptable level before that traffic develops. Or, its condition might be satisfactory but it could require the addition of one or two lanes to meet traffic needs.

<u>2b - Selection of National Concern Projects</u> - The MLA Finance Committee selects from among the projects that have been identified as possible candidates, based on an evaluation as to which projects will provide the most overall benefit. While there is usually general agreement as to identification of these projects, selection between them is another matter, particularly when budget limitations are stringent. An additional, quantified decision tool could be helpful.

2d - Fund Division by MLA Finance Committee - In this step, the MLA Finance Committee divides up monies remaining after the nation concern projects have been funded. Apparently, the process involves considerable negotiating and competition for funds. While parochial considerations may not be paramount here, they obviously receive a high priority. However, part of the debate problem could be eliminated if an indication of the relative benefit potentials of the contending projects was included.

2e - Project Selection By MLA's - Based upon the monies which each MLA is able to obtain during the final division step described above, he then decides which road projects he will recommend from his district. Again, the basis for selection is principally parochial, tempered by concern for the overall good.

Project Design and Approval - During this portion of the process, the PWD develops preliminary horizontal road alignments and obtains approval from the Portfolio of Communications, Works and District Administration. The Lands and Survey Department, as part of acquiring necessary right-of-way, then publishes the Gazette entries. If an affected land owner objects, his case is referred to the Assessment Committee for decision as to compensation. PWD then prepares final designs and cost estimates and obtains approval of the Financial Secretary.

3a - Central Planning Authority (CPA) Review - CPA takes note of projects which have passed the selection process, and how they will affect current development patterns. The review also provides basic tools to be used when considering future planning proposals, land use changes, and zoning adjustments.

3e - Portfolio of CW and DA Approval - In this step PWD obtains an approval (or modification) from the Portfolio of CW and DA of proposed project horizontal alignments. This approval is necessary because of the political repercussions which can result from land takings, particularly if the land owner is influential. Each case is considered on its own merits, but the MLA's are consulted wherever the property of one of their constituents may be at risk. The bases for decision are parochial and in consideration of the overall good.

3g - Legal Department Reviews Gazette Notice - If the notice meets legal requirements, the Legal Department forwards it to the Portfolio of CW and DA.

3l - Executive Council Approves/Disapproves Submission - The Council passes upon the Notice and returns it to the Legal Department.

3n - Landowner Does Not Object to Notice - The landowner has fifteen days after the publication of the Gazette Notice to present his application for assessment of compensation to the Governor. If he does not object, PWD can proceed with construction. There are indications that some landowners have received less than adequate advance notice of proposed land takings, and the notification system may therefore need adjustments.

3o - Landowner Objects to Takings Notice - If the landowner objects to the proposed land taking, he must deliver an application for assessment of compensation to the Governor's Office within the 15-day period.

3p - Governor Refers Objection to the Assessment Committee - If the landowner's application is received within the 15-day period, the Governor refers it to the Assessment Committee.

3q - Assessment Committee Determines Compensation - The Assessment Committee is composed of a magistrate and two other members nominated by the Legislative Assembly. Their term of office is four years and they may be reappointed. The magistrate is the Chairman.

Land is presently being taken for road improvement purposes under the Roads Law of 1974. Section 10 (3) of that law states that when losses to the landowner (in standing crops or trees, severing of the taken land from his other lands or the injurious effect on his other land due to the loss of the taken land) exceed the advantage gained by the applicant because the improved road is adjacent to this property, compensation may be assessed. If compensation is recommended, the Governor ensures that payment is made.

3t - PWD Comparison of Cost Estimates - In this step, PWD completes the final road project cost estimates and compares them to the preliminary estimates. If the final estimate for a particular project is lower than the preliminary estimate, PWD can initiate construction. If not, the project is forwarded to the Financial Secretary (with justification) for approval. The basis for the PWD decision is a simple comparison of estimate results.

3u - Financial Secretary Approves Overrun Project - The Secretary reviews those projects which have overruns in cost estimates and which have been forwarded to him by PWD for decision. His decision must be based upon a number of factors. First, the justification for the overrun must be adequate. Second, if such a proposal is to be implemented, the amount of the overrun must be made up. For example, if there is slack in the programme, or if there have been underestimates on other projects (as well as overestimates), there may still be sufficient funds available overall to implement the project at issue. However, if the overrun can not be met from this source, supplemental funding could be requested. If such is not available, it may be necessary to eliminate the project involved (or another project) with attendant political ramifications. The bases for decision are political and economic, with the overall good of the populace as a paramount concern. Again, some quantified system of rating projects as to benefits would be helpful.

Annual Work Program Preparation - In this four-step portion of the process, the PWD decides whether each project is to be constructed in-house or not, and prepares annual/quarterly construction schedules. The Lands and Surveys Department also establishes construction control points.

4a - PWD Decides - In-house or Contract - The PWD generally does in-house all the road construction of which it is capable, because studies have shown that design or construction by a contractor is more expensive. The PWD decision as to the annual total which can be handled is based upon an estimate of departmental requirements vs. capabilities during the impending programme year. However, the peak increases in road construction incident to implementation of the MGTP will exceed the present in-house capability of the PWD and the department will either require augmentation or will have to go more to contractors, or both.

Construction Inspection - In this portion of the process, road construction projects are inspected for acceptance by the Government.

5a/b - Construction Inspection - It is generally considered more effective for a construction job to be inspected by some agency other than the one responsible for the constructing. However, the PWD inspects its own construction, as well as that of contractors. The basis for both types of inspection is quality and quantity of completed work against contract specifications.

SUMMARY AND RECOMMENDATIONS

A number of the decisions discussed in the foregoing evidence the trademarks of the democratic process, e.g., legislators competing for scarce resources in the interests of their constituents. Others involve government officials who are trying to stretch these same scarce resources to cover road requirements which increase inexorably, year after year. In both cases, a tool which could quantify the benefit potential of projects would be of significant assistance.

Recommendation: That the process depicted in Table 5-10/Figure 5-4 (or a similar process) be considered for adoption by the Cayman Islands Government, for the assembly of the annual roads programme, and that PWD be designated as the government coordinating agency responsible.

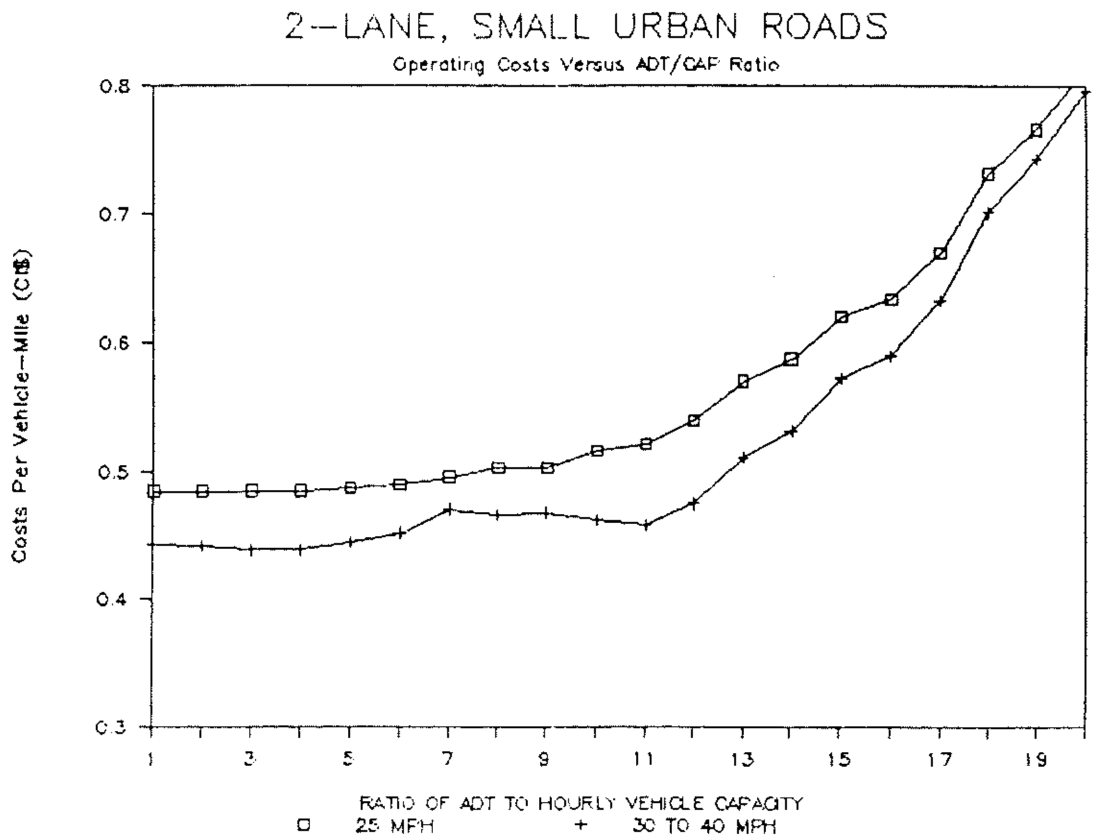
Recommendation: That during Step 1c (Preparation of Project Technical Description) of the process:

(a) That PWD attach a cover routing slip, listing the sequence of actions required, with spaces for date handled and initials of handling officer.

(b) That PWD add to each project coverage a designator termed here as a Road Viability Index that would provide a preliminary indication of the benefit/cost relationship of the projects, Figures 5-5 and 5-6.

Recommendation: That improvements be made in the present system of notifying landowners of proposed land takings to ensure that adequate advance notice is provided.

In the past, the assembly of the annual road programme has been largely a catch-as-catch-can matter. The annual investment in roads has consistently been less than the annual revenue in taxes, registrations, duties, etc., realised from road users. It has been recommended elsewhere that a multiyear road improvement programme be adopted. With implementation of the MGTP, this recommendation will become a must, since multimillion dollar investments will be required, over a period of several years. Increased competition for the road investment dollar will result, and a more structured, economic-oriented decision process for selection of road projects for inclusion in the annual road programme will be required. Implementation of the recommendations which have been made in a later section of the report should help in ensuring that such a process is both available and used.



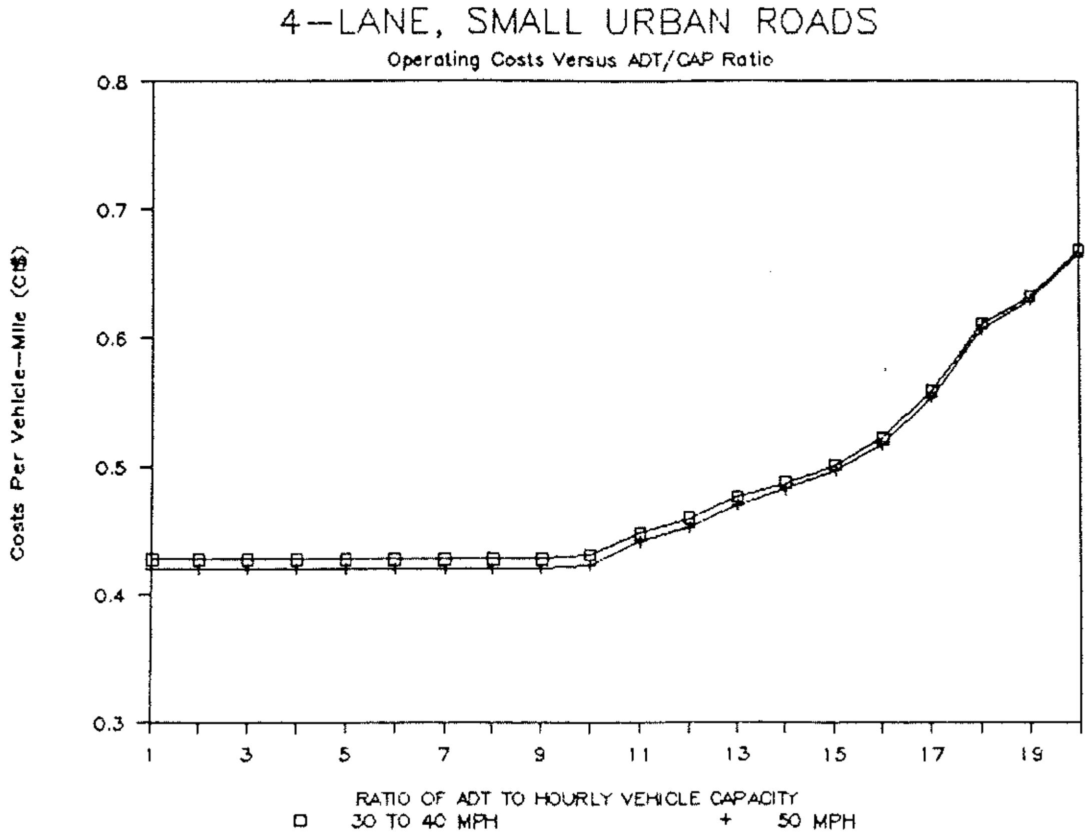
INSTRUCTIONS

1. For the existing road alignment:
   a. Calculate ADT/C Ratio (ADT - hourly road capacity).
   b. Plot ADT/C Ratio on horizontal axis.
   c. Read up to Cost per Vehicle Mile (CVM) on plotted line, vertical axis.
   d. Calculate ACVM (Annual Cost of Vehicle Miles)--(ADT x CVM x 365 x road segment length in miles).
2. Calculate ACVM for improved alignment.
3. Obtain AIB (Annual Improvement Benefit)--(ACVM existing road less ACVM improved road).
4. Calculate APR (Annual Payment Required) to meet assumed loan equal to construction cost at 12 percent for life of improvement.
5. If AIB exceeds APR, improvement should be economically feasible.

NOTES:

a. The costs per vehicle mile shown are weighted costs, calculated for the 6 vehicle types used in the MGTP.
b. If the improvement would not pay on opening year, test at halfway through the project life. This should give an average ADT.

Figure 5-5



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5. If AIB exceeds APR, improvement should be economically feasible.

<u>NOTES</u>:

a. The costs per vehicle mile shown are weighted costs, calculated for the 6 vehicle types used in the MGTP.
b. If the improvement would not pay on opening year, test at halfway through the project life. This should give an average ADT.

Figure 5-6

SECTION FOUR
ROAD FINANCING

This section examines the extent to which the recommended MGTP road investments could be met with present road revenues, if such charges were used solely to support roads. It also explores various ways in which road construction could be financed, in the event that road revenues continue to be diverted to other purposes, as is currently the case.

In the Cayman Islands, the use of motor vehicles is not taxed directly, e.g., there are no direct taxes on motor fuel or are there sales taxes or parking charges. Instead, the Government relies on a system of duties and fees, e.g., import duties on vehicles and fuel, motor vehicle registration fees, driver license fees, and motor vehicle license fees. The proceeds from these charges go into the general fund, upon which the various government departments then draw for their operating needs.

ROAD REVENUES VS. EXPENSES

One result of the above, is that there is not necessarily a correlation between the cost of service provided by the Government and the revenue which results from that service. For example, as pointed out elsewhere in this study, the annual government revenues attributable to roads (CI $6.47 million) are currently $2.75 million higher than annual costs (CI $3.71 million) which are incurred. The gist of this comparison is shown by Table 5-11.

The breakdown shows that related costs typically make up only 57 percent of the returns from transportation fees, levies and charges, with the remainder (CI $2.75 million or 43 percent) of such revenues being diverted to other purposes. Since this practice is of long standing, there is little reason to expect that it would change in the near future.

Even if all of the CI $2.75 million transportation excess were used for road construction, it would be insufficient for financing the road projects recommended by the MGTP. For example, road requirements indicated by the MGTP total CI $18.78 million in the period 1988-92 and CI $38.24 million in the 1992-97 timeframe, total CI $57.02 million. Financing a 12 percent

TABLE 5-11

GOVERNMENT COSTS AND REVENUES ATTRIBUTABLE TO ROADS

ITEM	1986 COSTS AND REVENUES
Revenues:	
Motor Vehicle Tax (1)	$ 1,300,000
Drivers Licences (1)	400,000
Licence Plates (1)	24,000
Inspection Fees (1)	130,000
Import Duty - Vehicles (2)	3,973,000
Import Duty - Gasoline (2)	639,000
Total Revenues	$ 6,466,000
Costs:	
Roads Maintenance (1)	$ 240,000
Drainage and Wells (1)	25,000
Traffic Signs and Signals (1)	55,000
Roads Construction (1)	1,800,000
PWD Roads Operations (3)	700,000
Police Roads Operations (4)	560,000
Provision for Cayman Brac/Little Cayman (1)	134,000
Miscellaneous Costs - Central Govt.(5)	200,000
Total Costs	$ 3,714,000

Sources:

(1) "Estimates of Revenue and Expenditures of the Cayman Islands - 1986," Financial Secretary. Revised 1986 figures.

(2) Customs Department, excludes duty on diesel fuels.

(3) Estimated allocation of PWD operations costs.

(4) Estimated cost of Police Traffic and Motor Vehicle functions.

(5) Estimate by Chief Engineer, PWD.

loan for 20 years of this total would require annual payments of CI $7.6 million. Even if only the essential Phase 1 (CI $13.48 million) and Phase 2 (CI $21.79 million) projects were funded, the annual payment on the total (CI $35.28 million) at 12 percent for 20 years would be CI $4.72 million. Obviously, the recommended transportation investments could not be financed from present transportation revenues, even if all of the excess of revenues over expenses were dedicated to that purpose. However, at least a start could be made towards such dedication. For example, it would appear that there would be a good opportunity here to earmark all (or part) of additional road revenues raised as attained herein. However, such a proposal can be expected to meet opposition because first, it represents a change from past practices and second, the transport revenues which are presently used elsewhere would probably have to be replaced if they were diverted to transport use.

LIKELY FUNDING SOURCES

Although there is a range of possibilities for sources of funds for the transportation projects recommended in this report, including local banks as well as the Caribbean Development Bank (CDB), selection between sources is not a matter for discussion in this report. However, a number of techniques are discussed later in this section by which a possible difference between loan proceeds and project cost could be met.

Recommendations for 1988-1992 Investments

a. That the Government obtain the best loan terms available to include as short a repayment period as expected annual fund availability will permit.

b. That the measures described herein as potential sources of local funds be considered for adoption to make up possible deficits between the value of the loan and the funds required.

c. That if there is a shortfall in funding, the CI $13.48 million required for the eight Phase 1 projects be funded first. All of the immediate Action Projects except Miscellaneous Roads would have been completed in 1988, while Phase 1 construction would not start until 1990.

Recommendations for 1993-1997 Investments

a. That the possibilities for funding these investments be determined during negotiations on the 1988-1992 program.

b. That the overall road situation including traffic be reevaluated in 1992.

c. That funding action then be taken as justified by the reevaluation.

METHODS FOR LOCAL FINANCING OF ROAD PROJECTS

The following discussion covers a number of ways in which the construction of roads has been successfully supported locally. While some of these techniques are not suitable for use in the Caymans at present, they may become more applicable over time.

Charges on Benefiting Properties - As the title implies, these techniques attempt to recapture at least part of the increase in real property values which results from road improvements, and to then use it in support of the road system. There are five approaches currently used under this category; connector fees, negotiated investments, special benefit assessments, tax increment financing and impact requirements.[4]

Connector Fees - This technique levies a charge on the owner or developer of an adjacent property for the privilege of connecting to the road being built. Forms which such charges may take include a lump sum payment, an annual contribution to operating (maintenance) costs or a property contribution Drawbacks include the fact that enabling legislation is often a prerequisite to the use of this technique, and developers usually object to having to pay to get access to a public transportation facility.

While the Government does not presently have a connector fee per se, it does require that the developer at a site with six lots or less must set aside a road reserve 30 feet wide, although he need not build a road upon it. A developer at a site with more than six lots must not only set aside the 30 foot strip of lane for a road, but he must also build the access road.

Negotiated Investment - In this technique, a developer agrees with a public body either to make a needed public improvement or to contribute a fixed sum towards an improvement which could benefit his development. He usually does this in return for some concession. Disadvantages of the technique include legal issues which are sometimes raised which question the extent to which a governmental body can attach conditions to zoning and land use, plus transportation agencies usually have little control over zoning and land use regulations.

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4 USDOT, *Innovative Financing for Transportation; Practical Solutions and Experiences*, April 1986.

Special Benefit Assessment - This technique assesses all property owners within a specifically designated area (an assessment district) for some or all of the costs associated with a public improvement. The assessment can either be a lump sum or collected over a period of years. There is some difficulty with this technique in equating the amount of the assessment with the level of benefit derived. As a result, indicators such as acres, square feet and distance from the improvement are often used. This technique is politically more acceptable than some of the others, because only those directly benefitting from an improvement are assessed to pay for it. Property owners have frequently challenged both the establishment of the assessment district and the assessment formula used.

Tax Increment Financing - This technique assumes that development results in areas around transportation improvements, thereby increasing tax revenues, with projections of these increases then used to back bonds to finance construction of the improvement. In order to use this technique, a tax increment financing district is first established, including the area which will benefit from the improvement. Next, a base year of assessed property values is established. Third, the increase in property taxes resulting from the improvement is dedicated to it, with the remainder distributed to the other tax jurisdictions involved. This technique is not currently applicable in the Caymans, since the only real property taxes in force at present are a 7.5 percent transfer tax on property sales, levied at point of sale.

Impact Requirements - This technique imposes charges or other conditions upon developers to mitigate or compensate for the impact of their projects. These requirements are established by local ordinances and are usually administered through the building permit process. Impact requirements can take a number of forms, e.g., a fee based on the square footage in a new development. While developers have claimed that these requirements slow growth, citizen groups have insisted that the fees charged are not high enough.

Joint Ventures with the Private Sector - Several alternatives for cost-sharing with the private sector are available.

Air/Land Rights Leasing - This technique, which does not appear to have much application in the Cayman Islands involves the leasing of air, surface and subsurface rights to government owned land which is used for another purpose, such as transportation. Examples of problems with the use of this technique include court cases questioning whether government agencies have used the process of eminent domain to obtain air and subsurface rights in excess of those required and criticism by citizen's groups of rates obtained on the leases involved.

Donations - Donations of money or real property from the private sector are another means of obtaining capital for transportation projects. However, the accepting agency must be authorised to accept the donation. In order to encourage participation, the accepting agency must also be aware of any tax breaks which can be realised by prospective donors.

Cost Sharing - This technique involves the sharing of operating expenses or capital costs by a developer for a transportation facility which is either connected with or integrated into his project. In order to make this approach most effective, the developer must be included in the facility planning, at an early date.

User Charges - As the name implies, these techniques involve fees or charges upon the use of motor vehicles. They include motor vehicle taxes and fees, tolls, commercial parking fees and taxes on motor fuels. Although these techniques are already widely known and used, a coverage of their advantages and disadvantages should be helpful.

Motor Vehicle Taxes and Fees - Examples include driver's license fees, vehicle excise taxes, registration fees, heavy vehicle taxes, tyre taxes, weight-distance taxes, personal property taxes on motor vehicles, and safety sticker fees. These levies are popular since they are productive and easily levied. Disadvantages of these techniques are:

a. Some of them are insensitive to vehicle use, e.g., vehicle licenses, titles and registration fees, vehicle excise taxes, personal property taxes on vehicles, and safety sticker fees. Sensitive techniques include heavy vehicle taxes, weight-distance taxes, and tyre, parts and repair excise taxes.

b. The administrative costs of collecting most motor vehicle taxes are high, despite the fact that mechanisms to collect most of them are in place.

c. Some of the taxes are difficult to impose, e.g., the levying of personal property taxes on the vehicle of an individual who claims to live outside of the area taxed.

Toll Roads - With the increasing demands being placed upon governments from all quarters, funding of road construction and maintenance has become increasingly difficult. This has led to a search for alternative ways to raise road revenues and therefore increased opportunities for the use of toll roads. Advantages of toll roads are first, that they are the most precise form of pay-as-you-go financing. Second, they can be implemented quicker than tax-supported road projects because complete funding can be available at the beginning of the project. Since traffic has been projected and tolls are pledged to finance the loan, the loan process is simplified. Third, since a project may be implemented quicker, capital costs are less during periods of inflation. Fourth, as part of the agreement with the bondholders, adequate funds for inspection are ensured for the maintenance and operation of a toll project. Fifth, where toll projects are funded with revenue bonds, proposals for facilities and operations are subject to the close scrutiny of inspectors prior to financing, during construction and after opening. Sixth, toll facility operations have in most cases provided extra services and safety measures or assets in attracting customers. Seventh, the continuous inspections required to meet toll facility funding requirements contribute to a high level of toll road operation and maintenance. Finally, a toll road may be used as a method of congestion policy, encouraging users to make more efficient route or mode choices.

Disadvantages include first, the high interest cost of borrowing funds. With revenue bond financing, this generally occurs prior to the design/construct period. Innovators are now using short-term, low interest bonds initially and converting them to long-term revenue bonds as funds for right-of-way and construction are needed. Second, there is a decided cost for toll collection. Third, motorists lose time when they stop to pay their tolls. Fourth, air quality and fuel consumption suffer at toll stops. Fifth, motorists who pay tolls also pay other user fees. Sixth, access is usually more restricted to toll facilities. Seventh, unless a toll road is fitted carefully into the overall road plan, it can lose money, e.g., a new, tax-supported road which competes with a toll road can draw off traffic. Finally, the cost of providing toll collection facilities is extraneous in that it does not provide services to the user. On some recent U.S. toll roads, these costs have run as high as 2-3 percent of the total cost of right-of-way and construction.[5]

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[5] N.H. Wuestefeld, Wilbur Smith Associates, *"Toll Roads"*, paper presented to AASHTO Conference on Understanding the Highway Financing Evaluation/Revolution, August 1986.

Marketing and Merchandising Approaches - These techniques involve the sale of advertising space and concessions at transportation facilities, and there does not appear to be much opportunity for their use in the Caymans.

Commercial Parking Taxes - This technique levies a tax on the receipts of commercial parking lots. Some critics have claimed that such taxes discourage downtown shopping and job seeking, and are therefore counterproductive, overall. Others have pointed out that all long-term parkers in the downtown area should be taxed, not just commercial parking customers.

Motor Fuel Taxes - These taxes vary with fuel usage and are therefore somewhat sensitive to levels of benefits received. They are easily administered, and tend to rise with inflation. However, this type of tax is at a disadvantage during periods when fuel prices drop, because they are tied to these prices.

SUMMARY

The above discussion has reviewed a dozen techniques by which monies for roads can be raised locally from road-related sources, examining the pros and cons of each. Some of these approaches are more appropriate for use here in the Caymans than others. However, certain of the latter can be expected to become more applicable, as time passes.

Recommendation: That the above techniques be reviewed and proposed for selective implementation by the Government, as practicable.

Recommendation: That consideration be given to earmarking part (or all) of the additional funds so raised, for transportation purposes

SECTION FIVE

INVESTMENT PLAN

There are two types of road improvement projects which will be required during the period 1988-1992. First, there are those essential projects on the existing road network which because of their location, criticality, etc., should be started immediately, i.e. in 1988. These projects will also have a positive impact upon Phase 1 projects as they are inplemented. The cost of these projects is estimated at CI $5.30 million. Second, there are the Phase 1 road projects. Phase 1 is the principal overall project planned for the period, with an estimated cost of CI $13.48 million.

GENERAL

All of the above projects are listed on Table 5-12, which shows proposed project expenditures by year. It shows projects by type, breaks down estimated construction costs between land and construction components, and indicates the proposed year of design and the construction period, with the design year indicated by an asterisk.

Phasing - Final design on all Immediate Action projects except "Miscellaneous Roads," an annual item, is expected to be completed in March 1988, with construction scheduled then to be started and finished in 1988. The final design for Phase 1 would require a year to complete, starting in January 1989, and the project would be three years in construction (1990-91-92). The remaining project, Miscellaneous Roads, would be designed and built in increments estimated at averaging $750,000 per year, starting in 1988 and ending in 1992.

Selected long term road construction projects likely to be needed by 1997 have also been identified. These Phase 2 projects, though not included in this investment plan, are an integral part of the 10-year devlopment plan for the MGTP Study.

Foreign Currency - The local and foreign currency components of each of the 1988-92 and 1993-97 projects are shown by Tables 5-13 and 5-14. In 1988-92 projects, foreign costs were about 50 percent of total financial cost of CI $18.78 million. For 1992-97 projects, such costs were 46 percent of the total of CI $38.24 million.

TABLE 5-12

PHASING OF ROAD IMPROVEMENT PROJECTS
1988 - 1992

Project Description	Type[1] Project	ESTIMATED COSTS Land	Project	Total	EXPENDITURES, BY YEAR[2] 1988	1989	1990	1991	1992
	(CI$000)								
1. Immediate Action Projects									
a. Owen Roberts - Dorcy Dr	I	4	10	14	* 14				
b. Eastern Ave - West Bay Rd	I	42	28	70	* 70				
c. Mary Street - Harbour Dr	I	104	8	112	*112				
d. Eastern Ave - Shedden Rd - Crewe Rd	I	268	110	378	*378				
e. School Access Rd	S	-	500	500	*500				
f. Walkers Road - Boilers Rd	I	261	134	395		*395			
g. South Church St - Boilers Rd	I	25	56	81		* 81			
h. Miscellaneous Roads	S	-	3750	3750	*750	*750	*750	*750	*750
TOTAL		704	4596	5300					
2. Phase 1 Projects									
a. North-South Arterial	P	1484	5552	7036		*264	1495	3518	1759
b. Roundabouts - N-S Arterial	I	282	750	1032		* 36	222	516	258
c. Fort Street Extension	P	1198	1170	2368		* 56	536	1184	592
d. Palm Heights Access Rd	P	36	328	364		* 16	348		
e. Hyatt Hotel Access Rd	P	32	293	325		* 14	311		
f. Holiday Inn Connector	P	269	593	862			* 28	834	
g. Royal Palms Connector	P	682	503	1185			* 24	636	525
h. Crewe Rd - N. Sound Way	I	80	232	312	—	—	—	* 11	301
TOTAL		4063	9421	13,484					
TOTAL		4767	14,017	18,784	1824	1612	3714	7449	4185

(1) Legend
I - Intersection
P - Primary Road
S - Secondary Road

(2) Includes design and construction cost. Design year indicated by asterisk.

TABLE 5-13

FOREIGN AND LOCAL COMPONENTS OF FINANCIAL COSTS 1988-1992

PROJECT DESCRIPTION	PROJECT TYPE(1)	ESTIMATED COSTS (CI $000) CONSTRUCTION Foreign	CONSTRUCTION Local	LAND Local	Total
1. IMMEDIATE ACTION PROJECTS					
a. Owen Roberts Drive/Dorcy Drive	I	7	3	4	14
b. Eastern Avenue/West Bay Road	I	19	9	42	70
c. Mary Street/Harbour Drive	I	5	3	104	112
d. Eastern Ave/Shedden Rd/Crewe Rd	I	74	36	268	378
e. School Access Road	S	336	164	-	500
f. Walkers Road/Boilers Road	I	90	44	261	395
g. South Church St/Boilers Road	I	38	18	25	81
h. Miscellaneous Roads	S	2517	1233	-	3750
SUBTOTAL		3086	1510	704	5300
2. PHASE 1 PROJECTS					
a. North-South Arterial	P	3727	1825	1484	7036
b. Roundabouts - N-S Arterial	I	503	247	282	1032
c. Fort Street Extension	P	785	385	1198	2368
d. Holiday Inn Connector	P	398	195	269	862
e. Palm Heights Access Road	P	220	108	36	364
f. Royal Palms Connector	P	338	165	682	1185
g. Hyatt Hotel Access Road	P	197	96	32	325
h. Crewe Road/North Sound Way	I	156	76	80	312
SUBTOTAL		6324	3097	4063	13484
TOTAL		9410	4607	4767	18784

(1) Legend

I - Intersection.
P - Primary.
S - Secondary Road.

TABLE 5-14

FOREIGN AND LOCAL COMPONENTS OF FINANCIAL COSTS 1993-1997

PROJECT DESCRIPTION	PROJECT TYPE[1]	ESTIMATED COSTS (CI$000) CONSTRUCTION Foreign	CONSTRUCTION Local	LAND Local	Total
1. PHASE 2 PROJECTS					
a. North-South Arterial to Batabano	P	4323	2128	4287	10738
b. Dual Carriageway Arterial	P	1243	609	-	1852
c. East-West Arterial	P	1860	911	338	3109
d. Outer Bypass to Walkers Road	P	1385	679	4034	6098
SUBTOTAL		8811	4327	8659	21797
2. OTHER PROJECTS					
a. North-South Local Extension	S	1102	540	2797	4439
b. New North Sound Road	S	602	295	1196	2093
c. Jennett Street Extension	S	115	57	500	672
d. Inner Bypass Extension	P	533	261	1426	2220
e. Airport Drive	S	707	347	1163	2217
f. Jennett Street/Edward Street	I	5	3	108	116
g. Hospital Road/Smith Road	I	42	8	-	50
h. Access Roads	S	294	144	447	885
i. Other Roads at 750/yr.	S	2517	1233	-	3750
SUBTOTAL		5917	2888	7637	16442
TOTAL		14728	7215	16296	38239

(1) Legend

I - Intersection.
P - Primary.
S - Secondary Road.

IMMEDIATE ACTION PROJECTS

As indicated earlier, the first five projects should be designed and built in 1988, the remainder as indicated.

Owen Roberts/Dorcy Drive - This airport area intersection would cost only CI $14,000 and would improve what is essentially a ninety degree curve on a heavily travelled primary road in the vicinity of the airport.

Eastern Ave/West Bay Road - This intersection just north of George Town handles a heavy volume of traffic from and to West Bay Road, at the point where West Bay merges into North Church Street. The project is an inexpensive (CI $70,000) solution to reduce congestion at this George Town intersection in anticipation of future diversion of traffic to the North-South Arterial.

Mary Street/Harbour Drive - This CI $112,000 project would improve safety and capacity at an important intersection in central George Town.

Eastern Ave/Shedden Rd - Crewe Rd - This CI $378,000 project would provide additional capacity at a congested intersection just east of the downtown area.

School Access Road - This proposed CI $500,000 project would immediately improve access to the schools area located east of Walkers Road and south of central George Town. Presently school-bound vehicles load and unload students on busy Walkers Road, causing severe traffic congestion and safety problems.

Walkers Road/Boilers Road - Boilers Road connects South Church Street with Walkers Road just south of George Town. The improvement will provide additional sight distance for traffic on both streets. This CI $395,000 improvement will reduce the increasing congestion at this intersection.

South Church St/Boilers Road - Improvements to this intersection on the southern edge of the CBD are estimated to cost CI $81,000. The improvement is required to relieve growing congestion at the intersection.

Miscellaneous Roads - The final project proposed for the 1988 -1992 timeframe is a series of miscellaneous roads which will be needed during the period. At CI $750,000 per year, the projects would allow the gradual upgrading of other segments of the existing road network.

PHASE 1 PROJECTS

The eight projects included in Phase 1, are all associated with the new North-South Arterial Road. Specific projects are described in the following paragraphs.

North-South Arterial - This new two-lane primary road would parallel the present West Bay Road from a point near the Holiday Inn to Crewe Road. It would cost CI $7.04 million, and would relieve present congestion on West Bay Road and serve future development in the travel corridor.

Roundabouts, North-South Arterial - There are three roundabouts which would be required on the new North-South road, one at the Holiday Inn Connector, another at the Royal Palms Connector, and the third at the Fort Street Extension. These intersection designs would help traffic flow at points where heavy traffic would be entering and leaving the new north-south road.

Fort Street Extension - This CI $2.37 million improvement would connect the new north-south road to Eastern Avenue and to the Fort Street/Mary Street intersection. This would provide an entry directly into the heart of George Town from the new arterial.

Holiday Inn Connector - This road would connect West Bay Road with the new North-South Arterial in the vicinity of the Holiday Inn. This connector would be expected to serve as a conduit for the flow of major volumes of traffic from the area north of the connector to the new road.

Palm Heights Access Road - This project, an extension of the Holiday Inn Connector, would provide access from the Palm Heights subdivision (north of the Hyatt Hotel) to the new North-South Arterial. It is estimated to cost CI $364,000.

Royal Palms Connector - This improvement would connect the North-South Arterial with West Bay Road in the vicinity of the Royal Palms Hotel. It would serve as a central traffic collector for the new road from the area north and south of the Royal Palms. It is estimated to cost CI $1.19 million.

Hyatt Hotel Access Road - This extension of the Royal Palms Connector would provide access from the Hyatt Hotel and Britannia development to the new north-south road. It is expected to cost CI $325,000.

Crewe Road/North Sound Way - Reconstruction of this intersection at the southern end of the North-South Arterial would ease congestion for traffic coming off the new road. It is estimated to cost CI $312,000.

SUMMARY

A road construction program totaling CI $18.78 million has been proposed for the 1988-1992 timeframe, along with recommended phasing of investments. Of this, CI $13.48 million is allocated for the principal investment, the Phase 1 projects. Since the proposed Phase 2 program (1992-1997) builds upon Phase 1, it is imperative that at least the bulk of the 1988-1992 program be successfully implemented.

CHAPTER SIX

ROAD NETWORK RECOMMENDATIONS

CHAPTER SIX

ROAD NETWORK RECOMMENDATIONS

For each area wide or local deficiency identified, one or more potential solutions was formulated. These alternatives have been evaluated based upon their geometry, construction cost, vehicle capacity ratio and Benefit/Cost parameters. The result of the analysis was such that all practical solutions considered necessary for the first five-year construction program proved to be cost beneficial.

Preliminary design drawings have been prepared for each recommended project in the first 5-year program. These drawings, prefixed "P", are reproduced in this chapter as figures with the same "P" number. Long-range proposals have been drawn as Land Acquisition plans and are referred to as "LA" figures. These LA figures have been reproduced as blue prints and are bound separately as an addendum to this report. Coordinates and azimuths locating each alignment plan are set out in Appendix D.

1992 RECOMMENDATIONS

The following recommendations are based upon the need to achieve a level-of-service C to the greatest extent possible. Each improvement is designed to stand on its own as a needed project, but each is also an integral part of the 1997 road network.

West Bay Road Corridor - Potential solutions considered for this corridor included upgrading of the existing West Bay Road within its present right-of-way, widening of the right-of-way to allow for the construction of dual carriageways, and a number of new routes across the partially developed land to the east of West Bay Road. Analysis of the advantages and disadvantages of each has resulted in a recommendation that the North-South Expressway is the only alternative that provides the necessary capacity for future traffic. The new expressway should be constructed as a two lane road between the Holiday Inn Connector Road and a new intersection with North Sound Road, with at-grade connections to West Bay Road at two intermediate points. The ultimate design should be for four lanes with a median, including full control of access and grade-separated intersections, except at the two terminal points where roundabouts are appropriate, see Figures P.3 - P.7.

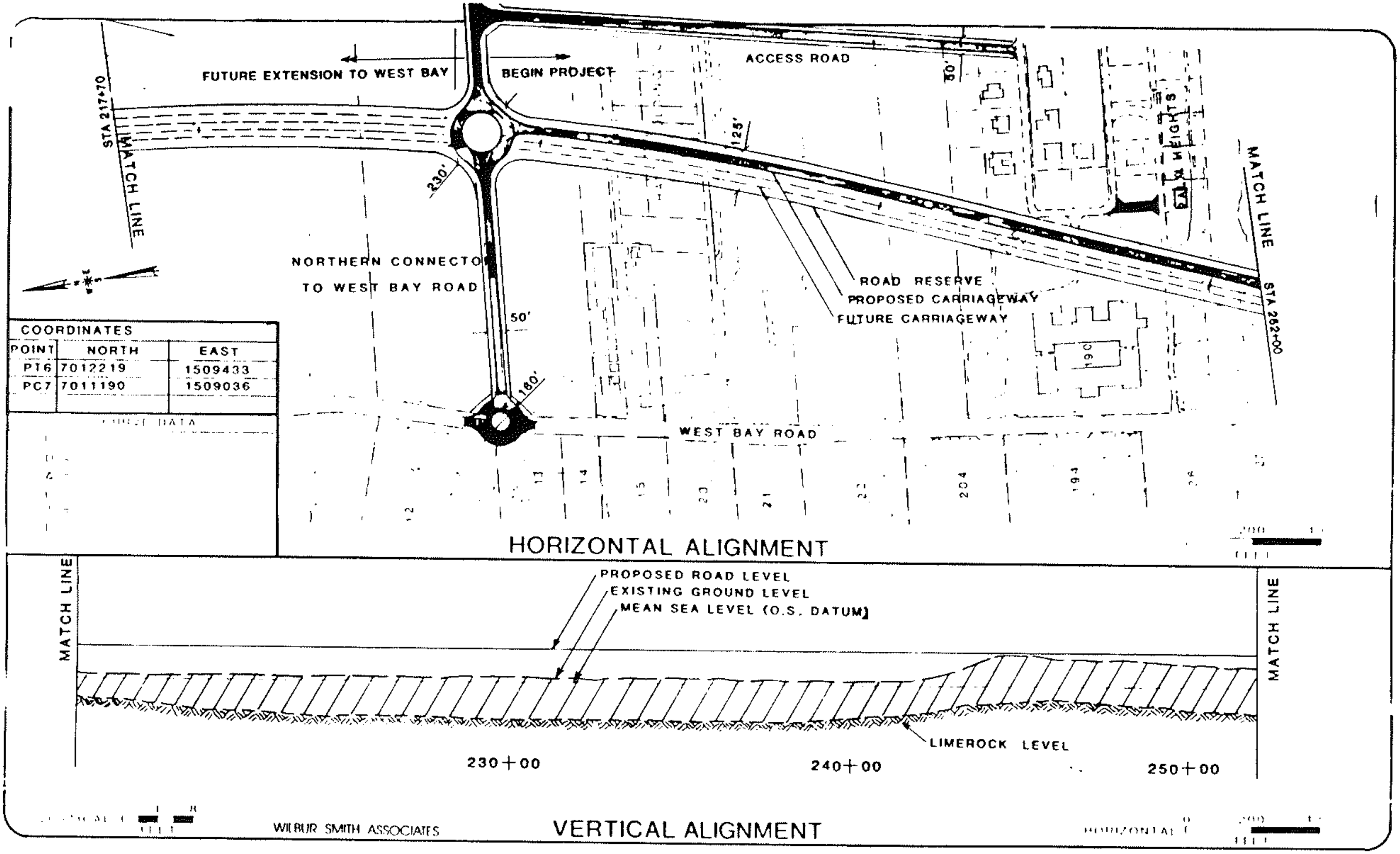
Two-lane connector roads to the new arterial should be constructed from new roundabouts on West Bay Road at two locations. One would be at a point just south of the Holiday Inn, and would extend east of the expressway to a junction with a new service road. The service road would run south with the expressway to intersect access roads in the area north of the canal, Figure P.3.

A second two lane connector road should begin at a new roundabout on West Bay Road just north of the Royal Palms Hotel. It would extend east and intersect the Expressway at a roundabout. Further east it intersects a service road running north to the Hyatt Hotel property, Figures P.4 and P.8.

Existing West Bay Road - Because of the rapid development expected to continue along this road, it is recommended that the right-of-way be increased to 64 feet of width. This should be accomplished quickly in order to preserve land for possible future widening of the road to four lanes. It is also recommended that existing road segments opposite shopping plazas and other major traffic generators be widened to accommodate protected right-turn storage lanes. This would provide additional capacity to the existing road at relatively low cost, and could be budgeted in the PWD annual work program.

George Town Area - There are a limited number of possibilities for improving the traffic flow into George Town. The solution which proved most beneficial was that of linking the North-South Expressway to Fort Street. This Fort Street connector would commence at a roundabout on the North-South Arterial before crossing the presently undeveloped land to the north and west of the Washington Road Development. A roundabout would be constructed at Eastern Avenue and the new connector road would continue across the "Rock Hole" area before linking to Fort Street. Initial construction would be two lanes for the entire length. However, sufficient right-of-way would be obtained to accommodate a four lane road between Eastern Avenue and the North-South Arterial, Figures P.9 and 10.

An improvement was also recommended for the intersection of Crewe Road with North Sound Way. The present condition allows free flowing traffic along Crewe Road by requiring all North Sound Way vehicles to stop. With increasing traffic expected on the latter road as it becomes a link in the Outer Bypass, it is necessary to build a small roundabout to equally serve all traffic approaches. It is also recommended that sufficient right-of-way be acquired initially to accommodate future widening of both roadways, Figure P-11.



COORDINATES

POINT	NORTH	EAST
PT6	7012219	1509433
PC7	7011190	1509036

M G T P STUDY
GRAND CAYMAN BWI

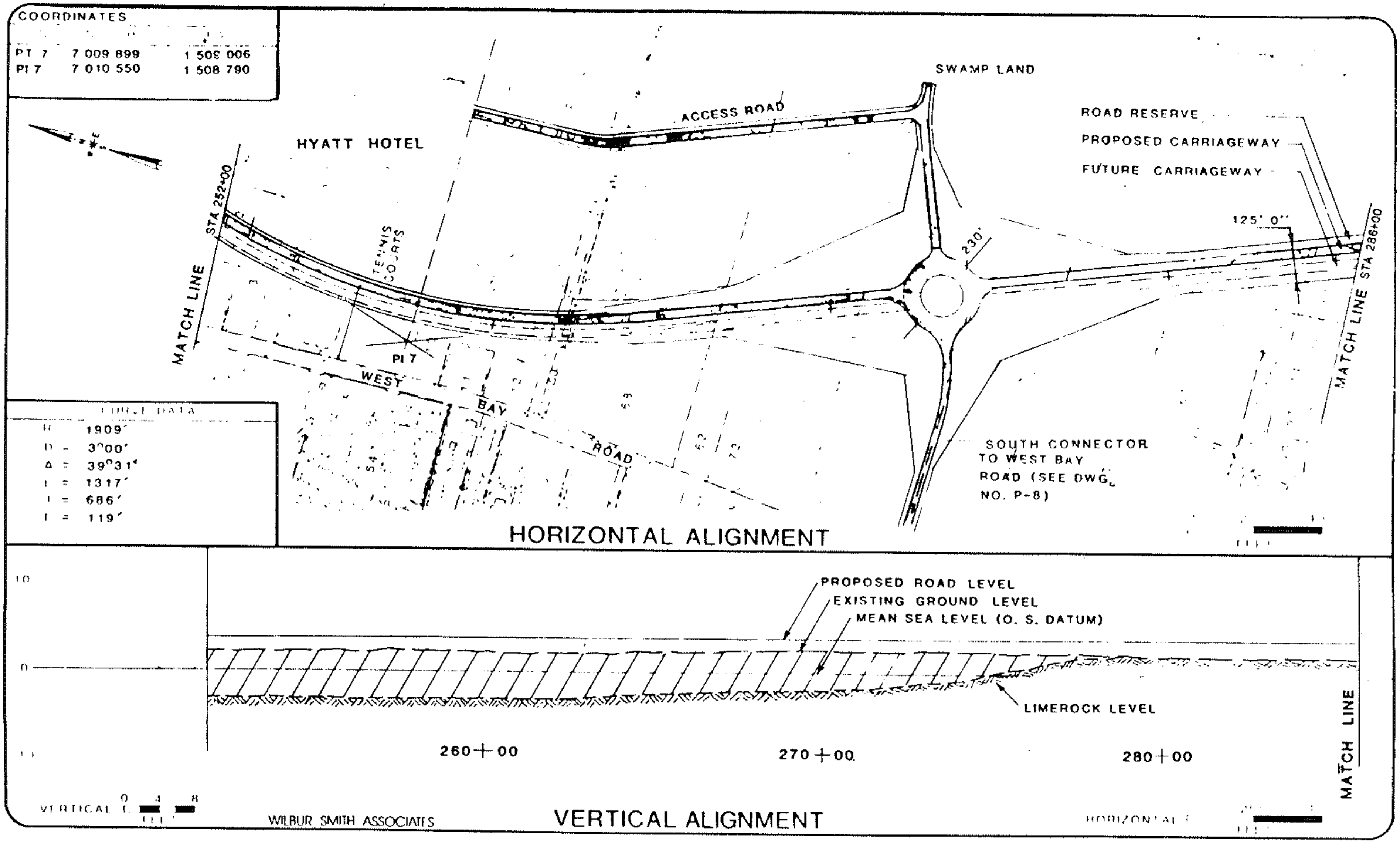
FIGURE P-3

PROPOSED NORTH SOUTH ARTERIAL
STA 217+70 TO STA 252+00

LEGEND

1. ALL LEVELS SHOWN ARE APPROXIMATE

- CONSTRUCTION PRE 1992
- PEAT
- LIMEROCK



M G T P STUDY
GRAND CAYMAN BWI

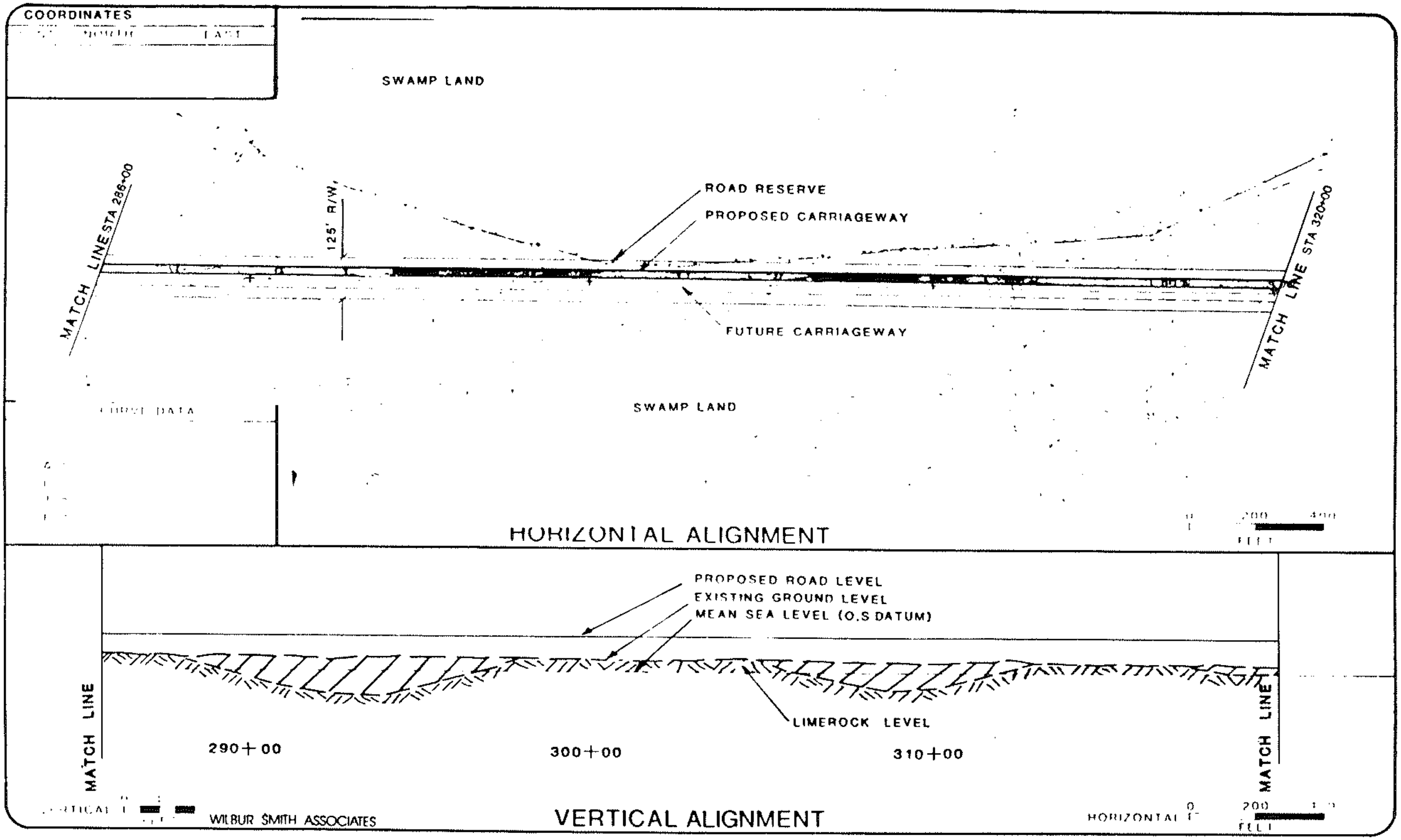
FIGURE P-4

PROPOSED NORTH SOUTH ARTERIAL
STA 252+00 TO STA 286+00

LEGEND
1. ALL LEVELS SHOWN ARE APPROXIMATE

CONSTRUCTION PRE 1992
PEAT
LIMEROCK

Wilbur Smith and Associates



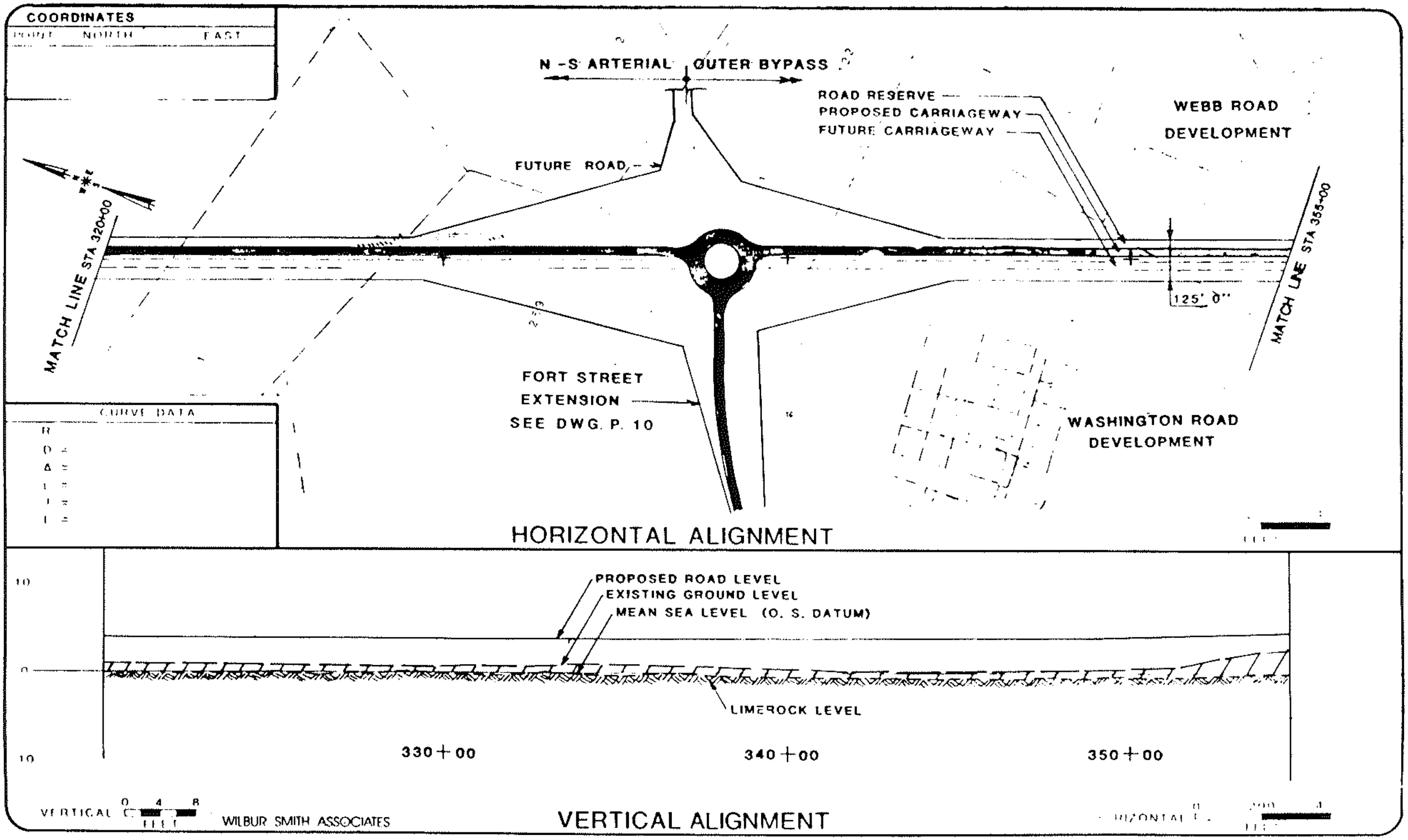
M G T P STUDY
GRAND CAYMAN BWI

FIGURE P-5

PROPOSED NORTH SOUTH ARTERIAL

STA 286+00 TO STA 320+00

LEGEND
ALL LEVELS SHOWN ARE APPROXIMATE
CONSTRUCTION PRE 1992
PEAT
LIMESTONE



M G T P STUDY
GRAND CAYMAN BWI

FIGURE P-6

PROPOSED NORTH SOUTH ARTERIAL

STA 320+00 TO STA 355+00

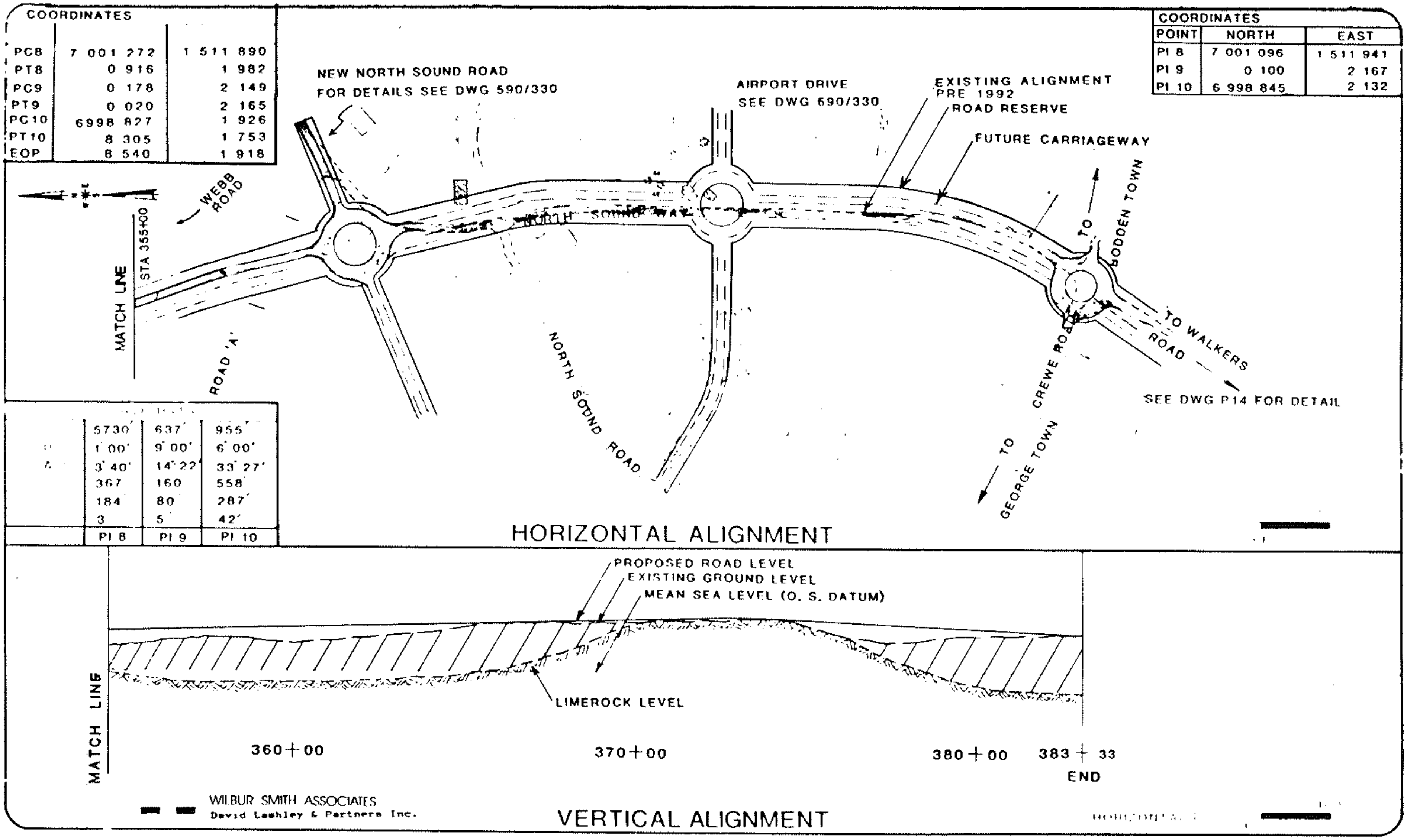
LEGEND

1. ALL LEVELS SHOWN ARE APPROXIMATE

CONSTRUCTION PRE 1992

PEAT

LIMEROCK



COORDINATES

PC8	7 001 272	1 511 890
PT8	0 916	1 982
PC9	0 178	2 149
PT9	0 020	2 165
PC10	6998 827	1 926
PT10	8 305	1 753
EOP	8 540	1 918

	5730'	637'	955'
	1°00'	9°00'	6°00'
	3°40'	14°22'	33°27'
	367	160	558
	184	80	287
	3	5	42
	PI 8	PI 9	PI 10

COORDINATES

POINT	NORTH	EAST
PI 8	7 001 096	1 511 941
PI 9	0 100	2 167
PI 10	6 998 845	2 132

M G T P STUDY
GRAND CAYMAN BWI

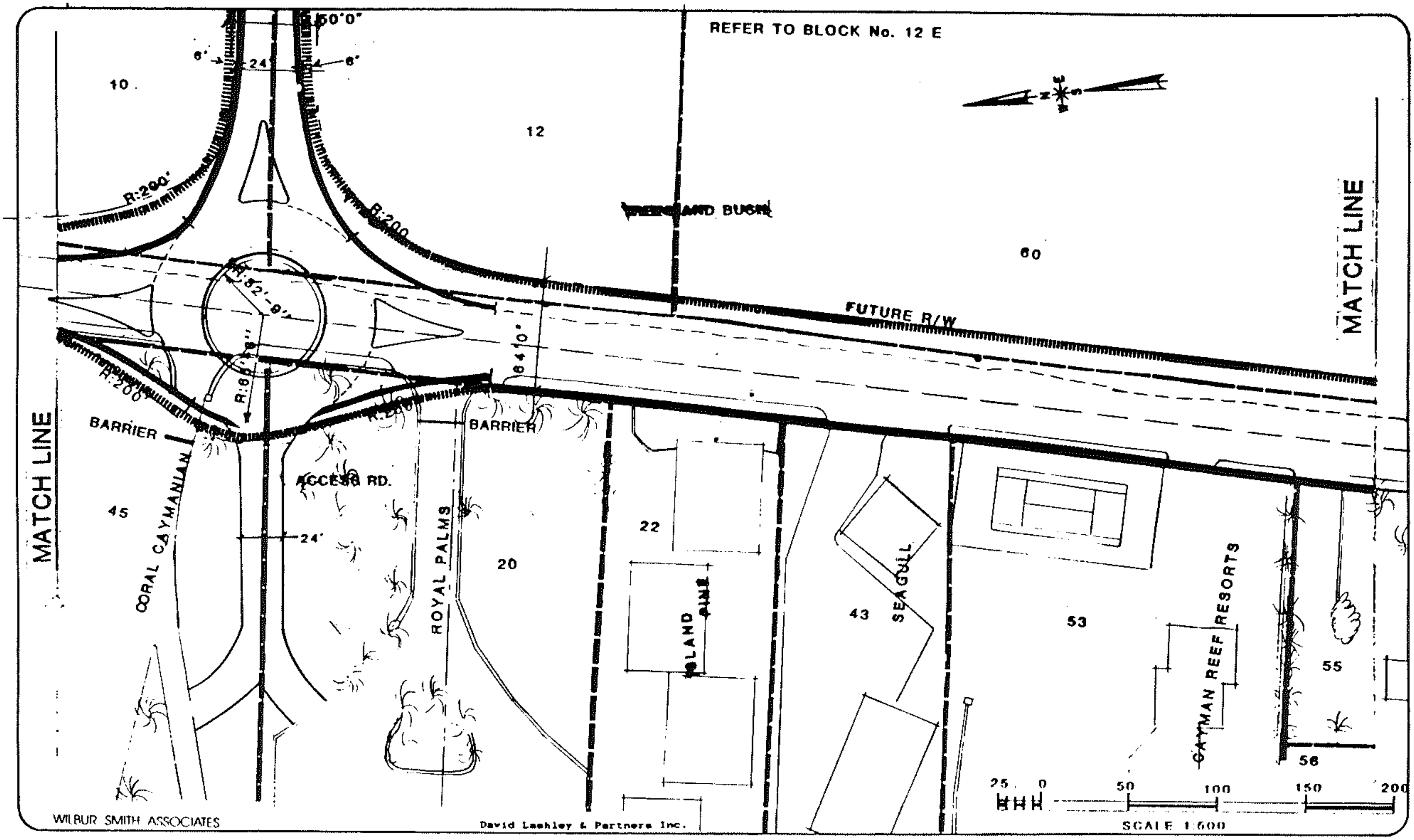
FIGURE P-7

PROPOSED NORTH SOUTH ARTERIAL
STA 355+00 TO STA 383+33

LEGEND

1. ALL LEVELS SHOWN ARE APPROXIMATE

CONSTRUCTION PRE 1992
PEAT
LIMEROCK



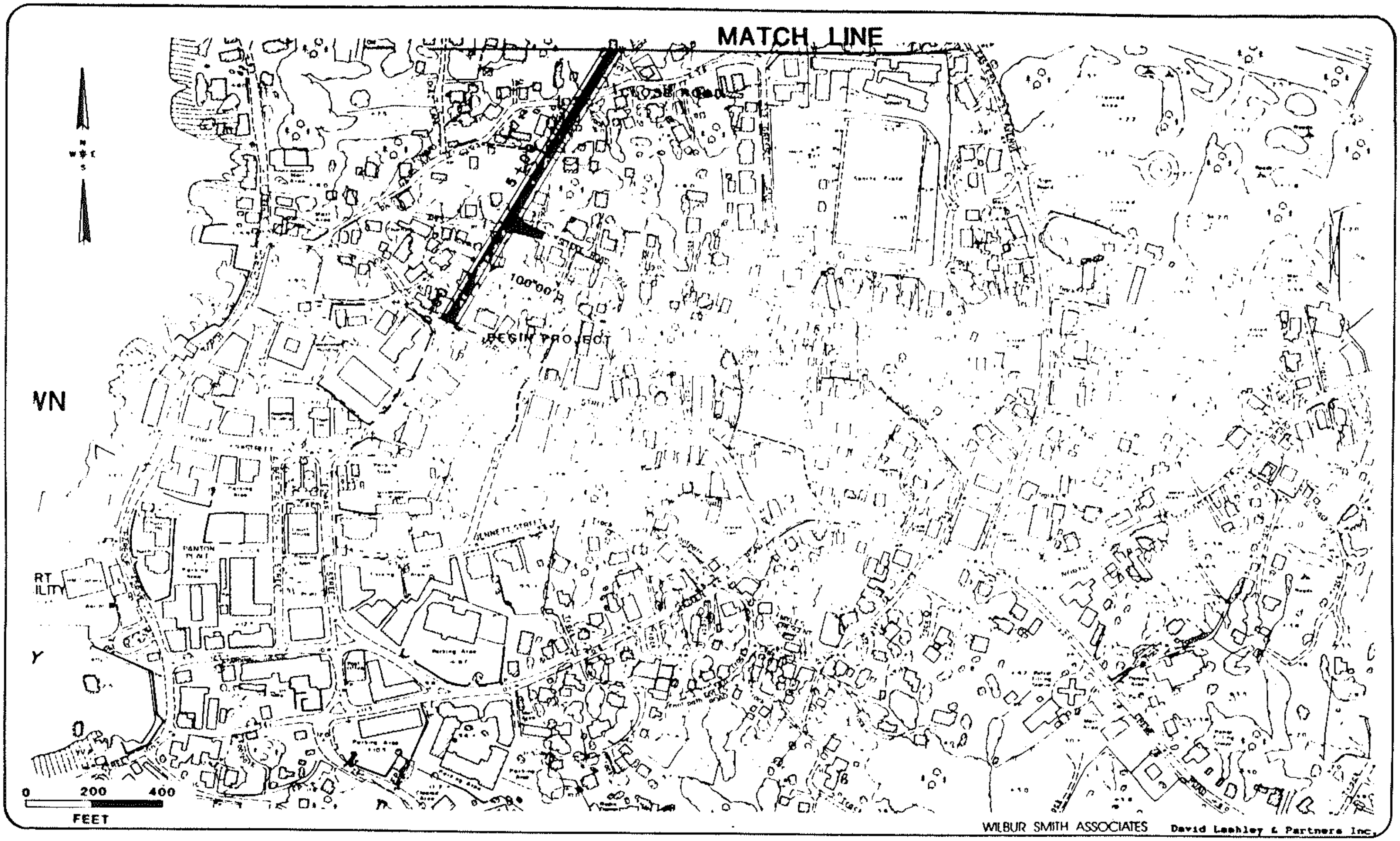
MGTP STUDY
GRAND CAYMAN BWI

FIGURE P-8

WEST BAY ROAD CONNECTION TO HYATT INTERCHANGE

LEGEND

- CHAIN LINK FENCE
- COCONUT TREE
- HEDGE
- SHRUB/BUSH
- LOW CONC. WALL
- EXISTING ROAD
- PROPOSED ROAD
- ELEC. POLE
- LAMP POLE
- TEL. POLE



MGTP STUDY
GRAND CAYMAN BWI

FIGURE P-9

FORT STREET EXTENSION

SHEET 1 OF 2

LEGEND

NEW ROAD CONSTRUCTION

NEW RIGHT OF WAY

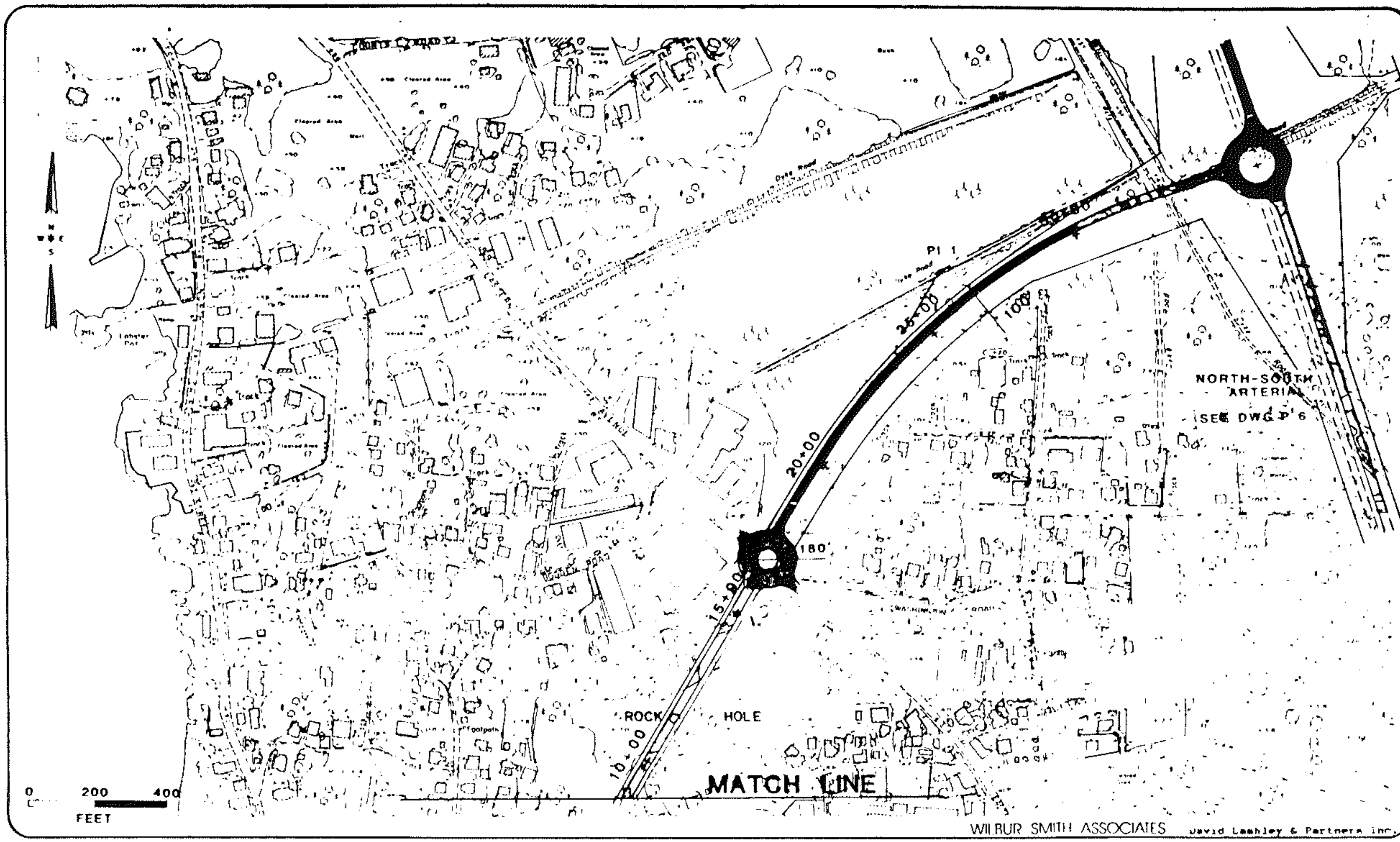


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FIGURE P-10

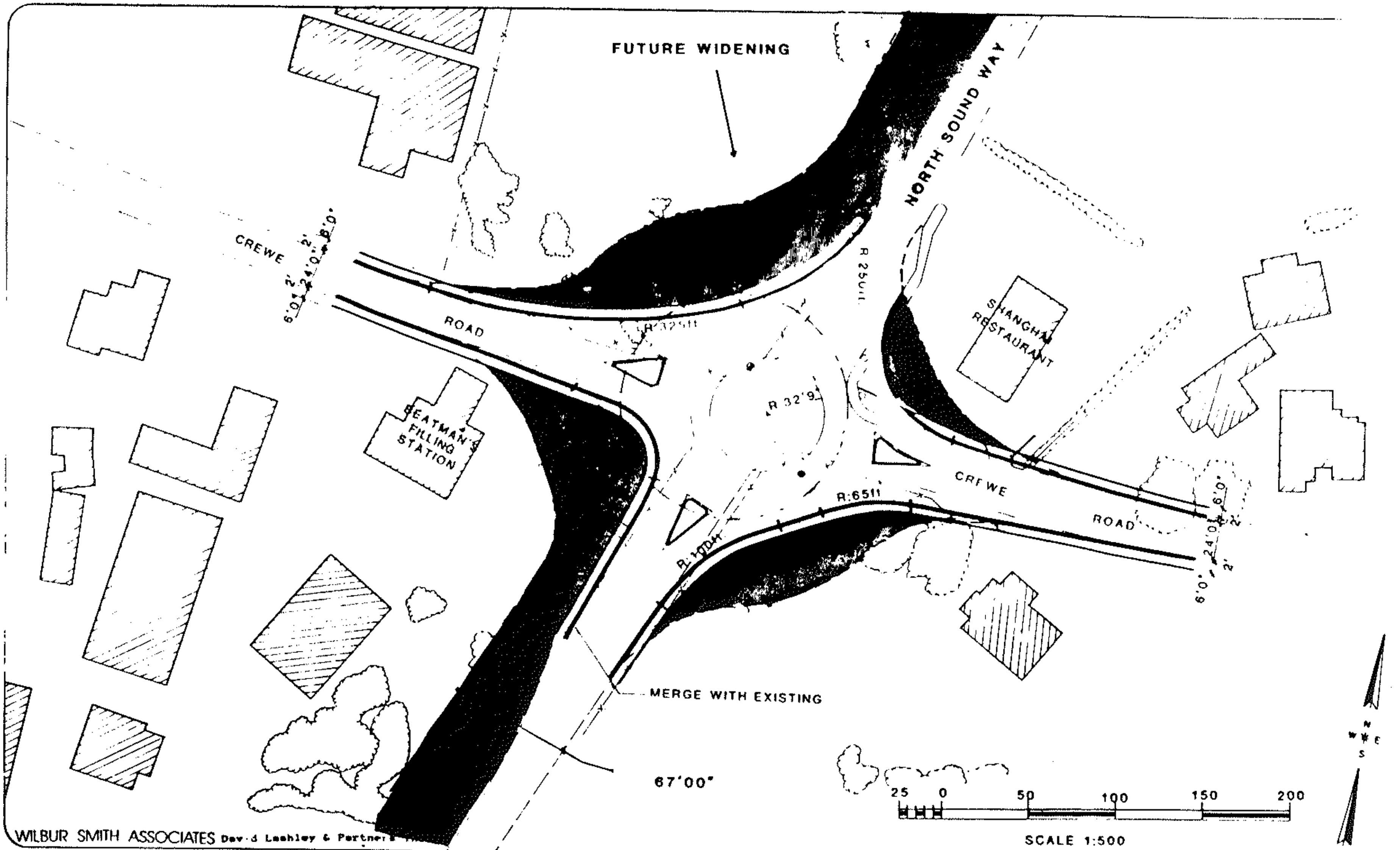
FORT STREET EXTENSION

SHEET 2 OF 2

LEGEND

CONSTRUCTION PRE 1992

NEW RIGHT OF WAY



MGTP STUDY
GRAND CAYMAN BWI

FIGURE P-11

CREWE ROAD / NORTH SOUND WAY

LEGEND

CHAIN LINK FENCE	ELEC. POLE
COCONUT TREE	LAMP POLE
HEDGE	TEL. POLE
SHRUB/BUSH	
LOW CONC. WALL	
EXISTING ROAD	
PROPOSED ROAD	

Immediate Action Improvements - The proposed 1992 road network will depend to a considerable extent on the ability of existing intersections to carry future traffic loads. A number of these junctions have been identified as needing modification in order to improve capacity.

* <u>Owen Roberts Drive/Dorcy Drive</u>: Currently traffic on the two legs of Owen Roberts Drive is favoured with a continuous flow through the intersections Traffic volumes, however, are almost equally distributed among the three legs of the intersection. The junction should be reconstructed to provide right turn lanes on both legs of Owen Roberts Drive, and Dorcy Drive should include a large left turn radius, Figure P.12.

* <u>Eastern Avenue/West Bay Road</u>: Traffic flow through this intersection is greater than at any other location in Grand Cayman. Short term improvements should include widening for a left turn lane from West Bay Road, widening to allow full width turn lanes from Eastern Avenue, and prohibition of right turns from North Church Street during hours of peak traffic flow. To facilitate these conflicting vehicular movements it will be necessary to install a modern signal controller capable of adjusting to changes in traffic flow through the junction, Figure P.13.

  Immediate action improvements to this junction will provide a considerable amount of additional capacity. However, the intersection will not flow freely until the North-South Arterial has been completed and part of the West Bay Road traffic is diverted to the new road. Future traffic through the intersection could conceivably exceed the capacity developed by the Immediate Action Plan design at some future date. In the event that this should occur, it is recommended that the traffic signal be removed and the intersection be reconstructed as a roundabout. Initial land acquisition must be sufficient to accommodate this ultimate design, Figure P-14.

* <u>Mary Street/Harbour Drive</u>: With the advent of the Fort Street Extension and the one-way traffic circulation system in George Town, Mary Street assumes an enhanced position in providing for access to the inner city. Mary Street must be widened to provide left and right turn lanes into Harbour Drive/North Church Street. In addition Mary Street right-of-way should be standardised at 50 foot width throughout it's length. This would be sufficient to accommodate two 12 foot traffic lanes, kerbs and gutter, and six foot sidewalks on each side, Figure P.15.

* Eastern Avenue/Shedden Road: At present Crewe Road traffic westbound is often stalled by vehicles waiting to turn right into Eastern avenue or North Sound Road. This situation is exacerbated by vehicles turning right from North Sound Road into Crewe Road.

  In order to improve traffic flow through the intersection, westbound Crewe Road must be widened to accommodate a right-turn lane. Shedden Road and Eastern Avenue both must be widened for left-turn traffic, with each vehicle yielding to those crossing from the right into Eastern Avenue and North Sound Road. The latter road would be closed to traffic wishing to enter Crewe Road, Figure P.16.

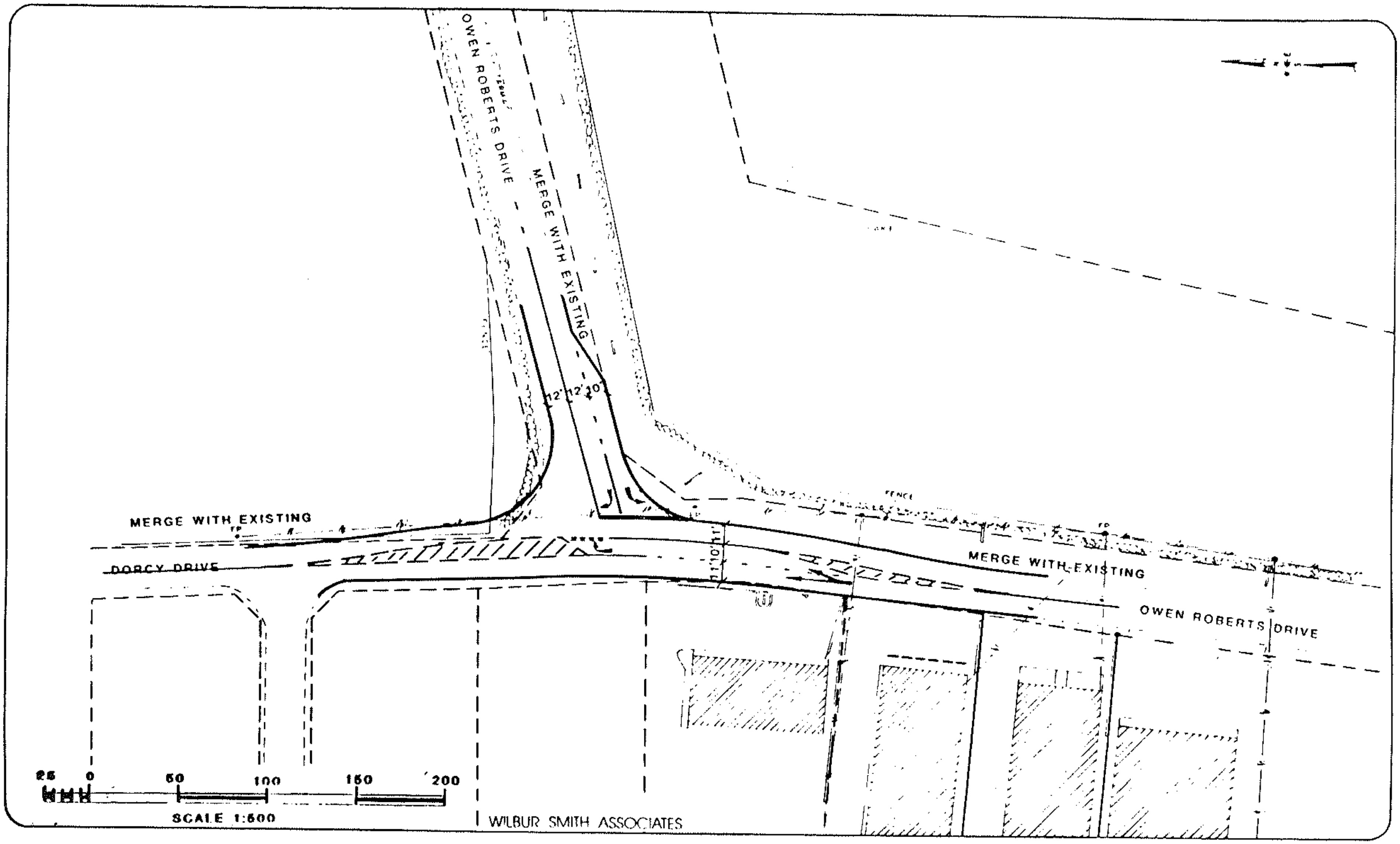
* School Access Road: Walkers Road presently provides the only vehicle access to Cayman Island Middle School and High School, and to Cayman Prep and Our Lady of Perpetual Help Catholic Schools. It is recommended that a new two lane road with eight foot sidewalks be constructed parallel to and about 700 feet east of Walkers Road in order to provide secondary access to the educational complex. The new road would extend northward about 2,300 feet from the existing Middle School Road to the north side of the complex, then turn west about 650 feet to a new junction with Walkers Road, Figure P-17.

* Walkers Road/Boilers Road: Sight distance is restricted for westbound traffic along Walkers Road at the Boilers Road intersection. That road must be realigned for a distance of about 600 feet in order to relieve the condition.

  Boilers Road at the same intersection is very narrow and has poor sight distance for vehicles turning to the east and those entering from the east. That road must be realigned for about 200 feet in order to eliminate the problem, Figure P-18.

* South Church Street/Boilers Road: Existing walls constructed along Boilers Road restrict sight distance severely. Boilers Road should be realigned for several hundred feet and widened to ease the problem of entering the junction, Figure P-19.

* Miscellaneous Road Needs - In addition to immediate needs at specific locations on the existing road network, it is recommended that a program of upgrading of all public



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GRAND CAYMAN BWI

FIGURE P-12

OWEN ROBERTS DRIVE / DORCY DRIVE

LEGEND

— — — LAND BOUNDARY

LAND TO BE AQUIRED

Wilbur Smith and Associates, Inc./David Lashley & Partners Inc.

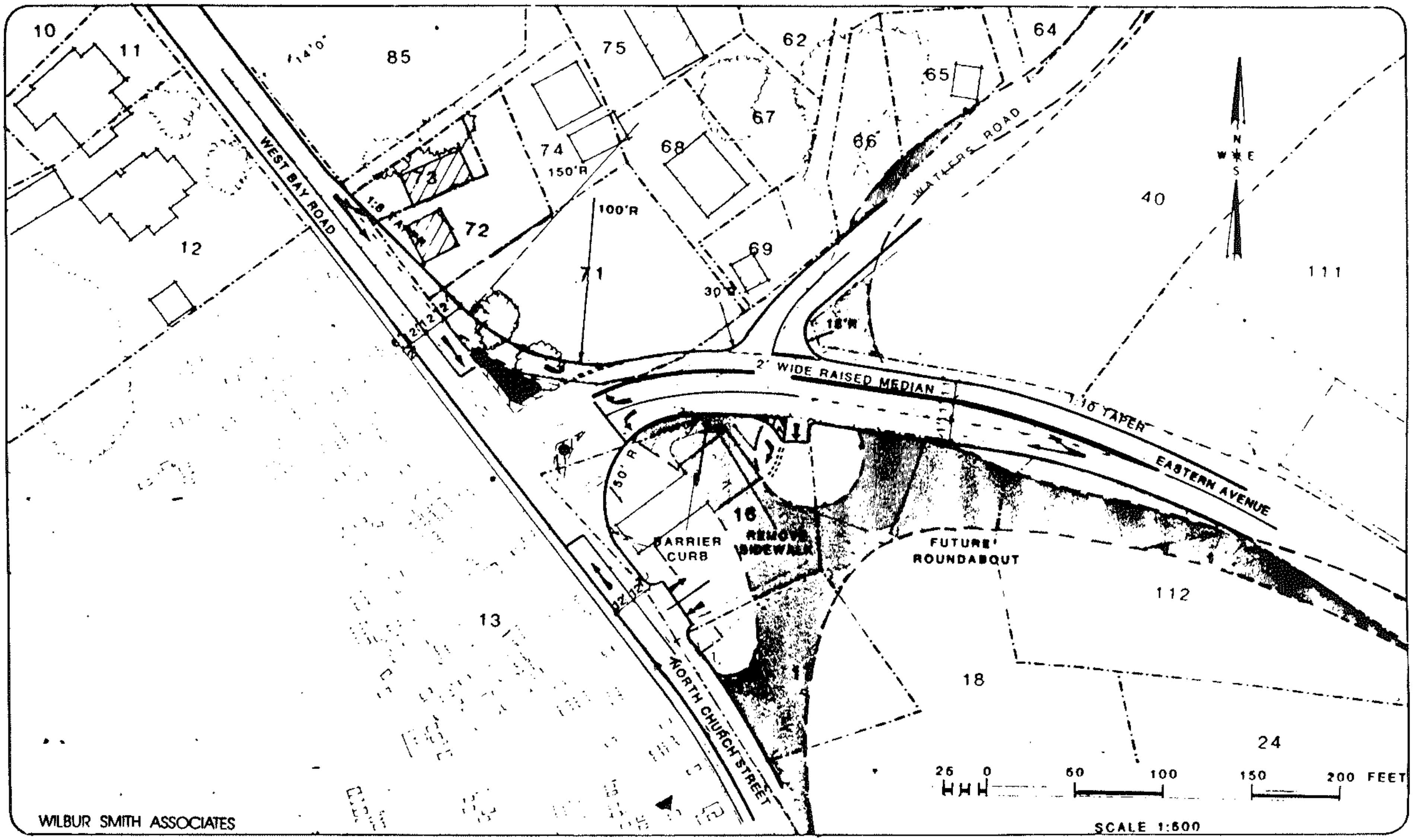

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FIGURE P-13

WEST BAY ROAD /EASTERN AVENUE

LEGEND
- CHAIN LINK FENCE
- COCONUT TREE
- HEDGE
- SHRUB/BUSH
- LOW CONC. WALL
- EXISTING ROAD
- PROPOSED ROAD
- ELEC. POLE
- LAMP POLE
- TEL. POLE
- PROPERTY BOUNDARY
- LAND TO BE ACQUIRED

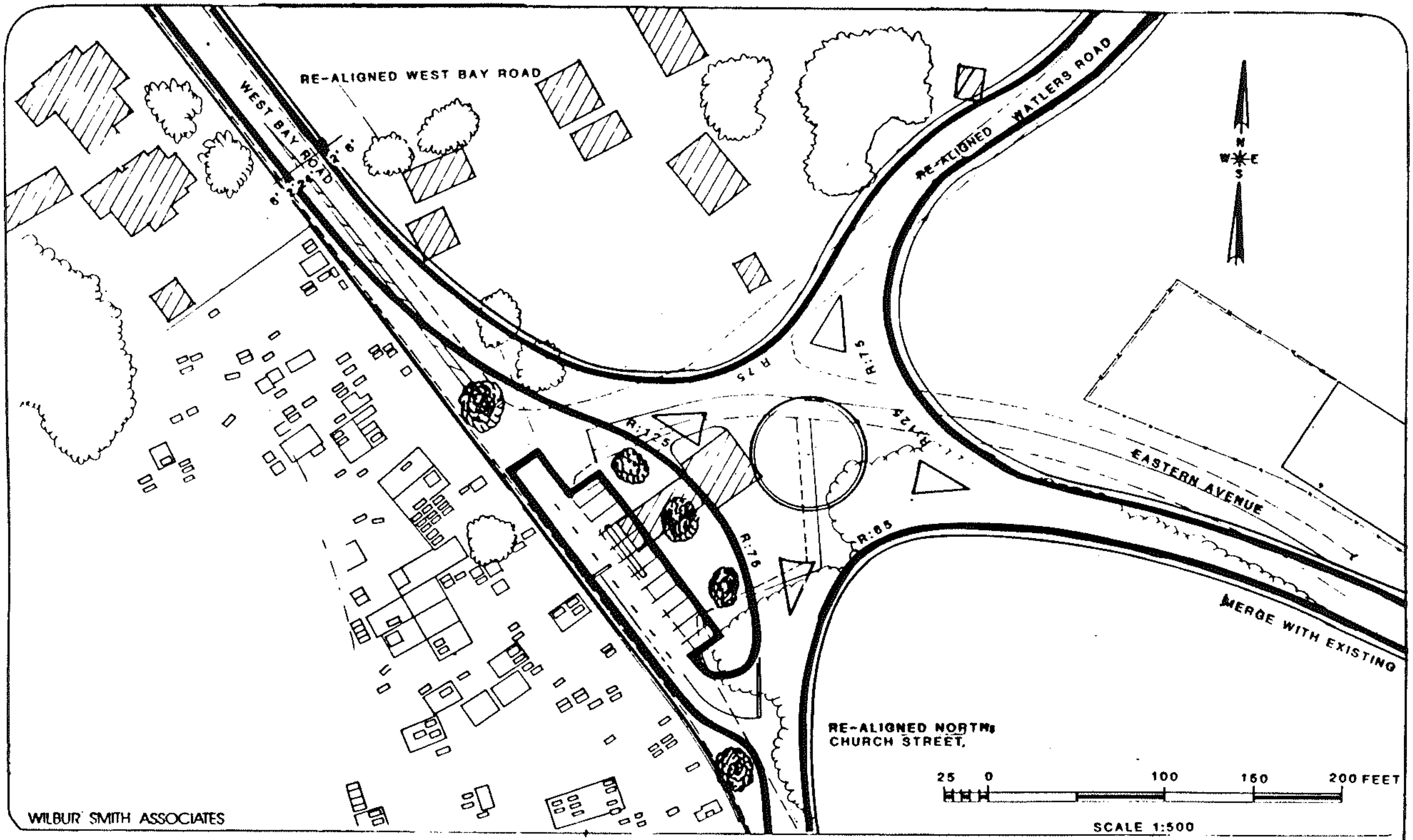

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FIGURE P-14

LONG RANGE IMPROVEMENT WEST BAY ROAD /EASTERN AVENUE /NORTH CHURCH ST.

LEGEND

- CHAIN LINK FENCE
- COCONUT TREE
- HEDGE
- SHRUB/BUSH
- LOW CONC. WALL
- EXISTING ROAD
- PROPOSED ROAD
- ELEC. POLE
- LAMP POLE
- TEL. POLE

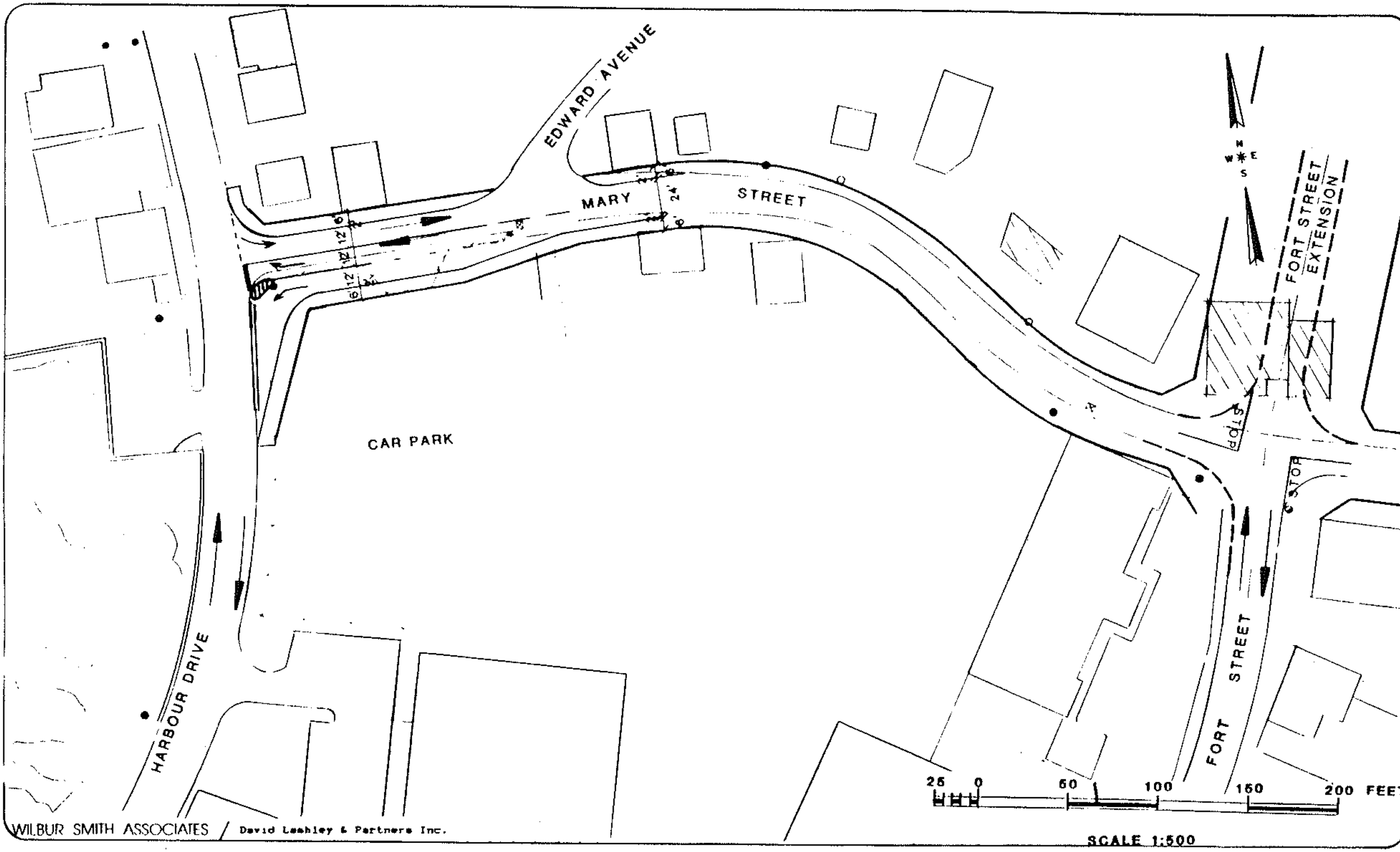

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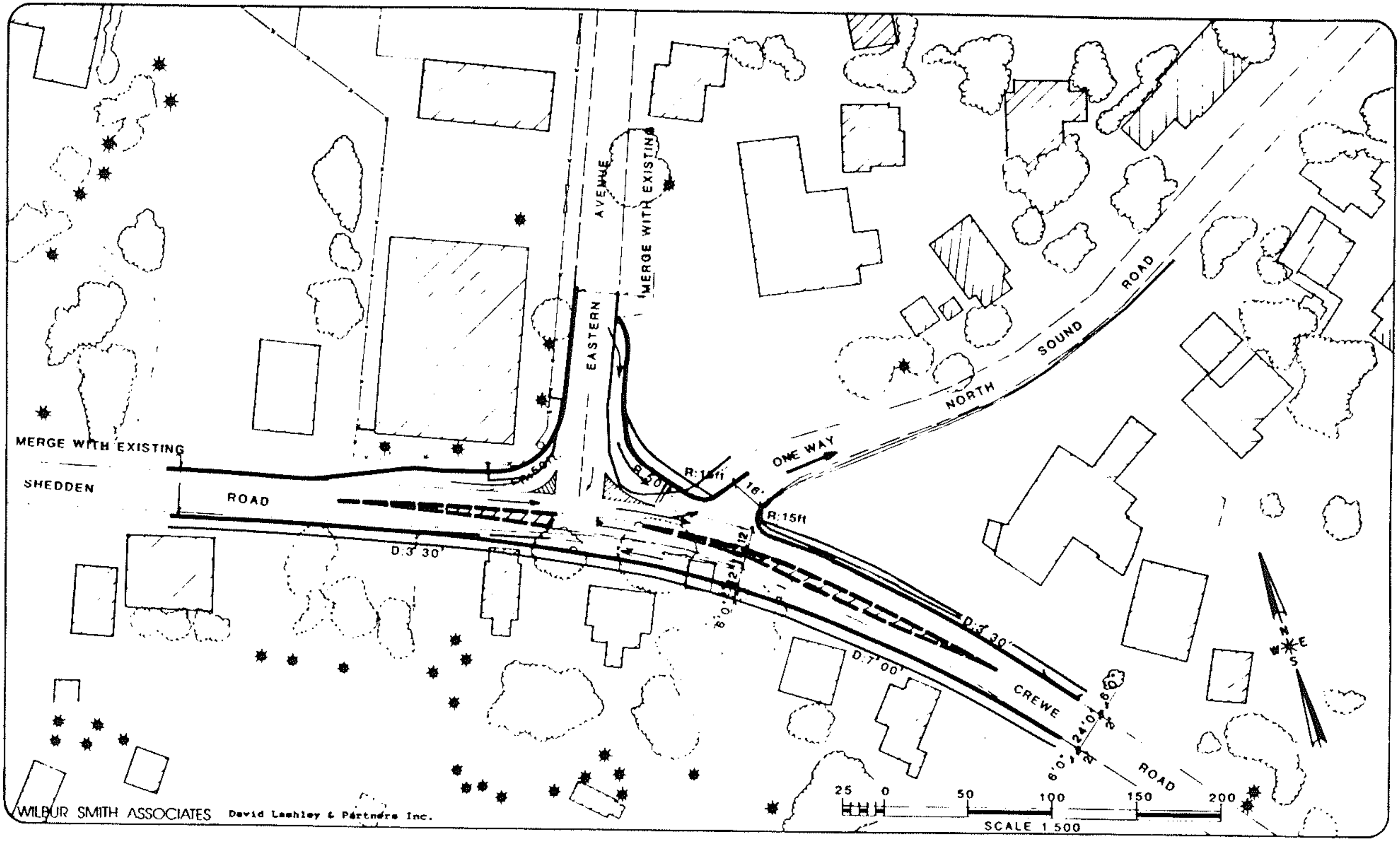
FIGURE P-15

CENTRAL AREA - PLAN
MARY STREET/HARBOUR DRIVE

LEGEND

● ELEC. POLE	TRAFFIC FLOW
LAMP POLE	TRAFFIC ISLAND
○ TEL. POLE	PEDESTRIAN SIGNAL
	PEDESTRIAN X-ING



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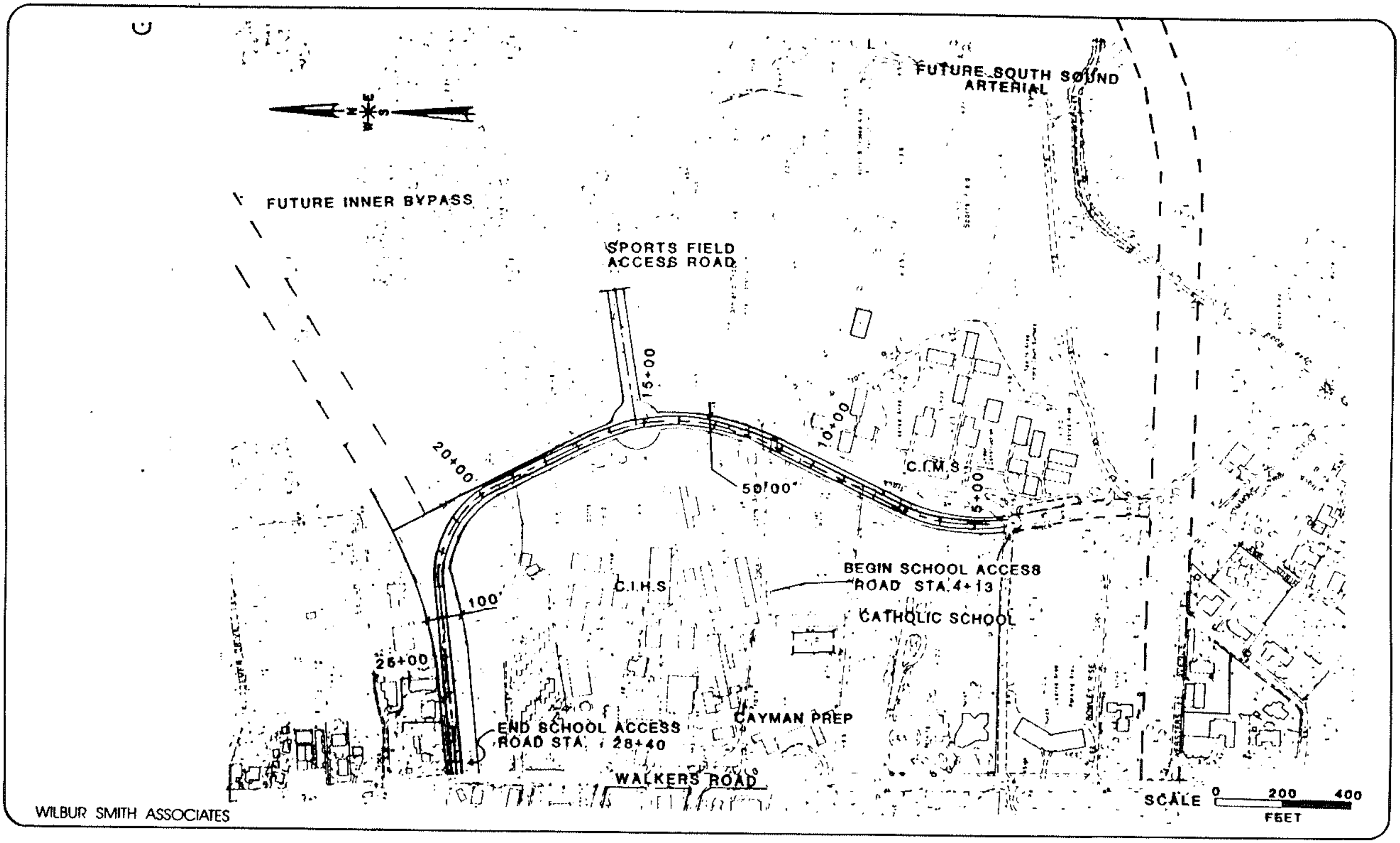
GRAND CAYMAN BWI

FIGURE P-16

SHEDDEN ROAD / CREWE ROAD / EASTERN AVENUE

LEGEND

- CHAIN LINK FENCE
- COCONUT TREE
- HEDGE
- SHRUB/BUSH
- LOW CONC. WALL
- EXISTING ROAD
- PROPOSED ROAD
- ELEC. POLE
- LAMP POLE
- TEL. POLE



MGTP STUDY
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SCHOOL AREA ACCESS ROAD

LEGEND

═══	NEW ROAD CONSTRUCTION
- - - -	FUTURE RIGHT-OF-WAY
········	EXISTING STREET

FIGURE P-17

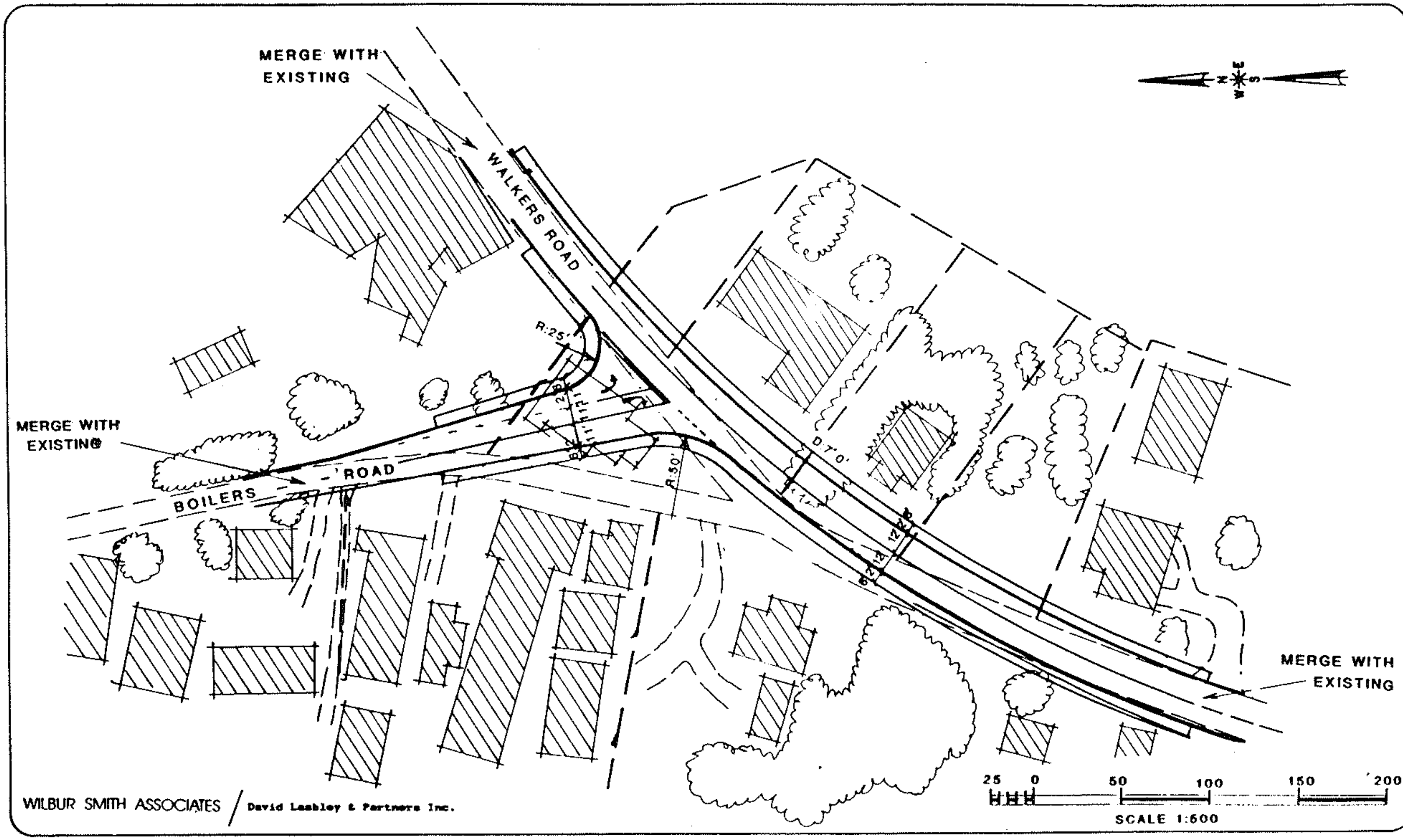

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FIGURE P-18

BOILERS ROAD/WALKERS ROAD

LEGEND

CHAIN LINK FENCE	ELEC. POLE
COCONUT TREE	LAMP POLE
HEDGE	TEL. POLE
SHRUB/BUSH	
LOW CONC. WALL	
EXISTING ROAD	
PROPOSED ROAD	

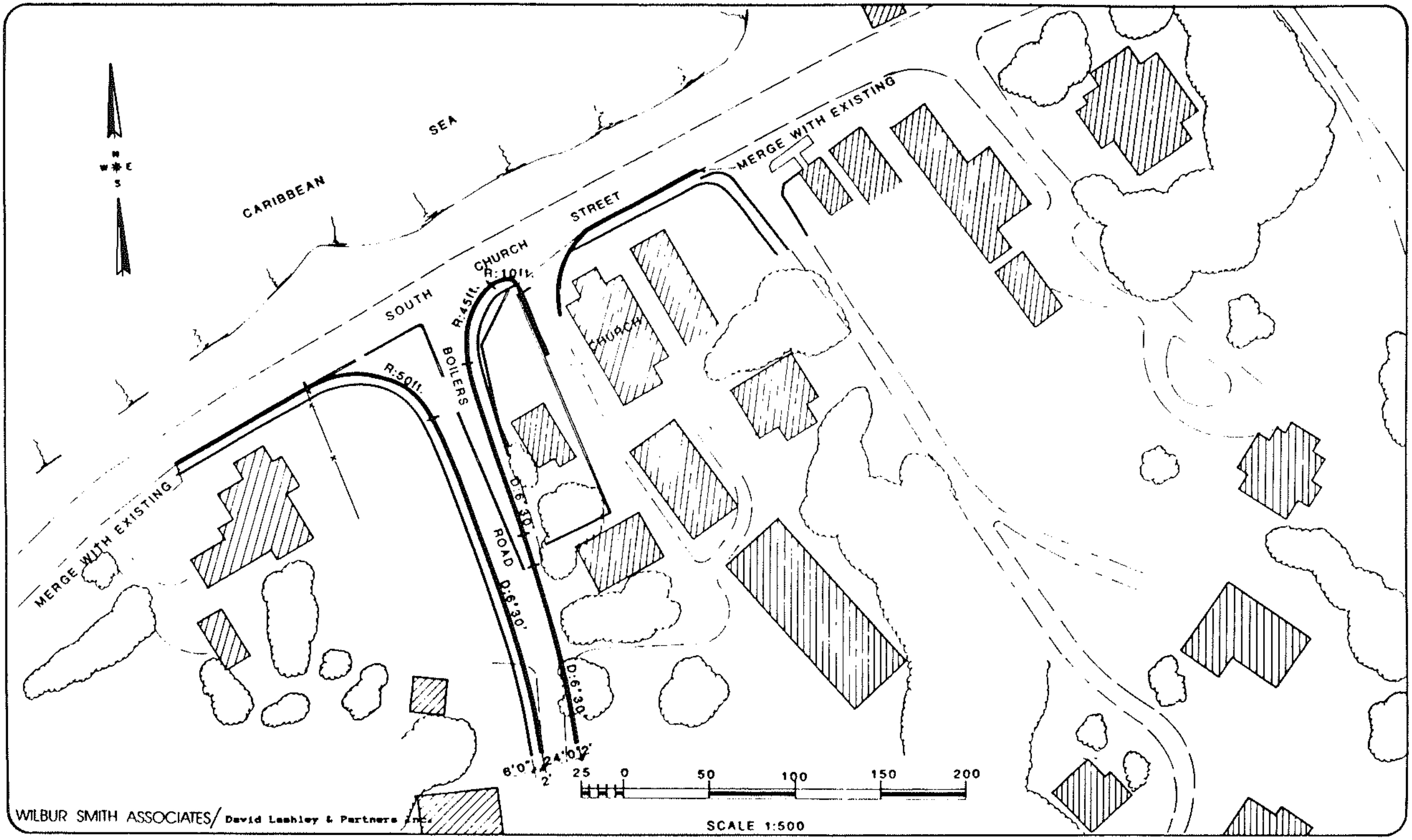

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FIGURE P-19

SOUTH CHURCH STREET/ BOILERS ROAD

LEGEND

—x—	CHAIN LINK FENCE	●	ELEC. POLE
	COCONUT TREE	◉	LAMP POLE
	HEDGE	○	TEL. POLE
	SHRUB/BUSH		
	LOW CONC.WALL		
	EXISTING ROAD		
	PROPOSED ROAD		

roads be instituted in order to bring them up to current design standards. This upgrading process is vital as increasing demands for service to accommodate more and heavier vehicles are experienced.

Central Business District - A modified one-way traffic system is recommended for the Central Business District This proposal does not necessitate the construction of capital intensive improvement schemes. Only minor modifications are necessary to achieve the system shown in Figure P-20.

With the opening of the Fort Street Extension from Mary Street to the new North-South Arterial, the CBD traffic circulation plan must change. Harbour Drive will lose traffic to the Fort Street Extension/North-South Arterial route and thus can be converted to one-way operation northbound between Shedden Road and Fort Street. This change will also improve the safety conditions of pedestrians using the Harbour Drive Crosswalk.

Fort Street and Cardinall Avenue should convert to one-way operation in a clockwise direction between Edward Street and Harbour Drive. Also Edward Street would change to one-way southbound between Fort Street and Cardinall Avenue. South of that point it would remain as is. Albert Panton Street, presently one-way southbound, would change to one-way northbound.

Shedden Road, currently westbound from the Cardinall Avenue junction to Harbour Drive, would continue to function in that manner but would allow only left turn traffic into South Church Street. Similarly, Cardinall Avenue would allow only right-turn traffic into Harbour Drive. All other road segments in the inner city would continue to serve traffic in two directions.

Several minor junction improvements must be made in conjunction with the one-way traffic system. A traffic island is necessary in Harbour Drive at Fort Street in order to enforce a right-turn only condition for the east lane. At the Cardinall Avenue intersection to the south a new traffic island will force both lanes to turn right into Harbour Drive, Figure P-21.

Further south a traffic island will turn all traffic on the single lane of Shedden road to the left into South Church Street. Vehicles exiting Goring Avenue would be allowed to turn either right or left, Figure P-22.

Traffic islands presently existing in Edward Street at its intersections with Fort Street and Cardinall Avenue will be modified somewhat in Horder to accommodate the one-way traffic flow in H the central city. A new island would also be constructed on Fort Street at Albert Panton Street for the same reason. Pedestrian signals may be required at crosswalks at the intersection of Edward Street with Cardinall Avenue, but should not be installed until the one-way system has been implemented and pedestrian traffic observed for a period of time, Figure P-23.

The location and design of sidewalks in downtown George Town is much in need of review. Many owners have made considerable effort to provide sidewalks adjacent to their buildings, but have not been encouraged to ensure continuity of design between adjacent properties. A major effort should be made to improve sidewalks along all streets by connecting existing sidewalks, removing obstacles in the walks, constructing safety rails along high sidewalks, etc. This effort is needed both for safety and to eliminate the tendency for pedestrians to walk in the roadway.

A final recommendation in the central area concerns the intersection of Mary Street and School Lane. The turning radius on the northwest quadrant must be enlarged in order to improve sight distance and allow a left turn from Mary Street, Figure P-24.

<u>Enforcement of Subdivision Standards</u> - At present the procedure for approval of private development projects requires application to the Central Planning Authority. That body in turn consults with technical branches of Government regarding appropriate design and specifications. Where such development includes provision of roads and streets, including storm drainage, it is recommended that the approval process include a stipulation that developers submit detail design drawings and specifications for review prior to approval for construction to begin. Plans to be reviewed should include geometric and structural design, storm drainage, site grading, traffic control, and material specifications.

A set of construction drawings and specifications would be retained by PWD during the construction period, and periodic inspections would be made to ensure that the approved design was followed. This process would tend to eliminate the possibility that sub-standard construction of public facilities may become a safety hazard. It would also ensure that

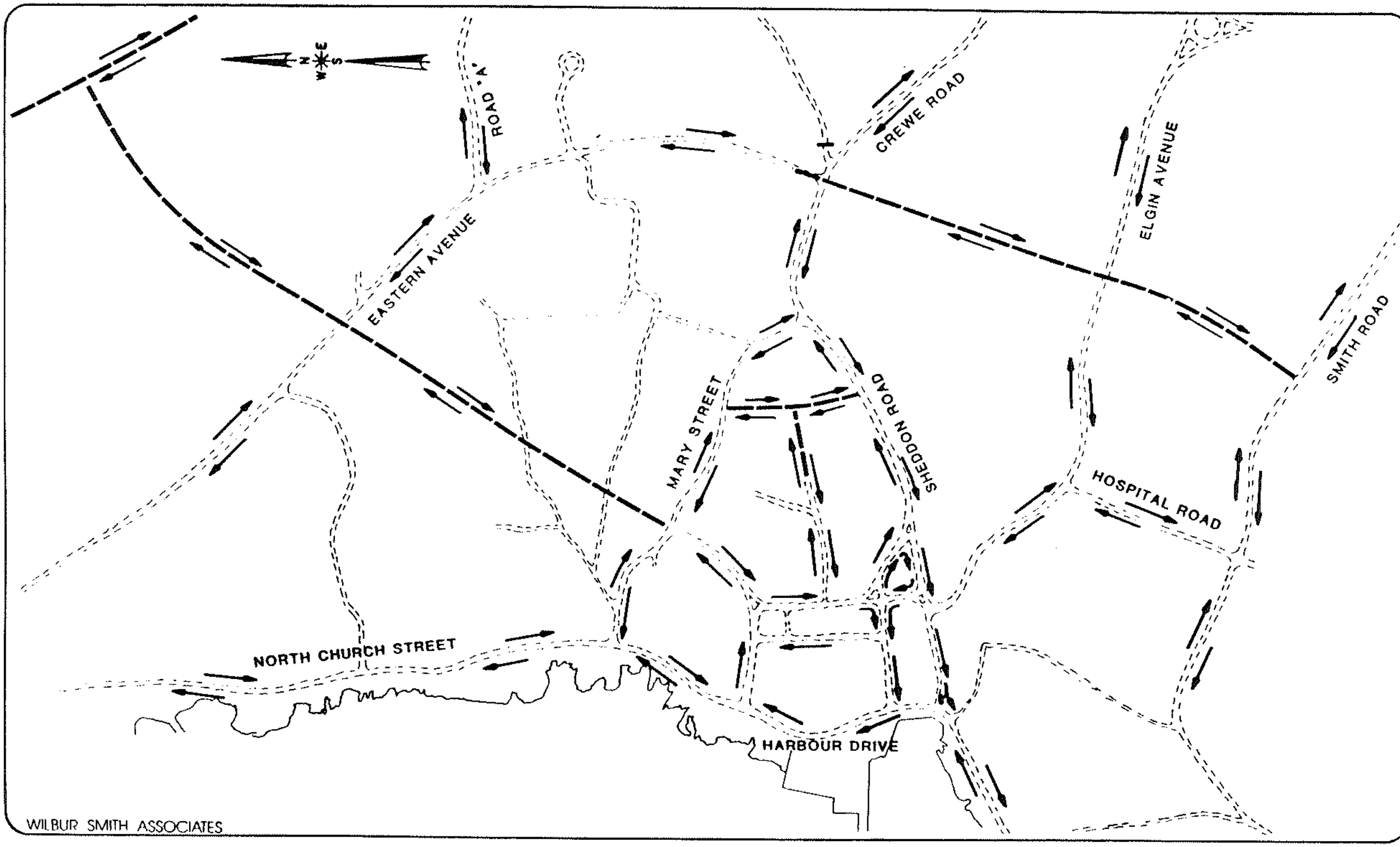

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FIGURE P-20

CENTRAL AREA

TRAFFIC CIRCULATION PLAN

LEGEND

FLOW ON PRINCIPAL EXISTING ROADS

FLOW ON PROPOSED ROADS

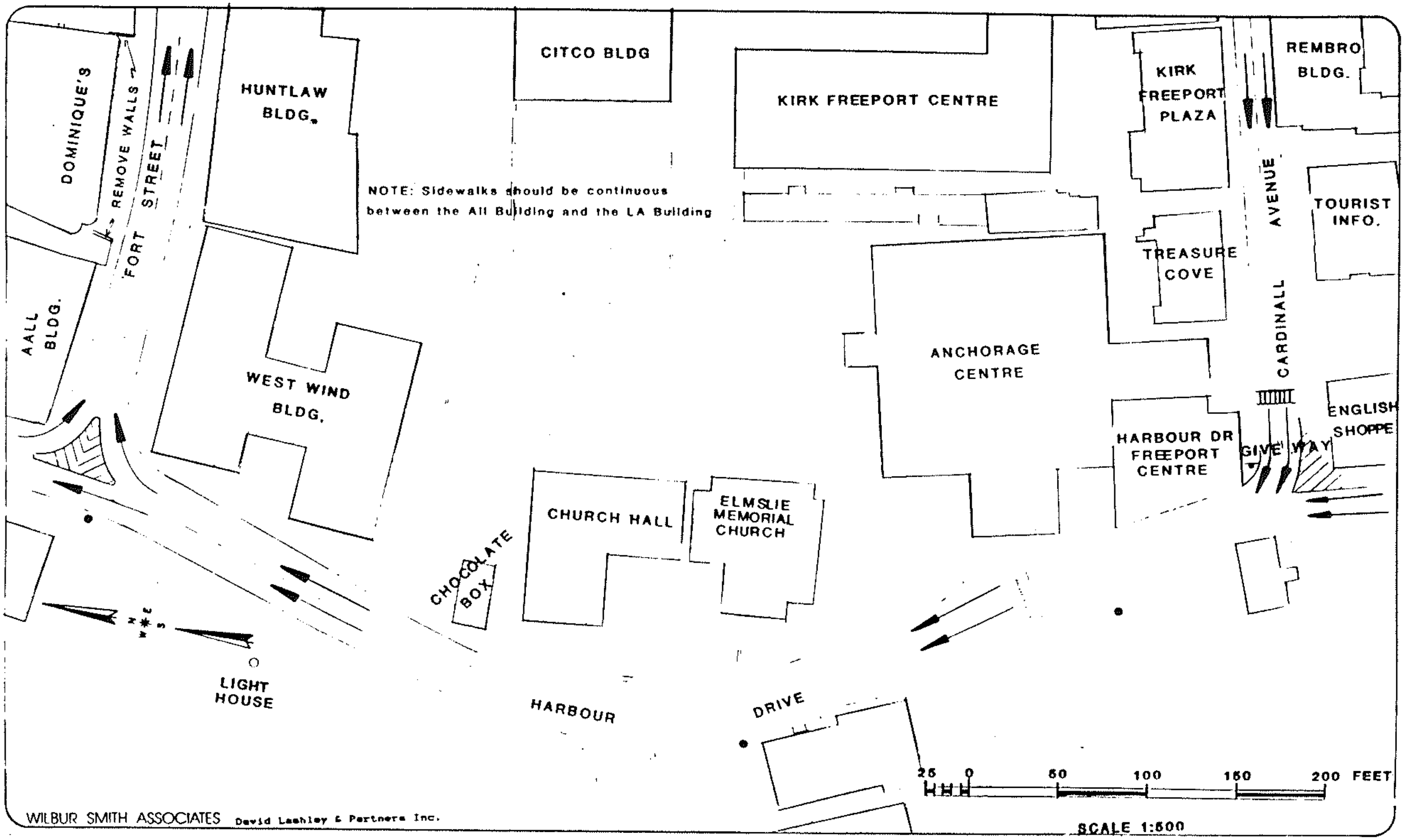

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FIGURE P-21

CENTRAL AREA PLAN

HARBOUR DRIVE/FORT STREET /CARDINALL AVENUE

LEGEND

- ● ELEC. POLE
- ○ LAMP POLE
- ○ TEL. POLE
- TRAFFIC FLOW
- TRAFFIC ISLAND
- PEDESTRIAN BARRIER
- PEDESTRIAN X-ING

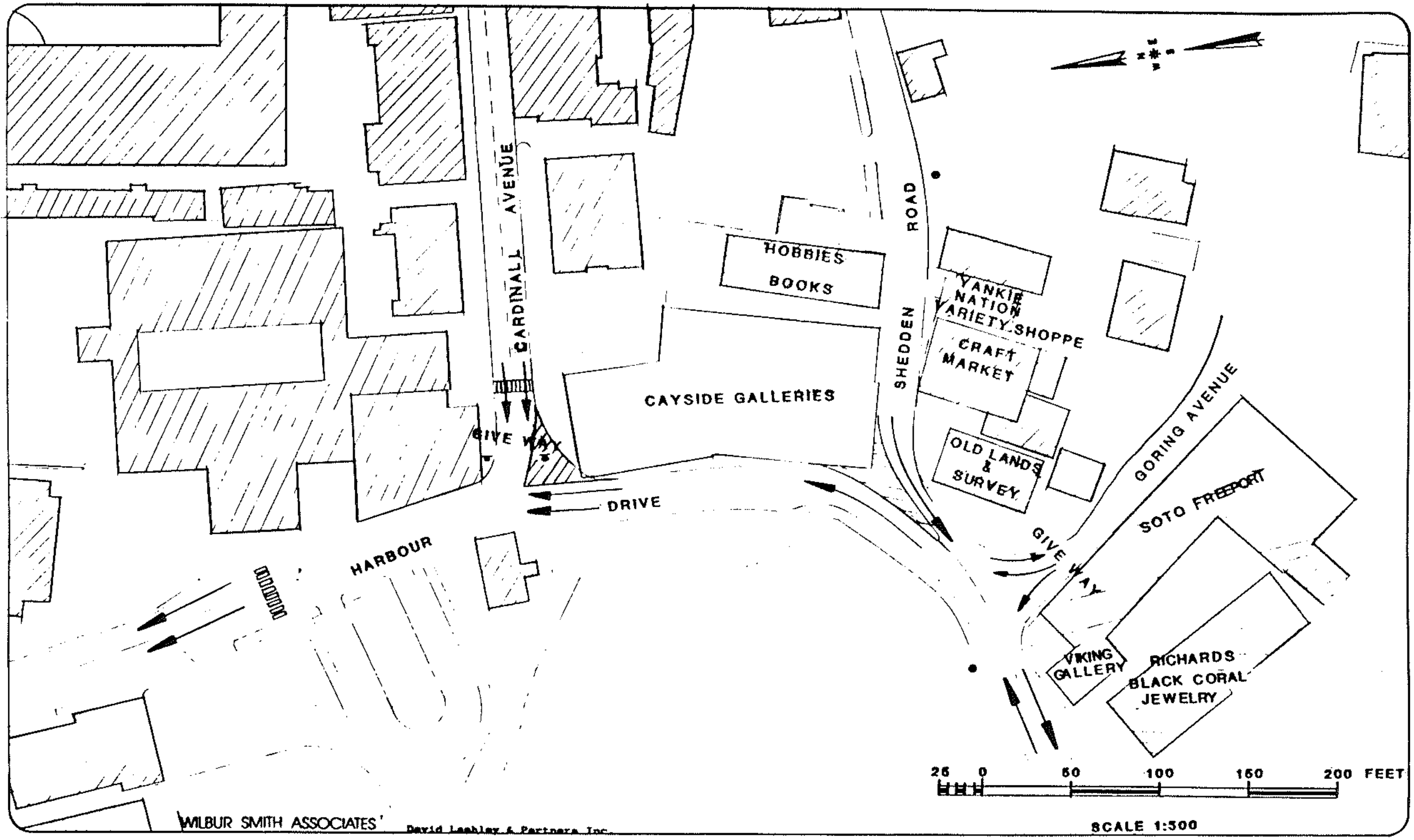

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FIGURE P-22

CENTRAL AREA PLAN
HARBOUR DRIVE / SHEDDEN ROAD

LEGEND

● ELEC. POLE	TRAFFIC FLOW
LAMP POLE	TRAFFIC ISLAND
○ TEL. POLE	PEDESTRIAN BARRIER
	PEDESTRIAN X-ING

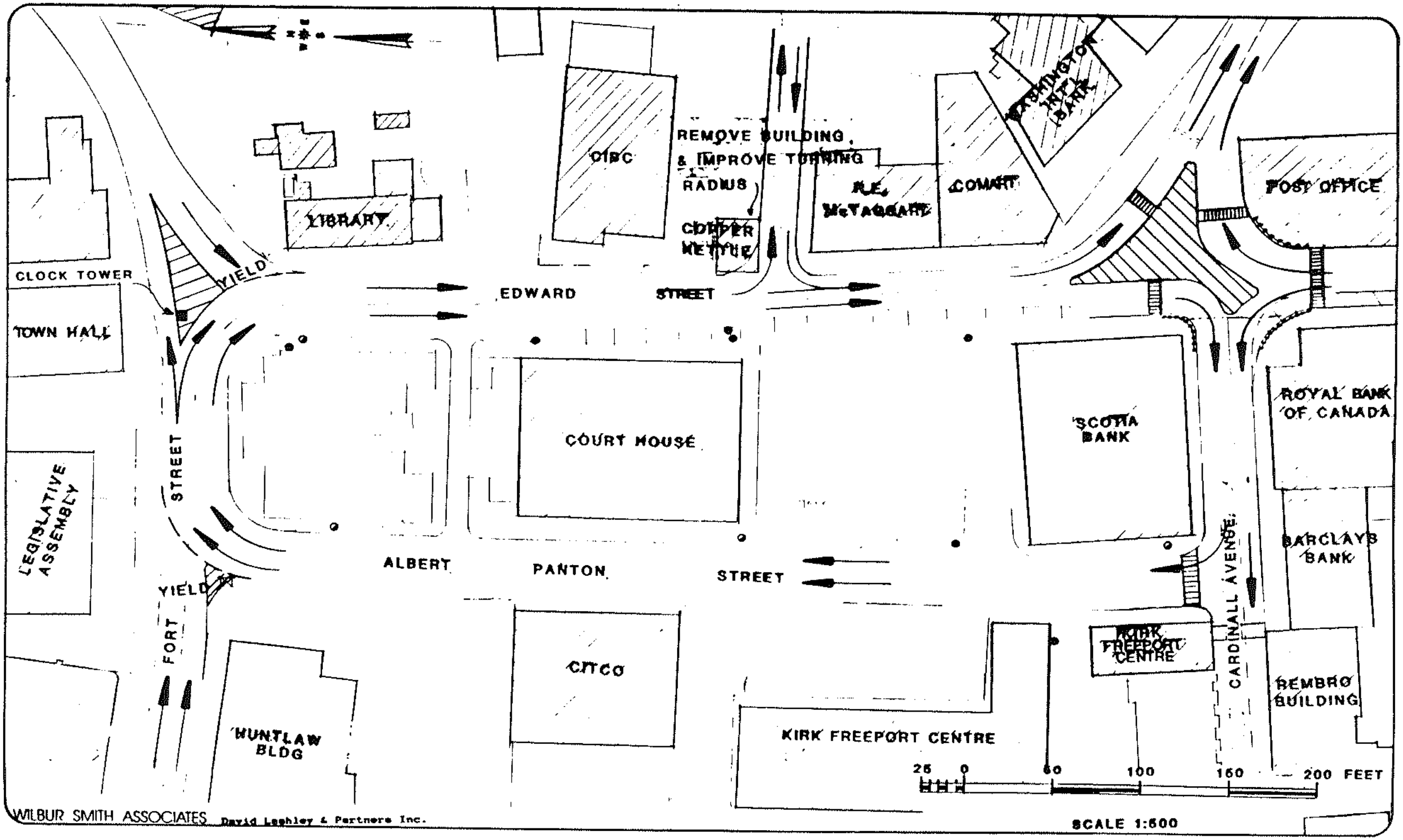

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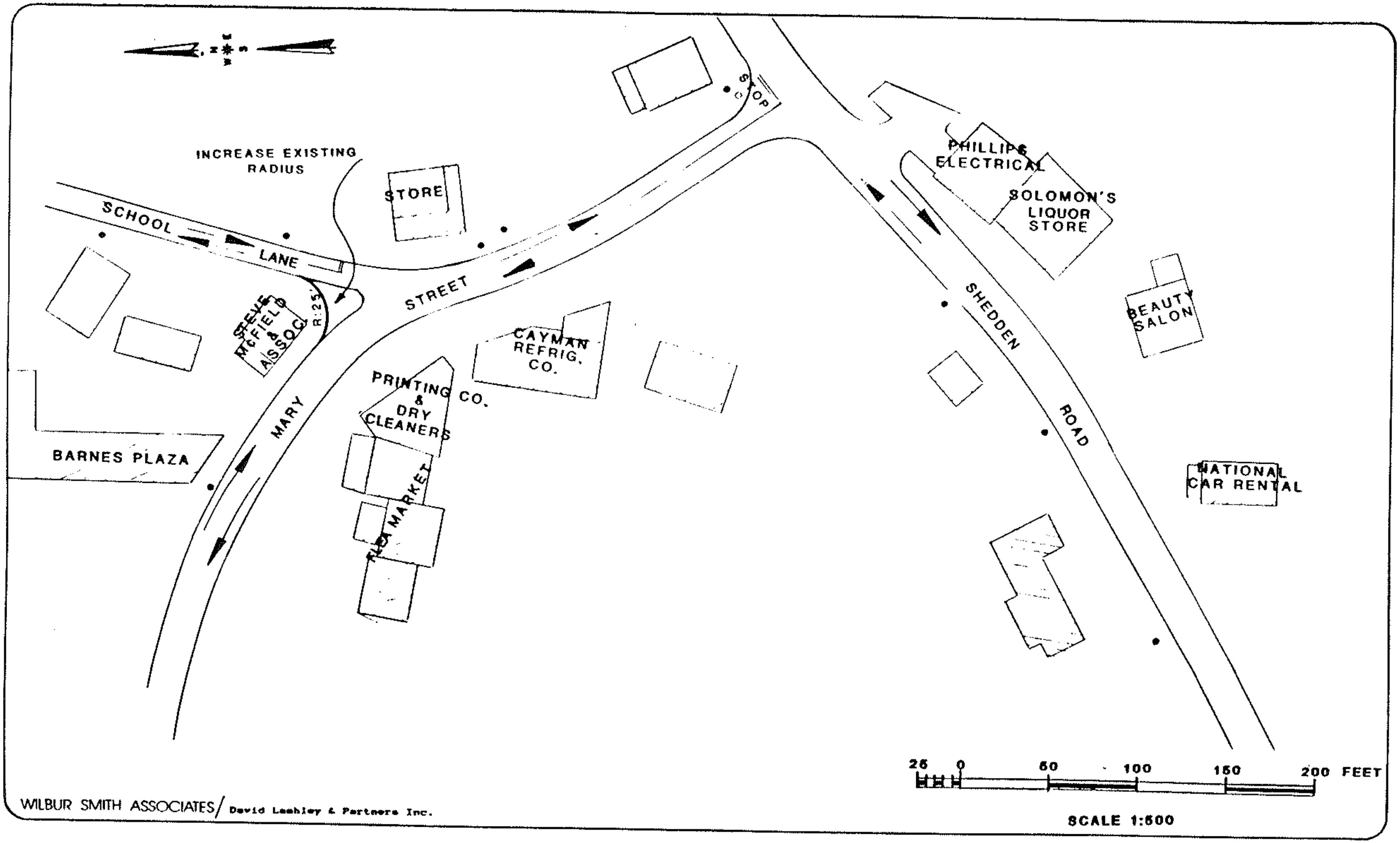
FIGURE P-23

CENTRAL AREA PLAN
ALBERT PANTON / EDWARD STREET

LEGEND
- ● ELEC. POLE
- LAMP POLE
- ○ TEL. POLE
- TRAFFIC FLOW
- TRAFFIC ISLAND
- PEDESTRIAN BARRIER
- PEDESTRIAN X-ING



MGTP STUDY
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FIGURE P-24

CENTRAL AREA – PLAN
MARY STREET/SHEDDEN ROAD

LEGEND

- ELEC. POLE
- LAMP POLE
- TEL. POLE
- TRAFFIC FLOW
- TRAFFIC ISLAND
- PEDESTRIAN SIGNAL
- PEDESTRIAN X-ING

public facilities transferred to the Government (roads, streets, sewers) would not become an immediate liability in that major repairs were needed.

Financial Cost, 1988-1992 Recommendations - Cost estimates have been prepared for individual elements of the recommended works prior to 1992 and are shown on Table 6-1. The land acquisition costs shown have been computed using the unit rates established in an earlier MGTP report on Existing Conditions. In all cases, the cost of engineering design is included in the first year of construction. It should be noted that all costs given in this table reflect financial cost rather than the economic cost which were used to determine economic viability. Financial costs are inclusive of taxes, duties, licence fees, work permits and all other revenues payable to Government by the private sector of the construction industry.

Immediate Action Projects, those needed improvements requiring relatively low capital expenditures and short design time, are estimated to cost C.I. $5.3 million. This figure includes $4.596 million for design and construction, and an additional $704,000 for property acquisition. An item for miscellaneous road improvements, $750,000 per year, is included in order to continue the present PWD program of upgrading public roads to current design standards.

New road construction needed during the first five years, 1988-1992, will likely cost about $13.484 million, including $4.063 million for land acquisition. The North-South Arterial between the Holiday Inn Connector Road and North Sound Road, including roundabouts at three locations, represents about 60 percent of the needed investment to complete Phase One recommendations.

Total expenditures have been distributed over the five-year program, with design and Immediate Action Projects making up the major portion of needs for the first two years. Total annual expenditures for 1990 are expected to be $3.7 million, rising to $7.4 million in 1991 and then decreasing to $4.2 million in 1992.

1997 RECOMMENDATIONS

These recommendations follow on in a logical progression from those given for 1992. Their implementation should be considered part of a 10 year development programme. Road

TABLE 6-1

FINANCIAL COST OF ROAD IMPROVEMENTS 1988-1992

PROJECT DESCRIPTION	PROJECT TYPE[1]	COST (CI$000) Land	Project	Total	EXPENDITURES (CI$000)[2] 1988	1989	1990	1991	1992
1. Immediate Action Projects									
a. Owen Roberts--Dorcy Dr	I	4	10	14	* 14	-	-	-	-
b. Eastern Ave--West Bay Rd	I	42	28	70	* 70	-	-	-	-
c. Mary Street--Harbour Dr	I	104	8	112	* 112	-	-	-	-
d. Eastern Ave--Shedden Rd--Crewe Rd	I	268	110	378	* 378	-	-	-	-
e. School Access Rd	S	-	500	500	* 500	-	-	-	-
f. Walkers Rd - Boilers Rd	I	261	134	395	-	* 395	-	-	-
g. South Church St--Boilers Rd.	I	25	56	81	-	* 81	-	-	-
h. Miscellaneous Roads	S	-	3,750	3,750	* 750	* 750	* 750	* 750	* 750
SUBTOTAL		704	4,596	5,300	1,824	1,226	750	750	750
2. Phase 1 Projects									
a. North-South Arterial	P	1,484	5,552	7,036	-	* 264	1,495	3,518	1,759
b. Roundabouts--N-S Arterial	I	282	750	1,032	-	* 36	222	516	258
c. Fort Street Extension	P	1,198	1,170	2,368	-	* 56	536	1,184	592
d. Holiday Inn Connector	P	269	593	862	-	-	* 28	834	-
e. Palm Heights Access Rd	P	36	328	364	-	* 16	348	-	-
f. Royal Palms Connector	P	682	503	1,185	-	-	* 24	636	525
g. Hyatt Hotel Access Rd	P	32	293	325	-	* 14	311	-	-
h. Crewe Road--North Sound Wy	I	80	232	312	-	-	-	* 11	301
SUBTOTAL		4,063	9,421	13,484	-	386	2,964	6,699	3,435
TOTAL		4,767	14,017	18,784	1,824	1,612	3,714	7,449	4,185

Source: MGTP Study

(1) Legend: I - Intersection,
P - Primary Road, and
S - Secondary Road.

(2) Design year indicated by asterisk.

construction beyond 1997 has been addressed by the delineation of recommended road reserves which define the anticipated traffic needs for the year 2000 and beyond.

North-South Arterial, Dual Lanes - Traffic on the new North-South Arterial is expected to increase rapidly during the first five years of operation. Therefore it is recommended that the segment between the Royal Palms Connector and Fort Street Extension be widened to a four-lane facility with centre median by 1997. Widening should be accomplished within the 125 foot wide right-of-way previously obtained for the first stage of construction.

New North Sound Road - Relocation of North Sound Road becomes necessary with the conversion of the old road to one-way operation at the junction with Crewe Road. The new alignment runs westward from the existing intersection with Webb Road to a junction with Eastern Avenue, about 700 feet north of Crewe Road. Continuing to the west on new alignment, the road joins School Road at its intersection with School Lane. This alignment is shown in Property Acquisition Sheet 590/330, included as a supplement to this report.

Jennett Street Extension - New development planned for central George Town will require the extension of Jennett Street to both Mary Street and Shedden Road. This is necessary in order to avoid heavy traffic flow between Edward Street and Jennett Street. The new alignment is indicated on Figure 590/330 supplementing this report.

Inner Bypass Extension - Traffic flow between Smith Road and Eastern Avenue will require a connection between the two road facilities by 1997. Construction should include two lanes with provision of two additional lanes in the future. Recommended alignment extending Eastern Avenue Southward is shown on LA Figures 590/320 and 330.

Airport Drive - Increasing traffic flow generated by the airport makes it necessary to add an alternative road connection in the area. The controlled access route would extend westward from a junction with Owen Roberts Drive near the weather station, crossing Dorcy Drive at the junction with MacLendon Drive. Continuing to the west across open land, it would intersect North Sound Way (Outer Bypass) about 1,100 feet north of Crewe Road. West of the Bypass the new route becomes a local road as it penetrates the older residential neighbourhood along Old North Sound Road, Figures LA 590/330, LA 610/330, and P-25.

Jennett Street/Edward Street - The downtown traffic circulation plan will allow only two turning movements at this intersection, a left turn from Jennett Street and a left turn from Edward Street. The latter maneuver is particularly difficult in that a small two storey business establishment is protruding into the intersection on the northeast corner. The building blocks the sidewalk to the extent that pedestrians must walk in the street. Thus it is necessary that drivers turning into Jennett Street must contend with random pedestrian movement and restricted sight distance and therefore must move with extreme caution. It is recommended that the offending building be removed and that an adequate turning radius and sidewalk be constructed.

Hospital Road/Smith Road - This intersection presently includes stop signs for each approach. Both horizontal and vertical sight distance restrictions make it difficult for vehicles to move through the intersection without delay. It is recommended that a traffic signal be installed with a controller capable of adjusting the signal cycle to accommodate changing levels of traffic flow. The controller should also be capable of accepting an override signal from the nearby hospital radio room in order to facilitate movements of emergency vehicles through the intersection.

Local Access Roads - Construction of new arterial roads that include control of access will result in a number of land-locked parcels and areas. It will be necessary to construct local access roads to provide these parcels with a means of entry to the public road network.

Miscellaneous Projects - Upgrading of all public roads not described elsewhere in this report should continue through the second phase of recommended road improvements. Many such projects will be apparent in West Bay and Bodden Town, and in other outlying communities.

Financial Cost, 1993-1997 Recommendations - An estimate of costs to complete each project included in the second five year plan is set out in Table 6-2. The largest single item is the addition of a second pair of lanes to the North-South Arterial, costing $1.85 million. This work would be carried out on right-of-way acquired for the construction of the initial two lane road.

Two new roads in George Town require more funds for the property than for construction. New North Sound Road and Airport Road together call for $2.36 million for right-of-way and an

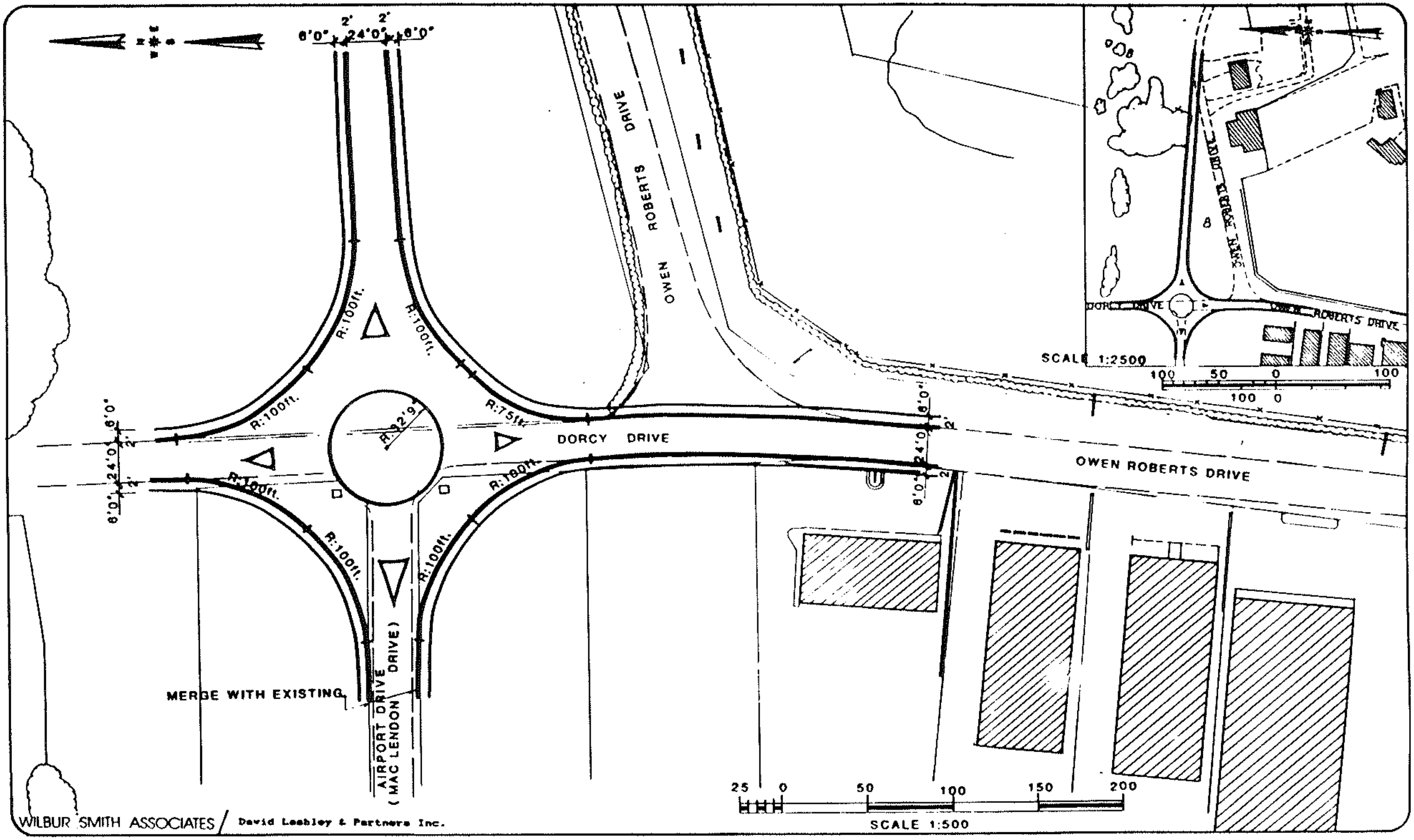

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FIGURE P-25

AIRPORT DRIVE / DORCY DRIVE

LEGEND

—x—	CHAIN LINK FENCE	●	ELEC. POLE
☼	COCONUT TREE	◉	LAMP POLE
▭	HEDGE	○	TEL. POLE
⬭	SHRUB/BUSH		
	LOW CONC. WALL		
	EXISTING ROAD		
	PROPOSED ROAD		

TABLE 6-2

FINANCIAL COSTS OF ROAD IMPROVEMENTS 1993-1997

PROJECT DESCRIPTION	PROJECT TYPE[1]	ESTIMATED COSTS (CI $000)		
		Land	Construction[2]	Total
a. N-S Arterial, Dual Lanes	P	-	1,852	1,852
b. New North Sound Road	S	1,196	897	2,093
c. Jennett Street Extension	S	500	172	672
d. Inner Bypass Extension	P	1,426	794	2,220
e. Airport Drive		1,163	1,054	2,217
f. Jennett Street/Edward Street	I	108	8	116
g. Hospital Road/Smith Road	I	-	50	50
h. Local Access Roads	L	447	438	885
i. Miscellaneous Projects	S	-	3,750	3,750
TOTAL		4,840	9,015	13,855

Source: MGTP Study

(1) Legend: I = Intersections;
P = Primary Roads,
S = Secondary Roads;
= Local Roads.

(2) Includes Design Costs.

additional $1.95 million for construction. The total cost for nine projects is estimated to be $13.86 million, including $4.84 to acquire right-of-way.

RECOMMENDED FUTURE ROAD NETWORK

All of the projects recommended for the 10-year improvement program were qualified through the benefit/cost analysis as being a valuable addition to the road network. It is quite likely that in the near future other projects will also be needed in order to serve future development on Grand Cayman.

Those projects considered for Phase Two construction but with currently low need relative to cost are set out in Table 6-3. Included are two projects to carry the North-South Arterial northward from the Holiday Inn Connector to Spanish Bay, LA-4 to 10; the South Sound Arterial from Smith Road to Walkers Road, Figures 590/310 and 320; and the first segment of the East-West Arterial from the South Sound Arterial to Crewe Road, Figures LA 590/320, 610/310 and 320, and 630/320. Alignment for a future extension of the East-West Arterial eastward to Bodden Town and Pease Bay is shown on Figures LA 650/320, 670/320, 690/320, 710/320, and 750/320 and 330.

TABLE 6-3

FINANCIAL COSTS OF ROAD IMPROVEMENTS, FUTURE

PROJECT DESCRIPTION	PROJECT(1) TYPE	ESTIMATED COSTS (CI $000)		
		Land	Construction(2)	Total
a. N-S Arterial to Botabano	P	4,287	6,451	10,738
b. E-W Arterial to Crewe Road	P	338	2,771	3,109
c. South Sound Arterial	P	4,034	2,064	6,098
d. N-S Botabano Road to Spanish Bay	L	2,797	1,642	4,439

Source: MGTP Study

(1) Legend: P = Primary Roads,
L = Local Roads.

(2) Includes Design Costs.

It is recommended that rights-of-way for all projects described in this section be reserved for future need at this time. Recommended legislative actions necessary to take this step are contained in Chapter Seven. It is also recommended that each future project be reviewed periodically in terms of cost and benefit in light of changing traffic needs and future development projects in each travel corridor.

RIGHT-OF-WAY RECOMMENDATIONS

Present Right-of-Way (R/W) widths of public roads in Grand Cayman vary between 30 and 50 feet, depending upon the age of the road and its geographical location. It is recommended that all existing public roads have at least a minimum lwdth of 40 feet in order to accommodate two 12 foot lanes, a two foot kerb setback on each side, and six foot wide sidewalks on each side.

Additional width is required on certain major arterial roads in order to accommodate paved shoulders, a median, and roadside drainage. Such important traffic routes should always include sufficient R/W to accommodate anticipated 20-year traffic demand. Four lane design in a suburban or rural setting should include 125 feet of R/W. This width could be reduced to 80 feet in an intensly developed urban setting, but would require special roadway design considerations and speed restrictions. Two-lane arterial roads in all areas would require a 50 foot wide R/W.

PARKING RECOMMENDATIONS

For many years parking in central George Town was not really a problem, primarily because ample space was available at the kerb but also because those parking regulations which existed were not stringently enforced. In the future, however, development in the inner city is expected to continue at a rapid pace and increasing demand for parking space will follow the trend.

Early implementation of a parking development programme for Central George Town is necessary to the continued economic growth and stability of the area. Recommendations for parking facility development presented herein were formulated after an analysis of existing and forecasted parking space demands and needs for 1992 and 1997. Efforts were made to integrate this program with anticipated land use changes as well as with changes in the

Central Area circulation plans, both in time and dimension. The suggested parking development program is flexible to permit its modification to meet unanticipated needs.

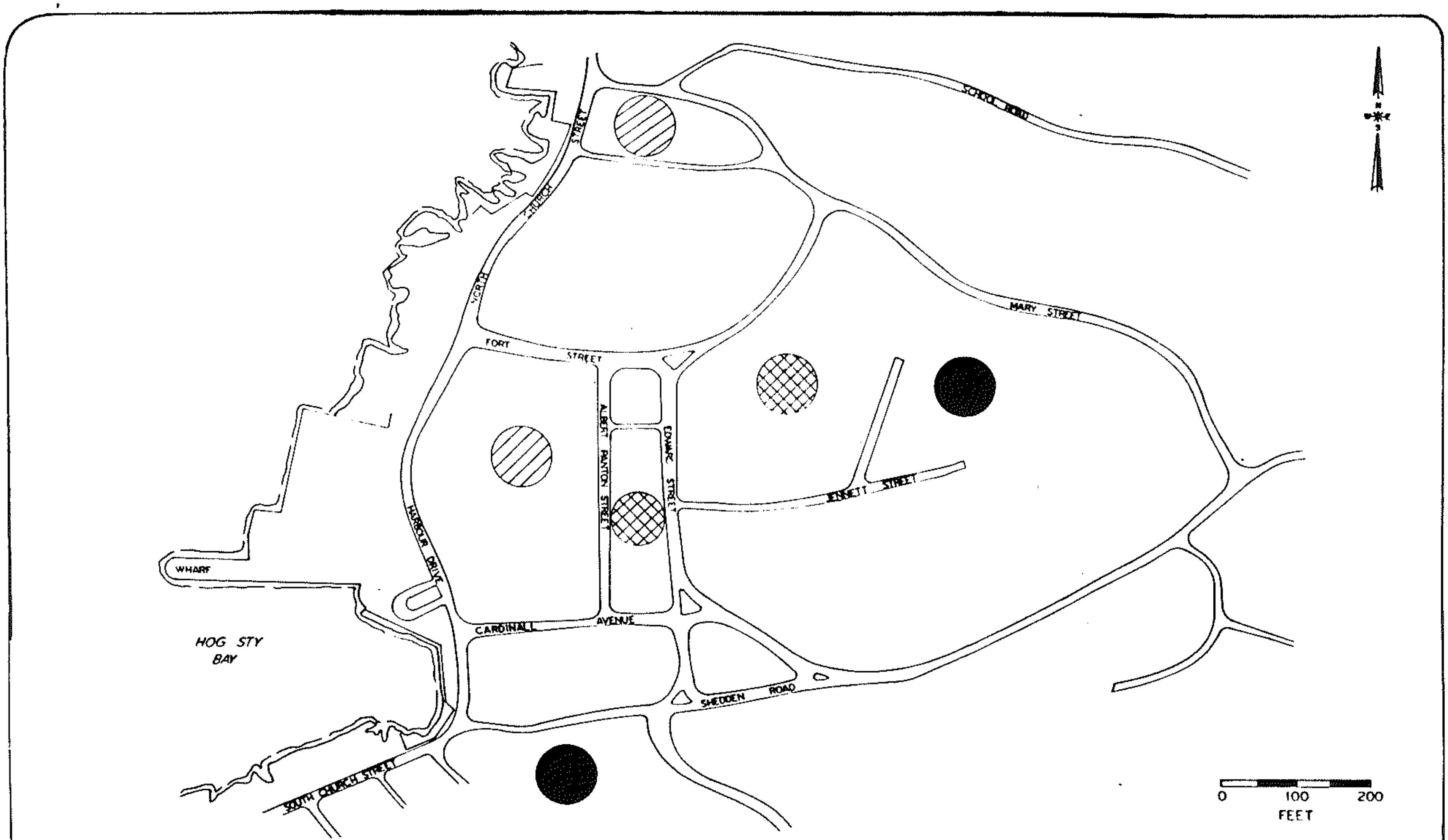
10-Year Parking Programme - The recommended parking programs for Central George Town recognised an expected shortfall of 316 spaces by 1992. Although the MGTP Study lacks sufficient information and resources to recommend specific solutions, general recommendations have been developed. Logical areas for new or improved parking facilities are indicated on Figure P-26.

Immediate development of a public parking facility is recommended for the former Public Works Compound in the southeast quadrant of the Fort Street/Edward Street intersection. The design of this facility must include a separate entrance and exit, both remote from the Fort Street/Edward Street intersection. The facility will be necessary to replace space lost with the construction of the new Post Office, and to serve kerb parkers who will be removed from Fort Street between Edward and Mary Streets. Expansion of the present parking lot serving the Court House is also suggested. Additional spaces could be acquired by building a multi-level garage on the site.

Other possible opportunities for additional parking space are apparent in the block between Harbour Drive and Albert Panton Street, and also at a location between the Tower Building and Mary Street. In the former location several small lots should be combined into a single facility in order to gain space through a more efficient design. The Tower Building site on the other hand is presently used as an unregulated parking facility. It should be developed according to a detailed parking layout and used to supplement parking at the Tower Building and elsewhere.

KERB PARKING RECOMMENDATIONS

Surveys of kerb parking revealed that nearly all kerb space is taken up by long-term users; and there are a significant number of vehicles parking illegally at kerb locations throughout the day. It is evident that these conditions are largely due to the lack of time restrictions on kerb parking and the lack of sufficient resources to restrain illegal parking. If proper traffic flow is to be maintained these conditions must be changed.



WILBUR SMITH ASSOCIATES

MGTP STUDY
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FIGURE P-26

PARKING PROGRAMME
CENTRAL GEORGE TOWN

LEGEND

- IMMEDIATE DEVELOPEMENT
- DEVELOPMENT BY 1992
- LONG RANGE DEVELOPMENT

It is generally accepted that kerb spaces should be reserved primarily for short-term parking, enhancing the convenience for people wishing to shop or to make brief visits for business purposes and thus encouraging multiple use of available space. When such conveniences are denied in the Central Area, shoppers and visitors who use private cars have an incentive to take their trade elsewhere. On the other hand, employees (i.e., all-day parkers) should park at locations which are less convenient than kerb spaces, or should be prepared to pay for the convenience of parking at a nearby off-street facility.

It is therefore recommended that legal kerb parking space available in 1987 should be retained for as long as possible in future years. Use of these spaces should be regulated in a manner that encourages a high rate of turnover rather than use for long term parking.

Allowable Parking Duration - A maximum allowable parking duration should be in effect at kerb spaces located in the prime commercial area. It is recommended that kerb parking be so regulated on all principal streets in the Central Area. The recommended time limit of 90-minutes is adequate for the majority of shopping and business visits. This should be in effect from 8:00 A.M. to 5:00 P.M., Monday through Friday, and from 8:00 A.M. to 1:00 P.M. Saturday. Kerb space in close proximity to high turnover generators, such as the General Post Office; Barclays Bank, Cayman National Bank, etc., should have a time limit of 15-minutes.

Proposed Parking Rates - Past experience with kerb parking fees in many U.S cities reflects a definite trend to increase the cost in more congested areas. Therefore, a set of parking rates appropriate for Central George Town was developed. A minimum charge of $0.25 is recommended for the first half hour, and $0.25 for each additional hour up to a daily minimum fee of $2.00. A minimum charge for monthly parking of $22.00 is appropriate, as noted in Figure P-27.

Kerb Parking Control - To achieve short-term kerb parking control, alternative regulation systems were studied. Recognising the particular needs of the George Town central area, it is recommended that the disc system be adopted for regulation of kerb parking. Such a system involves relatively little investment, and is easy to use by motorists.

In this system, each motorist obtains a parking disc which can be retained for regular use. Upon parking, the motorist sets the initial pointer on the disk to his arrival time. As the space between the pointers is fixed for each disc, the second pointer automatically shows the time when the maximum allowable duration has been reached. The disc is displayed inside the vehicle and traffic wardens can readily check for violations. It is unlawful to reset the pointers once the vehicle is parked.

Revenue is derived from the disc system by selling them to motorists on a quarterly basis. All discs sold for a particular quarter have a distinctive color, and so the use of an expired disc is easily identified. Commercial establishments can be authorized to sell discs to the general public.

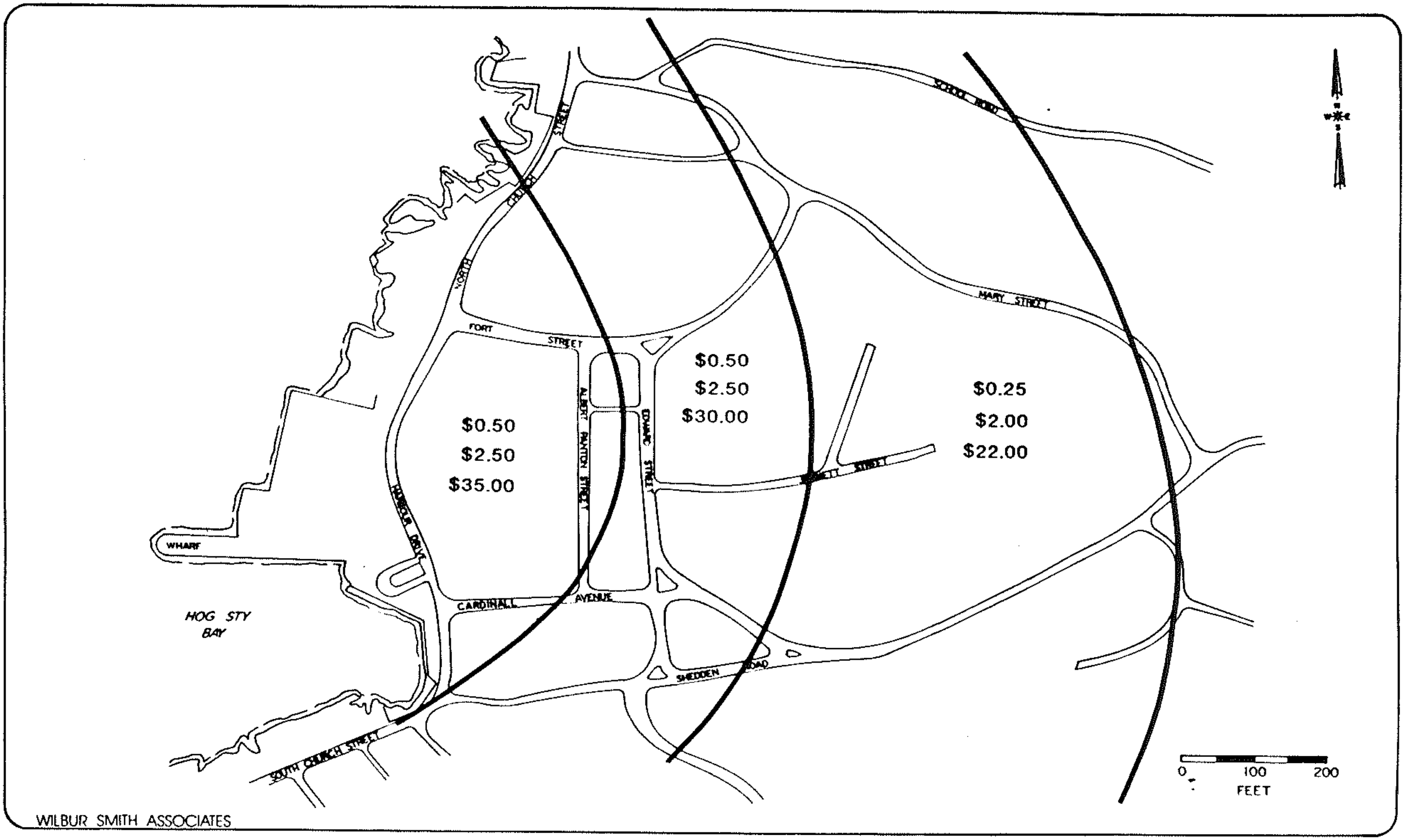
Enforcement - Any parking programs, in order to be reasonably effective, must have a means for enforcement. It is strongly recommended that a traffic warden system be implemented in George Town. Parking fees, collected through the sale of discs (renewable every three months), and fines for violations, should generate sufficient revenue to cover the expense of administering the salaries of the traffic wardens.

GEORGE TOWN PARKING STRATEGY

The recommended parking programme includes additional off-street facilities to achieve a parking supply consistent with future demand. Staging for development of future parking facilities will be largely contingent upon other construction activities in the area.

New facilities may be developed by public or private agencies, or by joint actions. The method chosen is often dependent upon the potential for the facility to generate, either directly or indirectly, sufficient revenue to balance development and operating cost. Thus, the proposed rate schedule may vary slightly to reflect the method chosen to develop the facility, as well as development cost.

Private Financing - It is important to note that a significant proportion of all off-street parking space in the central city is now privately financed, almost entirely in connection with parking lots provided specifically for customers and employees of particular establishments. Thus, to some extent new building development could take care of parking needs being generated if parking regulations were modified to reflect actual demands.



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PROPOSED PARKING RATES
CENTRAL GEORGE TOWN

LEGEND

CHARGE

$0.25 - FIRST HOUR

$2.50 - DAY TIME MAXIMUM

$30.00 - MONTHLY CHARGE

FIGURE P-27

Cooperative plans organised by downtown property owners and merchants have been successful in some cities. One such approach is formation of a non-profit parking authority as has been done is several U.S. cities.

These privately operated agencies acquire property and finance off-street parking development. In a variation of this plan, the city acquires the land through its power of eminent domain and leases it to the corporation which constructs the lot or garage. The non-profit group then leases it to the city, using the revenues to pay off its bond issue. The facility may revert to public ownership at the conclusion of the debt service period.

Government Financing - Enabling legislation would allow the Cayman Islands Government to finance and develop off-street parking facilities, and this option is applicable to the recommended program. More commonly used forms of legislation include:

* Vehicle Parking District Law
* Parking and Business Improvement Area Law
* Pay As You Go

Parking District Law: Such a law would provide that the cost of acquiring and improving off-street parking facilities be assessed upon the real property in the district benefitted. It is widely used, and since the cost is borne by property owners, free or low cost parking may be provided the facility users. A petition by owners in the proposed district would be required to initiate district formation. There should be flexibility in determining benefit, and corresponding assessment, for each individual property. Street parking revenue, general funds, sales tax revenues, or other revenues could be used to help finance the program. Generally an assessment bond issue would be employed to raise the major portion of the capital cost. A board of parking commissioners, appointed by the city, would then control and operate the off-street facilities. Kerb meter revenues within the district could be used for off-street facility maintenance costs to extend the program, or to make refunds on the assessments levied. Several variations of this type of legislation are also available.

Parking and Business Improvement Law: Under this type of legislation the Government could levy a business license assessment within the benefit area. Funds thus would be provided for improvements such as parking, decorations, promotion of public events, music, etc.

Pay As You Go: This is the time-honoured method used where no borrowing is involved. Through leasing of off-street space rather than purchase, a municipality can provide a sizable off-street parking program. Usually, however, this procedure cannot provide as much new parking capacity as quickly as in the case of borrowing programs.

Public Buildings - The Government has set an excellent example in providing parking space at the Glass House. Other Government agencies should follow the lead. Improved parking is needed at the Tower Building, the Post Office and the Harbour complex, to name a few.

CHAPTER SEVEN

RECOMMENDATIONS REGARDING ROADS ORGANISATION, POLICIES AND LEGISLATION

CHAPTER SEVEN

RECOMMENDATIONS REGARDING ROADS ORGANISATION, POLICIES AND LEGISLATION

Much of the Master Ground Transportation Plan (MGTP) Study is concerned with road network planning, i.e. development of a physical plan to guide the road improvement programme over the next ten years. Complementing and supporting the physical plan are various institutional matters encompassing Government's organisation for transport, its policies regarding roads and their use, and the legislation granting authority for various actions to be undertaken and prescribing conditions associated with a variety of subjects. Set forth herein are recommendations which are intended to improve these institutional matters so that the objectives for the ground transport sector are achieved. In particular, these institutional recommendations will provide some of the important tools and means whereby the substantial physical facility and operations plan can be accomplished at maximum cost-effectiveness and minimum inconvenience to the public.

This discussion commences with a number of items which are needed to achieve better utilisation and maintenance of the existing road system and Government's organisational resources associated with road transport. Included are several items under the general headings:

1. Traffic Management and Control (see pages 7-2 - 7-8)
2. Motor Vehicles and Drivers (see pages 7-9 - 7-14)
3. Road Maintenance and Utilities (see pages 7-14 - 7-15)
4. Performance Monitoring (see pages 7-16 - 7-17)

The discussion then addresses several matters related to planning for and expanding the road system as proposed in the MGTP. These discussions are organised under the general headings of:

5. Road Planning and Design (see pages 7-17 - 7-20)
6. Road Rights-of-Way and Access Control (see pages 7-20 - 7-32)
7. Developer Roads (see pages 7-33 - 7-36)
8. Transport Financial Planning (see pages 7-37 - 7-39)
9. Government Transport Organisation (see pages 7-40 - 7-46)
10. Other Legislation Matters (see pages 7-46 - 7-47)

TRAFFIC MANAGEMENT AND CONTROL

Reviews of existing legislation, policies and government organisation suggest that there are a number of improvements which can be made to achieve greater efficiency in traffic management and to improve traffic operations.

Traffic Signs and Markings - At the present time, there is general adherence to international standards for traffic signs and markings but some exceptions do occur. The Cayman Islands are a noted attraction to tourists and part-year residents from abroad. It is most important for road safety and operations purposes that persons only temporarily in the islands immediately understand the traffic signs and markings that they encounter. This can be accomplished if all signs and markings conform to international standards. By using only standard signs, cost economies should be realised when purchasing them abroad, particularly with regard to Road Code specifications concerning the size of signs.

Recommendation: Government should officially adopt a single set of internationally recognised standards for traffic signs and markings, including sign placement. Further, an inventory should be made of all non-conforming signs and markings and a programme should be undertaken to correct deviations from the adopted standards.

Government may wish to consider any one of five possible sets of standards in making choices regarding the set to be used on a consistent basis. These alternatives are:

1. "The Traffic Signs Regulations and General Directions," adopted in England.
2. "Traffic Signs Manual," published by the England Department of Transport, Scottish Development Department and Welsh Office.
3. "Manual on Uniform Traffic Control Devices," published by the U.S. Department of Transportation.
4. "Convention on Road Signs and Signals," published by the U.N. Economic and Social Council.
5. "Inter American Manual on Traffic Control Devices for Streets and Highways," approved by the Pan American Highway Congress.

Changes to Traffic Signs, Speed Limits - At present, any changes in speed limits constitute a regulation and must be referred to Executive Council for decision. It is not apparent that Executive Council would have the technical qualifications to make such decisions, including evaluation of road design speeds, conflicts with turning movements at driveways and intersections, etc. While it is not likely that changes in speed limits are required at frequent intervals or on a broad scale, referral of such matters to Executive Council is a complication resulting in minimum benefits. Nevertheless, the need for all regulations to be approved by Executive Council is an established process and it is not sensible to suggest that speed changes be exempted from this process.

Contrary to the more normal process, it is also understood that Executive Council sometimes elects to change speed limits and traffic signs on its own initiative. There is concern that such changes are undertaken without an appropriate level of technical scrutiny and justification.

> **Recommendation:** Executive Council should not undertake changes to speed limits or signs on its own initiative but should instead advise the cognizant department (PWD if MGTP Study recommendations are adopted) of any concerns it might have and require an investigation regarding such concerns.

Reassignment of Traffic Engineering Functions - Many of the responsibilities associated with traffic engineering (e.g. speed limits, traffic markings, signs and signals) currently are assigned to the Royal Cayman Islands Police (RCIP). In actual practice, the RCIP makes decisions concerning such matters and PWD plans, erects and maintains the traffic control devices. It is not apparent that the RCIP has the technical qualifications, knowledge or training to execute these responsibilities as effectively as might be achieved if these duties were assigned elsewhere within Government.

Further, traffic control devices are one of the important tools that facilitate road use and operations in the most effective and safe manner. Additionally, low cost improvements to the road system often are achievable by using traffic control devices as one of the tools in a comprehensive scheme for localised areas, such as road junctions. With the current split in responsibilities between RCIP (traffic control devices) and PWD (physical improvements), it is less likely that the most cost effective improvements are achieved in every instance.

Recommendation: All responsibilities for traffic engineering measures should be assigned to PWD. This change in the assignment of responsibilities could be accompanied by a requirement that RCIP be informed of all intended PWD actions associated with traffic markings, signs and signals and that RCIP be given an opportunity to provide comment regarding such matters.

This change in responsibilities should not in any way preclude RCIP having the authority, in the course of its duties, to erect temporary barricades, signs, etc. to accommodate unique and short term activities and circumstances.

Traffic Engineering Unit in PWD - While traffic engineering expertise currently exists in PWD, the multiple duties assigned to PWD staff will limit the extent to which these skills can be applied. As will be discussed subsequently, there also is a need for a transport planning function on a continuing basis. These functions could be combined into a new unit within PWD in an effective manner and with concomitant benefits to the transport system.

Recommendation: A small unit should be established in PWD to undertake Traffic Engineering and Transport Planning functions. It is recommended that the unit be comprised of a senior engineer plus a technician. Drafting, clerical and typing support should be drawn from a central pool in PWD until such time as experience indicates the need for support personnel to be assigned specifically to the unit.

Traffic and Parking Enforcement Responsibilities - The RCIP is charged with responsibilities to enforce traffic and parking laws and regulations. There have been some suggestions that the level of enforcement is inadequate, possibly due to limits on the number of uniformed officers in RCIP. Clearly, RCIP must place traffic and parking enforcement at a lower priority than some of its other responsibilities, particularly maintenance of the general state of law and order. Also, enforcement of these types of laws and regulations is an unpleasant responsibility, creates ill will and detracts from the image RCIP would like the public to have of the department.

RCIP clearly is the best suited of Government departments to undertake enforcement of traffic laws and regulations. However, there are some precedents elsewhere which suggest that certain transport enforcement functions can be undertaken effectively by transport agencies through the delegation of limited police authorities. For instance, motor carrier regulations often are enforced by transport agencies. In New Zealand, a special unit was established in the Ministry of Transport to enforce vehicle weight and size regulations and the road pricing scheme applicable to commercial vehicles.

> **Recommendation:** Consideration should be given to the establishment of a small, special "Traffic Warden" unit, perhaps assigned to PWD, to enforce parking regulations (but not traffic regulations). Of course, the Traffic Warden unit could be created within the RCIP also but it does not necessarily follow that the same priority would be given to staffing the unit if this was the case.
>
> As will be noted elsewhere, an important element of the MGTP is the application of parking regulations to achieve the most efficient utilisation of the road infrastructure. Government will need to undertake a significant effort regarding enforcement of parking regulations if full value of the MGTP is to be realised.

Parking Tickets - Under current legislation, RCIP can only enforce parking regulations by handing a citation to the offending vehicle driver. The Police cannot leave a parking ticket on a parked vehicle. Because of this unusual and onerous requirement, most offending parked vehicles therefore can not be cited. Some use of a wheel clamp/lock device ("Denver Boot") has been undertaken recently to improve enforcement of parking regulations at the airport.

As noted elsewhere, more extensive use of parking regulations are an important element in the MGTP. A means to enforce such regulations is essential if the plan is to achieve fully the intended road operations benefits.

> **Recommendation:** Existing legislation should be amended to accommodate the common practice elsewhere of parking citations being left with an offending vehicle. It is understood that there is no problem fundamental to the legal system of the Cayman Islands which would preclude such an amendment.
>
> Consideration should be given to expanded use of the wheel lock device as a deterrent to illegal parking.

Metered Parking - Currently, metered parking is not used to ration parking spaces and to ensure the optimal level of parking turnover on a location specific basis. The MGTP suggests the need to consider metered parking in the George Town business district at some time in the future.

Currently, existing legislation does not accommodate the use of metered parking as one of the tools in traffic engineering. Consequently, amendment of the legislation is required in order to undertake this parking control measure.

> **Recommendation:** The Traffic Law should be amended to permit the use of metered parking at such time as it may be needed as a means of achieving parking objectives. An addition is required to Section 77 providing the authority for regulations to be prescribed concerning the use of metered parking.

Road Encroachments and Sight Obstructions - Section 17 of The Roads Law requires that a written removal notice from the Governor in Council is to be given to the owner or occupier of the land or thing from which an encroachment proceeds. A similar notice requirement is contained in Section 18 regarding sight obstructions at road junctions (Section 16 defines sight obstructions to be an encroachment). The requirement for a written notice from the Governor in Council delays encroachment removal and a number of such encroachments still remain in place after years of existence.

Recently, Crown Counsel for the Attorney General has drafted letters for use by the PWD to request voluntary removal of encroachments and to advise that legal action will be taken if this becomes necessary. Nevertheless, the process requiring the Governor in Council to issue such encroachment removal notices is cumbersome and an unnecessary burden on these high Government officials.

> **Recommendation:** PWD should be empowered, as an agency of Government, to require encroachment removal on a more direct basis. In the event that a property owner considers that PWD may have misused its powers in this respect, the individual affected would have the common law right to apply to the Grand Court for a judicial review.

Reimbursement for Road Damage Costs - As a result of some traffic mishaps, damage is caused to road signs and other traffic and road infrastructure items. Sometimes, fines are assessed which, to a degree, recover the costs imposed on Government to repair the damage. Currently, fine revenues accrue to the general fund while repair costs come out of the PWD budget.

> **Recommendation:** Costs incurred by Government to repair damaged properties should be a factor considered when fines are assessed. To assist in this determination, it should be standard procedure during an accident investigation for the investigating officer to note any damage to public or private property on the accident report. RCIP should follow up by obtaining from PWD an estimate of the cost to repair and restore public property.
>
> PWD should be allowed to recoup such costs, either by establishing a revolving fund or by including a special item in the annual budget which is based on the previous year's collections of cost reimbursements.

Slow Moving Vehicles - Currently, Section 63 of the Traffic Law requires that trucks having a load capacity in excess of three tons as well as towed vehicles may not be driven in excess of 30 miles per hour. Also, speed limitations may be imposed by the Commissioner of Police on invalid or other special vehicles. A proposal has been advanced to delete these requirements because such vehicles impede traffic flow.

It is not uncommon for heavy equipment vehicles to be driven over the roads and to impede traffic by their slow speed. While it is necessary for heavy equipment vehicles to use the roads to move from one site to another, their impact during peak travel hours can be substantial in reducing road capacity and intensifying congestion.

> **Recommendation:** Peak hour restrictions should be imposed on special vehicles which must operate at slower than normal speeds. These restrictions should apply only in those areas where peak hour congestion is experienced. PWD could achieve significant good will with the public by initiating (and publicly announcing) a voluntary programme to keep its heavy, slow vehicles off the roads during peak hours.

Traffic Law Amendments/Redrafting - It is considered that the Traffic Law and the Traffic Regulations "over-legislate" by containing too many details. Because these legal instruments are so detailed, annual modification has proven to be necessary. In fact, even the Road Code has excessive details, particularly specifications of the size of traffic signs and markings. Regarding the size of signs and markings, this limits the flexibility to use signs of different sizes even when it would be in the best interests of traffic safety.

Recommendation: Many of the details currently contained in the Traffic Law, the Traffic Regulations and the Road Code are unnecessary, unduly encumbering and inappropriate. A comprehensive review should be made of these legal instruments and unnecessary details should be purged or moved to the proper legal instrument. For instance, the matter of the dollar amount of fine for traffic violations is more properly placed in the Regulations rather than The Traffic Law. Also, certain items should be deleted from the Traffic Law, Traffic Regulations and Road Code. A prime example of such details is the specification of the size of traffic signs in the Road Code. The Traffic Law should become a piece of enabling legislation rather than prescriptive legislation.

Given the magnitude of changes that possibly would be required, consideration should be given to repeal of current legislation and enactment of essentially a new Traffic Law, Traffic Regulations and Road Code. Government may wish to consider model legislation from the U.K. or the "Uniform Vehicle Code and Model Traffic Ordinance" promulgated in the U.S. by the National Committee on Uniform Traffic Laws and Ordinances as the basis for drafting new legislation for the Cayman Islands.

It is further recommended that an interdepartmental committee be established for purposes for this review and redrafting of traffic legislation. The committee should include representation from the Legal Department, RCIP and PWD.

Because of the technical nature of this legislation it also may be advisable to retain a consultant knowledgeable in both traffic and motor vehicle matters and legislation drafting to work under the guidance of this committee. Because of pressures from their normal duties, it does not appear that redrafting can be completed in a timely fashion if current staff in the relevant government departments are required to add this major undertaking to their existing workloads.

MOTOR VEHICLES AND DRIVERS

In a number of areas, existing policies, legislation and Government organisation satisfactorily address matters associated with motor vehicles and drivers. However, in several cases, improvements can be made as discussed below.

Mechanical Standards for Vehicle Imports - Unlike some countries, Cayman Islands does not have terrain or development characteristics that suggest the need for higher mechanical standards than are typical with motor vehicles. Further, upon being imported, all vehicles must be inspected and certified to be fit for use on the road. There are no apparent problems with the present system that require to be addressed by the MGTP.

Vehicle Safety Inspections - Road worthiness standards for motor vehicles are prescribed in Section 53 of the Traffic Law. Section 24 specifies the requirement for an annual road worthiness inspection. Additionally, Section 7 empowers a vehicle inspector to conduct inspections of any vehicle which he might suspect to be not in roadworthy condition. Under provisions of Section 8, an inspector may require that a vehicle not be used on the roads if it is deemed to be unroadworthy. Section 9 conveys similar authority to any constable.

RCIP currently has the responsibility to perform the annual vehicle inspections. A small staff, specially trained to undertake vehicle inspections, has been assigned to these duties. This assignment largely precludes them from undertaking other police duties and activities. Also, vehicle inspection responsibilities sometimes can create an unfavourable relationship between the public and RCIP.

Despite the vehicle inspection programme, it is not unusual to see vehicles operating on roads while in apparent poor condition. Therefore, there may be a problem concerning enforcement of the vehicle safety inspection, even though road checks are undertaken by RCIP.

> **Recommendation:** Consideration should be given to the transfer of vehicle safety inspection responsibilities from RCIP to the Central Funding Scheme. The Central Funding Scheme has responsibilities for maintenance of government vehicles and equipment. Consequently, the Central Funding Scheme has staff with the mechanical

skills and knowledge to perform vehicle safety inspections, perhaps even more so than RCIP. A modest increase in the staff compliment of the Central Funding Scheme may be necessary in order to undertake these new duties.

Vehicle Loading Standards - Section 53 of the Traffic Law prohibits the operation of a vehicle which is "overloaded or unsafely loaded with passengers or goods". Section 74 requires marking by day and illumination by night of any vehicle with a load overhanging the profile of the vehicle. Section 24 of the Traffic Regulations further stipulates the nature of such markings and requires a police escort if the "overhanging load projects beyond three feet over either side of the vehicle". Regarding unsafe loadings of vehicles, Section 20 of the Traffic Regulations authorises a uniformed constable to require a driver to remove the risk of any nuisance or danger, including "the use of tailgates, coverings and devices for the prevention of spillage".

Some concern has been expressed that these requirements are not enforced adequately. If this is the case, it would appear to be more a problem of limited RCIP staff resources and the demands of duties with higher priorities rather than any absence of enabling authority.

Recommendation: Given the narrow roads in Cayman, the allowance for a vehicle with an overhanging load up to three feet over either side of a vehicle to proceed without police escort appears to be too liberal, particularly regarding lateral overhangs. It is suggested that, in the case of lateral overhangs, the total width of the vehicle and its load should not exceed 8 feet because of the narrow roads and sharp curves which exist.

A "special load permit" scheme should be adopted regarding occasional nonreducible, indivisible oversize movements. Such permits should be required to be obtained before the oversize load is moved on the public road system. RCIP should have the authority to specify the time when such movements may be made (typically this should be during daylight, non-peak traffic hours), the routes that must be used, any need for the vehicle to display warning flags and/or signs, and any requirements for an escort vehicle.

A fee should be assessed for issuance of special load permits to recover Government administration costs plus the inconvenience imposed on the public. Fixed penalties should be assessed for violations of loading standards. These fines should be sufficiently severe to serve as a significant detriment to those who otherwise might choose to take their chances on getting caught.

RCIP should retain enforcement responsibilities for vehicle loading standards. PWD should coordinate with RCIP on such matters, including suggestions regarding circumstances where special enforcement efforts may be appropriate.

<u>Vehicle Size Restrictions</u> - Currently, there are no restrictions in the Traffic Law or the Roads Law about the maximum dimensions of vehicles. Thus far, the number of large vehicles is minimal, primarily consisting of articulated petrol tankers, container trucks and excavation material hauliers. Given the general narrow widths of roads, short curve radii at certain locations, many instances of walls, fences, etc, at the pavement edge, and limited sight distance that often exists, large vehicles pose a significant traffic safety hazard despite their obvious economic necessity.

<u>Recommendation</u>: A thorough study should be undertaken regarding the trucking industry with the principal objective of determining the needs for large trucks in the future and their accommodation in traffic regulations. These needs should be related to road safety considerations and, as appropriate, restrictions should be developed regarding the maximum allowable dimensions for such vehicles.

During the MGTP Study, it was not possible to conduct a thorough study of the trucking industry. In particular, it was not possible to conduct interviews with those industries which use large trucks in the course of their business. Also, data were not available about the size of trucks currently operating in the Islands. Nevertheless, some interim guidelines are provided in Appendix C regarding vehicle size restrictions.

If it is determined subsequently that specific industries require the regular use of vehicles which exceed the maximum dimensions, a special registration permit scheme should be introduced. RCIP should have the authority to issue special registrations in respect to such vehicles once the Department is assured that the exception will address an applicant's unusual and serious hardship and that the good of the general public is not seriously diminished. PWD should be given the opportunity to provide comments regarding such applications as a standard procedure, before operating authority is granted. Where appropriate, special registration permits should be restricted to certain routes and possibly certain times of the day to minimise the inconvenience and safety hazard of the general public.

Vehicle Weight Restrictions - Nothing in current legislation restricts the maximum weight of vehicles (gross weights, axle weights). Nevertheless, research has demonstrated that pavement damage is affected by axle loads in a dramatic fashion. Pavement damage increases exponentially with axle load (a power of 4 to 4.5 has been supported by road research).

Enforcement of vehicle/axle weight restrictions usually involves the use of static scales, sometimes supported by the use of weigh-in-motion (WIM) devices to identify vehicles in the traffic stream which should be required to undergo static weighing.

Greatly increased attention to pavement needs and their high costs has led many road jurisdictions to intensify enforcement of vehicle/axle weight laws. Also, expanded research is finding low-cost methodologies to weigh vehicles. For instance, work is well advanced in the U.S. to develop a piezo-electric WIM device which would cost about U.S. $10,000.

Recommendation: In connection with the trucking industry study recommended above, an investigation should be performed to determine the need to adopt restrictions regarding vehicle and axle weights. The economic costs of pavement damage in relation to axle weight restrictions should be considered. If restrictions on vehicle/axle weights prove to be desirable, a system for enforcement should be developed. Clearly, enforcement costs should be considered in determining the desirability of instituting a vehicle/axle weight restriction. The possibility of restricting heavy vehicles to certain roads also should be considered. This can be done under existing enabling legislation.

Again, it is noted that a thorough trucking industry study was not possible during the MGTP Study. Despite this limitation, interim guidelines are suggested in Appendix "C" regarding weight restriction and their enforcement.

A "special permit" scheme should be established to accommodate those occasions when a weight overload is necessitated because of nonreducible, indivisible loads. Permits should be required in advance. RCIP, with advice from PWD, should be empowered to restrict the hours when such movements may occur and specify the routes that must be used.

<u>**Vehicle Registration and Driver Licensing**</u> - The RCIP has responsibilities to register vehicles, license drivers and maintain the corresponding data systems. Driver licensing is a normal function of police authorities elsewhere but vehicle registration often is performed by a Motor Vehicle Department. Nevertheless, there is no overriding reason why RCIP should not perform vehicle registration functions, particularly since any other agency would have to set up a comparable organisation to undertake these activities. In fact, there is an advantage to police accident and crime investigations to have vehicle registration information readily available at all times. Accordingly, there does not appear to be a strong justification for altering the current arrangement.

It is understood that vehicle registration records include vehicles which have not been in service for some time (scrapped, wrecked).

> <u>**Recommendation:**</u> Consideration should be given to a system of revoking registrations when the annual licence fee has not been paid within a set period of time. The vehicle owner could be given notice of such action and advised of the consequences if the vehicle is operated without being re-registered. This action should help purge the records system of vehicles which have been withdrawn from use.

<u>**Demerit Point System**</u> - Proposals have been advanced to institute a system of demerit points for convictions of traffic offences. These systems work reasonably well in the U.S. as long as persons are not able to acquire multiple licenses under fictitious names.

Recommendation: A demerit point system should be instituted. It should be supported by a computerised system for recording driver licenses and court convictions. The system should be designed to permit easy and accurate correlation between the two data bases.

ROAD MAINTENANCE AND UTILITIES

The following discussion is concerned with four items intended to ensure that resources for maintaining and preserving the existing road system are used most effectively.

Pavement Management System - Pavements are the most costly item in a roads budget. To minimise pavement resurfacing, rehabilitation and reconstruction costs, many road agencies have adopted structured pavement management systems (PMS), most of which are computerised. These systems are used to track pavement condition and performance and to help schedule remedial pavement activities at the optimum, most cost-effective time. For instance, proper scheduling of a resurfacing project can avoid the need for more costly actions. In fact, it can be shown that $1 spent at the optimum point in a pavement deterioration cycle can obviate the need for $4 or $5 just shortly afterwards, i.e. after the pavement condition deteriorates so far that resurfacing no longer is an effective measure.

The MGTP gives significant attention to road construction (improvements to existing roads plus new roads). It is important that these construction activities not divert attention unduly from a programme of maintaining pavements in the most economic fashion. Further, the addition of new roads in the future will increase the need to manage pavements in the most cost-effective manner.

Recommendation: PWD should investigate the advantages of a PMS and the requirements to institute and operate such a system. Given the small size of the road system and the intimate familiarity PWD staff have with the condition of existing pavements, it is possible that a non-computerised PMS may be all that is needed to begin developing a schedule for future pavement needs.

Maintenance Management System - A properly designed road maintenance management system (MMS) complements a PMS by addressing the myriad of additional road maintenance activities. A MMS can assist a road agency, such as PWD, to schedule its maintenance resources most effectively. It also facilitates monitoring production rates and establishing maintenance levels of service guidelines to facilitate maintenance budgeting.

> **Recommendation:** PWD should investigate the feasibility of a modest road MMS as a means of more effectively scheduling and monitoring road maintenance activities and expenditures.

Coordination with Utility Companies - PWD recently inaugurated a monthly meeting with representatives of the various Cayman Islands utilities. The purpose of the meeting is to coordinate civil works and it has proven to be quite successful.

At times, PWD has not been informed of plans to make utility cuts or other digging of roads for utility purposes. Except in those cases where planning consent has been given, this practice is in contravention of Section 10 (2)(c) of the Development and Planning Law which requires, in effect, that such undertakings are to receive advance approval of the Chief Engineer of PWD.

> **Recommendation:** The PWD should advise the utility companies that, hereforth, approval must be obtained from PWD in advance of any digging or other such activities that affect roads. Further, the RCIP should be informed of, and give advance approval for, any utility action that will disrupt traffic or alter traffic safety.

Mosquito Control Trails - Dikes constructed in connection with the mosquito control programme remain the property of the land owner. However, these dikes are sometimes used as access trails even though they are not designed for such purposes. Currently there is no means to ensure that these trails will not become a public obligation for maintenance as a public road.

> **Recommendation:** Legislation should be enacted to protect Government from any future responsibilities to maintain mosquito control trails as public roads.

PERFORMANCE MONITORING

It is most important that various activities be undertaken on a continuing basis in order to achieve the most efficient and cost-effective use of the road system and to plan for future road actions. Two monitoring systems have been discussed thus far in this analysis, i.e. the possible need to institute a structured PMS and/or MMS. Two additional elements to a performance monitoring programme should also be considered.

Traffic Monitoring - It is most important that PWD's traffic monitoring programme be conducted on a continuing basis to assess traffic conditions, patterns and trends.

> **Recommendation:** In places with more extensive road systems, traffic monitoring typically comprises the conduct and analysis of traffic volume count, vehicle classification and vehicle weight surveys. In Cayman Islands, it is possible that the current programme of regular traffic counts at selected locations may be sufficient to permit assessment of traffic trends and patterns and to identify congestion levels and concerns. A review should be undertaken to determine whether the system of data management and analysis should be improved and/or extended in connection with the programme of traffic data collection.
>
> Collection and analysis of vehicle weight data should be undertaken if a weigh-in-motion scheme is introduced in connection with enforcement of new vehicle weight restrictions (see previous discussion and the Technical Appendix).

Accident Analyses - Section 73 of the Traffic Law requires posting of accident black spots, i.e. locations where three or more serious accidents occur within a period of six months. In addition, the Commissioner of Police is required by Section 72 to publish every three months selected statistics regarding traffic offenses and accidents. However, there does not appear to be a routinely performed assessment of the characteristics of accidents and the potential to undertake remedial measures to reduce accident risk. Also, there is no formal requirement for a coordinated review involving both RCIP and PWD.

> **Recommendation:** Analyses should be performed by PWD on a periodic basis regarding the characteristics, trends and patterns associated with traffic accidents and fatalities to determine the need for remedial safety measures (road improvements,

traffic control measures) and to guide planning and design of new road projects. Computerised accident analysis systems from the U.K. and other countries should be considered in establishing this analytical process. Coordination with RCIP should be undertaken as a matter of course. A system of mileposting might be beneficial in order to define more precisely the location of accidents.

ROAD PLANNING AND DESIGN

The MGTP Study involved a substantial transport planning effort which should be updated in the future. Also, certain actions are advisable in order to advance the preliminary plans developed in the MGTP study to final design, as discussed below.

Continuing Transport Planning - The preceding section discussed the need to undertake a structured performance monitoring system centered around traffic monitoring and accident analyses. These are key elements in the continuing transport planning process.

The MGTP Study developed and applied a transport model which facilitates analyses of the impacts of future development and forecasting of future traffic volume on alternative road networks. Further, the study developed and applied a structured economic analysis for evaluation of project justifications.

Uncertainties continue about the amount of future development to be accommodated by the MGTP and the timing of such development. Also, there are uncertainties regarding the level and timing of funding for the recommended road programme. These uncertainties and other matters such as world economies, technology developments, etc., indicate the vital need to undertake transport planning on a continuing basis.

Recommendation: The MGTP transport model should be recalibrated at intervals (about every five years). Planning data need to be compiled in a form that facilitates model updating and recalibration.

As portions of the road programme proposed by MGTP are implemented and/or future development deviates from the levels and distribution assumed in this study, the transport model should be reapplied and evaluations should be performed to determine any adjustments needed in the plan.

PWD should be assigned the responsibilities to maintain and continue the transport planning process incorporated in the MGTP Study. A unit should be established in PWD for these purposes and also to undertake traffic engineering functions as recommended in a preceding section.

In connection with these transport planning activities, regular and continuing coordination should be required between PWD and the Planning Department. The Planning Department should have a staff member assigned to work with PWD and to compile planning data needed for such analyses.

Traffic Levels of Service - The MGTP is based upon a traffic operations goal of Level of Service "C", a condition which will provide a reasonably good standard of traffic mobility. Of course, some roads will exceed this "standard"; in fact, all roads will exceed Level of Service "C" during parts of the day and night.

Recommendation: Future transport planning should be based on the policy guideline/planning goal of Level of Service "C". However, in some instances, practical considerations may require acceptance of a lower level of service at some locations during parts of the day.

Road Design Standards - Cayman Islands has not officially adopted a set of design standards for roads, despite the requirement of Section 3 of The Roads Law. The engineer of the day may choose to use U.S. (i.e. AASHTO), U.K. or other standards. A set of detailed design standards has been proposed by the MGTP Study.

Recommendation: A formal set of design standards for public roads should be adopted as a means of achieving consistency in design and construction practice.

The design standards should formalise PWD's practice of minimum road elevations (levels) which promote achievement of mosquito control objectives.

Road System Classification - Section 3 of The Roads Law provides for the classification of public roads within four categories, viz:

a. "Throughway" means a public road giving direct connection between towns and settlements;

b. "Feeder road" means a public road giving access to a throughroad;

c. "Access road" means a public road giving access from a feeder road or throughroad to any particular premises;

d. "Service road" means a public road intended to be used for the parking of vehicles and for the loading and unloading of goods.

Unfortunately, the classification system has become highly politicised and the gazetted designations no longer provide a clear indication of the service characteristics of all roads.

Recommendation: The system of functional classification was determined to be the most appropriate for the purposes of the MGTP, and should be applicable to both existing and proposed roads. The classification scheme in Section 3 of The Roads Law should be amended to use the MGTP designations as follows:

1. **Primary Arterial Highways** - The roads in this category carry proportionately high traffic volumes between and within centres of population. Their design focuses primarily on serving the needs of the motorist making longer than average distance trips. Access from adjacent land is discouraged except at selected locations.

2. **Secondary Arterial Roads** - Roads in this category provide access to Primary Arterials and connect small communities and nearby areas. Such routes serve long distance trips, but at the same time give access to adjacent property.

3. **Collector Roads** - These roads are primarily of local interest regarding trip length and purpose. They provide access to higher-type roads and facilitate community travel needs. One of their major functions is the provision of access to abutting property.

4. **Land Access Roads** - This category includes local (neighbourhood) streets and minor rural roads carrying a low volume of traffic. They do not serve long

distance trips or large volumes of through traffic. Instead, they primarily provide access to adjacent homes and land.

5. **Freeways** - This class of facility is not presently needed in Grand Cayman. In view of the present pace of development in the study area, however, the category may be required in the future. A freeway serves longer distance through traffic only, and provides no direct access to abutting property. Design features restrict the spacing of access points to about 0.5 miles in more congested urban centres, and to several miles in more rural areas.

ROAD RIGHTS-OF-WAY AND ACCESS CONTROL

Cayman Islands is embarking on a new era in the development of its road system. The MGTP features selective use of limited access and dual carriageway facilities, including major widenings of existing roads. Achievement of the MGTP depends in large measure upon the ability to acquire right-of-way and control road access in a manner which is different from previous practice.

Very much associated with these matters is the principle of compensation to land owners when part or all of their property is taken under Government's powers of eminent domain. In the past, Government has required the donation of rights-of-way on the basis that road access benefits provide adequate compensation. However, this principle does not readily apply regarding some prominent road facilities included in the MGTP.

Another matter of particular importance is the protection of road alignments which are not planned for immediate works but which are included in the MGTP for future implementation. The matter of land reservation is an integral part of the MGTP and is discussed herein.

Table 7-1 present a summary of the major policy recommendations regarding right-of-way acquisition and road reserves. High priority should be assigned to these matters, including supporting recommendations presented in subsequent pages. Implementation of the MGTP will depend in large part upon expeditious adoption and institution of these recommendations.

TABLE 7-1

SUMMARY OF PRINCIPAL RIGHT-OF-WAY POLICY RECOMMENDATIONS

TYPE OF FACILITY/ACTION	RECOMMENDED POLICY
1. Land Access Roads	1A. Continue current policy of no compensation except in unusual cases 1B. Require transfer of right-of-way ownership to the Crown as a condition for Government maintenance of such roads
2. Widening of Existing Roads	2A. Amend Section 3 of the Roads Law so as to apply to both existing and proposed roads. 2B. Use authority of Section 3 of the Roads Law to schedule the width of such roads. 2C. Use the authority of Section 5 of the Roads Law to declare Government's intent to acquire additional width as necessary. 2D. Henceforth, CPA should base setback requirements on the gazetted width. 2E. Amend Section 5 of the Roads Law so that when land is acquired for the road widening, the principle of compensation is applied (i.e. if the land value/ damage exceeds road benefits).
3. Road Reserves for New Arterial Roads	3A. Declare the site of such roads under Section 6 of the Development and Planning Law. 3B. Amend Section 6 to eliminate the five year limit on road reserves. Permit property owners to petition Government for immediate acquisition if the road is planned for more than 10 years in the future. Otherwise, Government should not deny development approval for properties within the road reserve. 3C. Allow hardship cases to petition Government for advance acquisition. 3D. Amend Section 5 of the Roads Law so that when land is acquired for new arterials, the principle of compensation is applied (i.e. if the land value/damage exceeds road benefits). 3E. Under the authority of Section 5 as amended, complete the acquisition of rights-of-way on a timely basis consistent with the schedule for construction of each facility.

Land Access Roads - As already discussed, these roads generally provide access from a higher order road to particular premises. Such roads are not intended to carry large volumes of traffic or to accommodate high vehicle speeds. Typically, these roads are built by developers. Various aspects of developer roads are discussed in a subsequent section. With regard to the matter of rights-of-way, Section 20 (f) of the Development and Planning Regulations requires a minimum right-of-way of 30 feet with a maximum reserve of 50 feet "or as laid down by the Roads Law". Since the Roads Law provisions for setting the dimensions of roads (see Section 3) have not been officially exercised (except as contained in Section 12 of the Roads Law), developer roads at present may be required to be between 30 and 50 feet wide. With regard to the provision of right-of-way for developer roads, the following recommendations are made.

> **Recommendation:** The present practice of requiring developers to provide rights-of-way and to build new land access roads should be continued on the basis of the benefits abutting properties receive from access to the road network.

Rights-of-Way Ownership - Although the rights-of-way associated with some developer roads have been conveyed to the Crown, this is not the practice in all cases even though Government assumes responsibilities to maintain such roads. Since the land remains in private ownership, the owner has the right to do things which would not be permitted on the public road system. For instance, provisions in the Roads Law regarding encroachments are applicable only on a Public Road.

> **Recommendation:** In the case of future roads built by developers, ownership of the road right-of-way should be required to be transferred to the Crown as a condition for Government to accept maintenance responsibilities.
>
> Legislation should be enacted which would require transfer of right-of-way ownership to the Crown on existing privately-owned roads as a condition of continued Government acceptance of maintenance responsibilities.
>
> In each instance (existing privately-owned roads and future developer roads), the property owner/developer should have the perogative to retain ownership of such roads with the understanding that Government will not be responsible for road maintenance.

Should the developer choose to keep the road private, the Central Planning Authority (CPA) should require the developer to form a corporation to assume responsibility for future maintenance of the road. All land owners in the devlopment served by the road would be members of the corporation, thus Jointly responsible for road maintenance.

Right-of-Way Standards and Access Control Features - Section 20 (f) of the Development and Planning Regulations provides for a minimum right-of-way of 30 feet and a maximum of 50 feet unless otherwise prescribed by the Roads Law. Under the Roads Law, the maximum right-of-way width that can be acquired is 50 feet because Government has not exercised its perogative under Section 3 to otherwise prescribe right-of-way widths. Fifty feet is inadequate to accommodate some of the roads included in the MGTP. Nevertheless, the tradition of a 50 feet maximum has influenced expectations and perceptions of the public and the MLA's and will adversely impact the effectiveness of the MGTP if it is not changed.

The MGTP has proposed roadway cross sections with varying right-of-way widths, depending upon the particular facility and the traffic demands which are forecast by the Study. It is important that legislation be enacted to accommodate these dimensions.

Recommendation: Section 3 of The Roads Law provides for the classification of roads. It also requires that standards be laid down regarding the dimensions of such roads and other aspects of design, maintenance and improvement. The road classification, access control features and right-of-way standards proposed in the MGTP should be adopted under the provisions of Section 3. Regarding right-of-way standards this could be accomplished by amending Section 12 and adopting Regulations pursuant to the Roads Law.

Once this is accomplished, Government should exercise the authority of Section 3 and schedule the widths and access control features of roads included in the MGTP.

Widening of Existing Roads - Section 5 of The Roads Law permits acquisition of land for purposes of road widenings, inter alia. Such takings are without compensation to the land owner unless, under Section 8, he submits an application for "assessment of compensation for any undue damage or serious hardship likely to be suffered by him as a result of the intended

Where particular and unique hardships are incurred by specific land owners whose property is planned for acquisition within 10 years, advance acquisition of such properties should be permitted if the landowner petitions Government to do so. Legislation will have to be developed to permit advance acquisition and to define the conditions for considering compensation awards.

Excess Land Takings and Disposal - Sometimes property lines are such that alignments for new roads or widenings of existing roads can result in the severance of parcels or the creation of parcel fragments which have significantly diminished value of themselves. As already discussed, the injurious effect of such takings can be dealt with after amending current laws as recommended herein. Nevertheless, there sometimes will be situations in which it is more logical to acquire entire parcels even though all of the parcel is not needed for the proposed road project.

The Land Acquisition Law addresses in Section 36 the matter of acquiring part of a piece of property. Where the Governor in Council determines that a claim for land severance compensation is unreasonable or excessive, the whole of the parcel may be acquired. This type of provision is not contained in the Roads Law.

Disposal of excess property thus acquired is provided for in the Governor (Vesting of Lands) Law which provides that all Crown lands vest in the Governor to be held in trust by him and his successors in office, and empowers the Governor to sell or otherwise deal with Crown lands. Crown lands can be disposed of to achieve better management of such lands.

Recommendation: If property is to be acquired under the Roads Law, legislation should be enacted which permits the acquisition of entire parcels for road purposes when claims for severance damages are deemed to be excessive or unreasonable or when undue hardship is suffered by the landowner and he petitions Government to so act.

Right-of-Way Surveys - A cadastral survey was performed between 1972 and 1976 at which time a substantial effort was exerted to define as precisely as reasonably possible the descriptions of land parcels. Nevertheless, the property descriptions which were developed are not accurate in all instances. The Lands and Surveys Department sometimes finds that physical evidence in the field of property boundaries and corners differs from the map descriptions of the property metes and bounds. This difficulty significantly complicates land acquisition process. Under the provisions of the Land Acquisition Law, the Lands and Surveys Department must set out the boundaries of the land proposed to be taken and the intended line of work to be executed. Given the scale of right-of-way acquisition required by the MGTP, this process will constitute a substantial burden on the Lands and Surveys Department.

Under the Roads Law, the process is somewhat different. A declaration must be gazetted of Government's intent to acquire certain lands. Section 5 (2) states that "The declaration shall state the locality in which the portion of land is situated, the approximate area of such portion of land, the intention of the Government to construct a road or portion of road over such portion of land without payment of compensation for any interest therein, and the place where a plan can be inspected". Then it is the responsibility of the land owner to declare his interest in the affected property and to petition Government for compensation.

Recommendation: Discussions with Government officers made it clear that Government must accept the responsibility to sort out the difficulties noted regarding inaccuracies in property boundaries. Given the magnitude of the road programme included in the MGTP, it will be necessary to provide additional Lands and Surveys staff to undertake the required surveys. Alternatively, consideration could be given to use of the private sector or contract officers to undertake designated MGTP projects. Otherwise, it is likely that the survey process will adversely affect attainment of the MGTP on a timely basis.

Legal Descriptions of Road Reserves - In the past, roads have not always been built in the precise locations that were intended in the design plans, for a number of reasons. In these circumstances, the legal description of road reserves as gazetted under Section 5 of the Roads Law differs from the actual location of roads as built.

Recommendation: To avoid this discrepancy in the future, Road Regulations should be enacted which will ensure that legal descriptions coincide with road reserves demarcated on the ground. A sequential process should be adopted involving definitive road surveys, preliminary design to establish the road alignment and right-of-way reserve, and final design and construction of the facility within these limits.

Regarding existing roads, the Lands and Surveys Department should be empowered to rectify differences in the legal descriptions of road reserves as compared with their actual physical as-built locations.

__Land Appraisal and Acquisition__ - The Lands and Surveys Department currently processes an average of only about five cases a year where land owners petition Government for compensation for road rights-of-way. In this process, the Lands Officer determines the value of the land to be taken, any damages or injurious effects to the remaining portions of a parcel, and the benefits conveyed to the remaining portions of a parcel through the road construction. In the course of its duties, the Lands and Surveys Department maintains records regarding the selling price of properties. This information is considered in determining the market value of lands for which appeals for compensation are processed in connection with road construction.

__Recommendation__: While the Lands and Survey Department possesses the expertise to make land appraisals and to perform other duties associated with right-of-way acquisition, these staff resources are very limited and usually are engaged in other activities. Therefore, additional staff positions should be assigned to the Department so that there will be sufficient resources to undertake the right-of-way acquisitions required by the MGTP.

__Implementation Plan__ - Recommendations regarding Government's policies in relation to right-of-way acquisition and reservation of lands for future roads undoubtedly are the most important and the most urgent of all the institutional recommendations. Government must institute measures whereby major arterial roads can be widened and new roads constructed in order to implement the MGTP. As discussed, amendments are needed to existing legislation as a matter of some urgency. Also, the exercise of existing authority and the new authority conveyed by amendments to the relevant legislation are pressing matters in some instances. The general sequence for actions required to implement MGTP Study recommendations regarding right-of-way acquisition and access control is presented in Table 7-2.

TABLE 7-2

IMPLEMENTATION PLAN FOR RIGHT-OF-WAY ACQUISITION AND ACCESS CONTROL RECOMMENDATIONS

STEP	ACTIVITY
1	Amend Section 5 of the Roads Law to introduce the concept of compensation for rights-of-way acquisition in the case of arterial roads (i.e. if the land value/damages exceeds road benefits).
2	Amend Section 3 of the Roads Law so as to apply to both existing and proposed roads.
3	Exercise the authority granted by Section 3 of the Roads Law to schedule the locations, width and access control features of arterial roads in the MGTP.

Two concurrent streams of activities are required next. The first stream (designated by the letter A) are associated with implementation of major MGTP projects. The second stream (designated by the letter B) are associated with land reservations for future MGTP roads.

Implementation of MGTP Projects

STEP	ACTIVITY
4A	Conduct definitive road surveys and prepare preliminary design plans to establish the road alignment and right-of-way reserves for the earliest scheduled projects in Phase I, followed in sequence by other MGTP projects.
5A	Exercise the authority of Section 5 to declare Government's intent to construct the roads which have undergone Step 4A.
6A	Prepare final design plans for projects which have undergone Step 5A.
7A	Conduct land appraisals and acquire the rights-of-way for projects which have undergone Step 6A.
8A	Construct the projects which have undergone Step 7A and open them to traffic.

Reservation of Lands for Future MGTP Projects

STEP	ACTIVITY
4B	Amend Section 6 of the Development and Planning Law to eliminate the five year planning horizon restriction in the case of arterial roads. Add a proviso that if planning approval is sought for a property located in a road reserve where the property is not scheduled for acquisition within the next 10 years, Government shall have the right to either grant planning approval or acquire the portion of such property which is within the road reserve.
5B	Adopt the MGTP as part of the Development Plan.

TABLE 7-2 (continued)

IMPLEMENTATION PLAN FOR RIGHT-OF-WAY ACQUISITION AND ACCESS CONTROL RECOMMENDATIONS

STEP	ACTIVITY
6B	Exercise the authority of Section 6 as amended (Step 4B) to protect the MGTP road reserves by denying requests for planning approval in the case of projects which are scheduled within the next 10 years. Acquire properties within these rights-of-way on an ongoing basis when owners petition Government to do so. For properties within road reserves which are not planned within the next ten years, either grant planning approval upon request or acquire the right-of-way depending on which action is in the best interest of Government.
7B	In the case of road widening projects, exercise the authority of Section 5 of the Roads Law (as amended) to declare Government's intent to acquire the designated right-of-way. Thereafter, setback requirements should be based on the scheduled width of the particular board. Acquire the additional widths on an ongoing basis in accordance with Section 6 of the Development and Planning Law as amended (Step 4B).

DEVELOPER ROADS

Recommendations were presented in the preceding section about rights-of-way for developer roads. The following discussion is concerned with other matters associated with roads designed and constructed by developers.

Design Standards - The lack of adopted standards for developer roads is viewed by the Planning Department to be a reason for inconsistence in development approval. Nevertheless, in 1983, PWD did set forth "Subdivision Road Standards, as Presented by the Public Works Department". These "standards" must be treated as guidelines since they enjoy no legal standing.

> **Recommendation**: Under provisions of Section 6 (4) of the Development and Planning Law, a development plan may make provisions for a number of road matters listed in Schedule 2, including dimensional features. The 1983 PWD standards should be given official status under provisions of this law. Also, they might be included in regulations made pursuant to Section 35 (1)(h) of the Development and Planning Law (Revised) or Section 19 (i) of the Roads Law.
>
> Prior to officially adopting the 1983 PWD standards, a review should be made of them to ensure that they still are appropriate. For instance, road reserves are required to be a minimum of 30 feet regardless of road classification (a higher minimum may be appropriate for certain roads). Width requirements should reflect the needs for a usable road surface, suitable shoulders, and accommodations for drainage and utilities.

Design Plans - Private developers currently are not required to submit for approval any type of detailed design plans regarding the nominated road system. Instead, the overall process is as follows:

1. Private developer submits his site plan to the Planning Department. This often is nothing more than a generalised physical layout map showing general road locations.
2. Planning Department grants initial planning approval, usually subject to certain conditions.

3. At times PWD is asked to review and comment on the site plan. However, the efforts of the Planning Department to expedite the review and approval process results in limited time for referral of all plans to PWD for review.

4. Developer builds the roads. Some developers seek PWD inspection or advice during road construction, but most do not.

5. PWD is then called in to physically inspect the road, as built. If PWD believes it is satisfactory, then the Planning Department approves; if not satisfactory, developer should rebuild or otherwise overcome the difficulty.

6. Planning Department then acknowledges compliance with all conditions as appropriate. The Registrar of Lands issues the parcel numbers, with the road being one of the parcels, and the developer can then build his development.

7. PWD assumes responsibility for maintaining the privately owned and built developer road. The developer is not required to guarantee the road works or to transfer the right-of-way to the Crown.

   Recommendation: The current procedure should be amended to require developers to submit more specific plans regarding the roads to be included in the development. This may require amendment of Section 19 of the Development and Planning Regulations.

PWD Review of Site Plans/Design Plans - PWD has no direct authority over how and where developers of private roads connect with the existing public road system. PWD also does not have authority over the internal road networks in private developments. It is the practice of the Planning Department, however, to liaise with PWD on such matters.

> **Recommendation:** A mandatory protocol should be formally adopted involving PWD review and approval of any preliminary, intermediate and final design plan for developer roads. This should include designation by PWD of a particular officer who is to have review responsibilities. During the plan review process, PWD should ensure that connections to the existing road system are consistent with accepted transport planning and traffic engineering practices, and that the road networks within the development are acceptably laid out and in conformance with adopted standards for such facilities (as recommended above). Private driveway entrance locations also should be reviewed by PWD and the Department should determine the needs for traffic signs and markings.

PWD Inspection During Construction - PWD is expected to review developer roads at the site plan stage and to inspect the roads after they are constructed. Although it is desirable for PWD to inspect roads during construction, this is not done normally. There are no enabling powers for construction inspection by PWD and PWD has little or no developer contact under current arrangements.

> **Recommendation:** Current procedures should be modified to require developers to request and obtain PWD inspection of roads during the construction phase. Developers should be required to furnish PWD with detailed design drawings to facilitate review and inspection. The developer should be protected from any unreasonable delays caused by this construction inspection requirement.
>
> Provisions should be made to ensure that sufficient staff are assigned to PWD to undertake these added duties.

Acceptance of Roads for Maintenance - Even the procedures proposed herein to expand the inspection activities of PWD will not ensure that developer roads are constructed totally in accordance with design and construction standards. Nevertheless, current practice involves "automatic" acceptance of maintenance responsibilities by PWD after the Department has given its approval of the road construction. This policy can expose Government to significant future obligations for remedial measures if parts of the roads are not built to standards or poor materials and construction techniques result in early deterioration. At present, there is no way for Government to recover the costs for unusual and premature maintenance and rehabilitation on roads designed and built by developers.

> **Recommendation:** Developers reap significant benefits from the current practice of automatic assumption of maintenance responsibilities by PWD. Therefore, Government should be protected from premature and expensive maintenance and rehabilitation requirements. Developers should be required to post a bond to cover such eventualities. PWD should examine the adverse experiences that have occurred and develop a suitable formula for determining the size of the bond and the time duration for such bonds to be maintained.

Small Subdivisions - Regarding the planning approval process, Section 10 (4) of the Development and Planning Law specifies that "Approval will be given to the subdivision of land into six lots or less subject to compliance with zoning, access and other requirements." Control over subdivision roads is limited in these instances. Section 10 (4) can be used by developers to develop properties in stages, thereby avoiding some of the controls that might otherwise be exercised if an entire parcel was subdivided all at one time.

> **Recommendation:** Section 10 (4) should be amended to preclude further subdivision of a parcel (i.e. beyond the original six lot maximum). Otherwise, the developer should be required to bring prior and proposed development into full conformance with all planning requirements applicable to subdivisions in excess of six lots.

Redevelopment of Buildings - Planning controls are not exercised regarding "the carrying out of works for the maintenance, improvement or other alteration of any building, if the works affect only the interior of any dwelling-house or do not materially affect the external appearance of the building" (see Section 10 (2)(a) of the Development and Planning Law). In such circumstances, there is no way to require conformance with planning requirements, including parking provisions, which would apply otherwise.

> **Recommendation:** Section 10 (2)(a) should be amended to stipulate that the renovation works shall not result in increased parking demands if the existing parking supply is less than that required for a comparable new development. Otherwise, the renovation should be considered to be "development of land" and subject to normal development controls.

Development Provisions for Parking - Section 7 (1) of the Development and Planning Regulations sets forth minimum parking space requirements for new developments. It is understood that these requirements have not been reviewed in some time.

> **Recommendation:** The Planning Department and PWD should jointly undertake a review of Section 7 (1) to determine any need to revise parking space requirements for new development and renovations or redevelopment.

TRANSPORT FINANCIAL PLANNING

Chapter Eight of MGTP Technical Memorandum - "Existing Ground Transport System" describes the project selection and budget formulation process used only with the 1987 Budget. The process used by the Finance Committee has been changed for the 1988 Budget. Obviously, PWD is obliged to follow the instructions it receives regarding the budgeting process. Nevertheless, there are some aspects that should be addressed to achieve an adequate and cost-effective budget. Given the MGTP implications of a greatly expanded roads budget, the financial planning process will be the vital link in its timely accomplishment.

Roads Capital Budget Formulation Duties - Currently, the PWD Engineer - Roads Design has the assignment of preparing the annual budget for capital projects. This assignment is in addition to many other duties assigned to this staff position (see page 295 of Technical Memorandum - "Existing Ground Transport System").

> **Recommendation:** A small PWD unit to undertake traffic engineering and transport planning has been recommended herein. One of the duties of this unit should be the compilation of the annual budget for roads capital works. These duties are a natural extension of the transport planning and engineering functions for which the unit will be responsible. Close coordination will be required with the Engineer - Roads Design and Senior Superintendent - Roads Construction in order to obtain information regarding cost estimates and scheduling requirements for design and construction.

Multi-Year Road Improvement Programme - The Budget developed for all Government expenditures covers only one year. However, many road projects require multiple years to design, acquire right-of-way and construct. Therefore, multi-year scheduling is required even if the approved budget covers only one year. Otherwise, the budget will tend to concentrate only on projects which can be implemented readily. Also, a multi-year programme will facilitate advance design of major projects so that they are ready for construction as soon as funds become available.

> **Recommendation:** In addition to the annual budget, PWD should develop and maintain a forward-looking programme of road capital works. Care should be taken to designate non-budgeted projects so that it is clear that they constitute no commitment of

Government's intent. The multi-year programme should cover about five years of projects and should be based on the level of funding proposed in the MGTP.

Technical Evaluation of Projects - Each year, many road projects originate from the Members of the Legislative Assembly (MLA's). The projects sometimes are of parochial concern. Under present practice, such projects do not undergo a thorough technical evaluation to assess their justification in terms of traffic operations, safety, economic and environmental considerations. As a consequence, it is not possible to ensure that the most worthy and needed projects are undertaken. This, in turn, fails to achieve maximum cost-effective use of scarce road funds. The practice denies the public the assurance that public funds are being used to achieve the greatest good. Also, continuation of the practice will detract from achievement of the MGTP, especially since it tends to overemphasise small projects which can be implemented more readily than the rather substantial projects contained in the MGTP.

Recommendation: Projects desired by MLA's should be presented to PWD so that a technical evaluation can be performed regarding traffic and transport engineering, and economic benefits in relation to costs and road system needs. PWD should report back its findings to the Finance Committee in connection with the annual budget formulation process.

Priorities should be assigned to projects on the basis of their relative merits. A simple, easily applied prioritisation process should be adopted since complex procedures can place excessive demands on staff without a proportional increase in the refinements thus achieved. Projects should be arranged into several groups which are reflective of their priority, the type of project, and the road system classification. Within these groups, priorities for specific projects should not be indicated (unless there is a very strong justification to do so) so that certain perogatives are reserved for the Finance Committee.

Public Participation - PWD has achieved a most commendable high level of interaction and participation with MLA's, other Government departments, business organisations, development interests as well as the general public in connection with the MGTP Study. Consequently, there is a high degree of awareness and interest regarding the MGTP.

Recommendation: The MGTP will be translated into a multi-year programme upon implementation of recommendations presented herein. PWD should maintain a reasonable level of continuing interaction and participation with the public and others so that the accomplishments during the MGTP Study are extended to the implementation stage.

Road Finance Policies - It is Government's implied policy to not levy direct taxes or road user charges, instead using import duties and various fees for revenue generation. In MGTP Technical Memorandum - "Existing Ground Transport System", it was noted that Government derived about $5.4 million from fees charged on vehicles, fuels, etc in 1986. Only $3.2 million was spent on roads. That is, road revenues exceeded expenditures by $2.2 million.

It is the policy of Government that most revenues are deposited in the general fund and there is no revenue dedication or ear-marking of funds. Nevertheless, many countries as well as international lending agencies typically adopt/promote cost recovery policies for transport systems, particularly roads. The economic principles embodied in such policies suggest that output prices should be equal to the marginal cost of producing the output in order to optimise allocations of economic resources.

Developers in the Cayman Islands enjoy a favourable status compared to other countries and jurisdictions. While developers must provide the initial capital works associated with a development, there is no policy of cost recovery for the impacts the development has on Government expenditures. In the case of roads, even the future costs of road maintenance are transferred to Government without obligation to the developer or the purchaser of developed properties.

Recommendation: The MGTP will provide significant benefits to the entire community. However, there is limited opportunity for the high costs of the plan to be recovered from those who potentially may derive unique benefits, that is new property developments. Government should give serious consideration to measures which will achieve a better recovery of road costs. In particular, the development impact fee approach may be appropriate both as an instrument of cost recovery and as a means of growth management. Development impact fees can be structured to address a multiplicity of Government cost impacts in addition to roads (e.g. schools, water and sewer systems, police and fire protection, etc.).

GOVERNMENT TRANSPORTATION ORGANISATION

To some degree, various organisational matters have been addressed in preceding sections. Four areas of particular emphasis are discussed below.

Traffic and Transport Unit - Proposed in previous sections is the creation of a unit in PWD to undertake a number of functions which are important if the objectives of the MGTP are to be realised and the most cost-effective use of road resources is to be achieved.

Recommendation: The placement of the recommended unit should be within PWD, as depicted in Figure 7-1. The key functions for the recommended unit are:

* Transport planning, including continuance of the planning process instituted in the MGTP Study (periodic recalibration and application of the transport model, review and reassessment of the MGTP).
* Traffic engineering (requiring transfer of some responsibilities now assigned to RCIP) including continuing analysis of traffic safety and operational matters and the formulation of remedial measures.
* Performance monitoring, including the systematic and continuing collection and analysis of traffic and road safety data.
* Road safety analysis in coordination with RCIP and encompassing accident blackspot analysis, vehicle safety standards, driver education, training and testing, emergency medical services, road safety publicity, road safety education and road safety legislation.
* Road capital works budget formulation and multi-year programme development, including assistance to the Chief Engineer in the execution of a public involvement process.
* Legislation review and analysis, including the near-term purging of unnecessary and encumbering details from The Traffic Law, Traffic Regulations and Road Code; continuing consideration of desirable changes in the Roads Law including those proposed herein, as well as review of proposed changes in other relevant legislation; and monitoring the institution of changes in legislation recommended by this study and the con- comitant effects of these changes.
* Other duties and responsibilities as may be assigned by the Chief Engineer.

PWD Staff Responsibilities - The MGTP proposes a substantially increased budget for road capital works to alleviate current and forecast congestion, improve road safety and accommodate future development. However, the PWD Roads Unit, as presently staffed, has

PUBLIC WORKS DEPARTMENT

RECOMMENDED ORGANISATION CHART

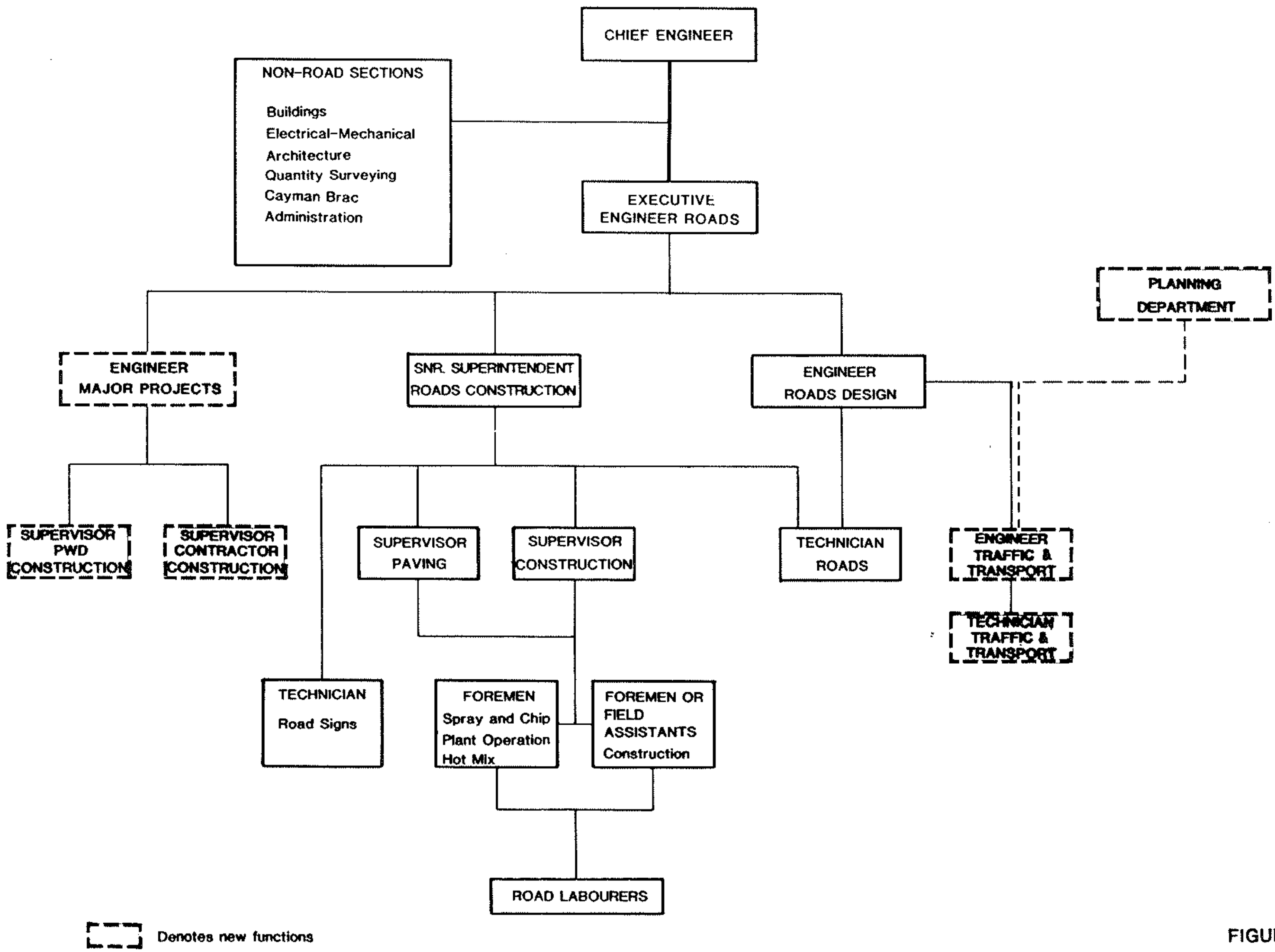

FIGURE 7-1

capacity to carry out only a programme of $1 million - $1.2 million capital/maintenance works annually. This is substantially less than the level of expenditure required to implement the MGTP on a timely basis.

There are two alternative approaches to increase the capacity of PWD to undertake a larger roads programme. One is to substantially increase PWD roads staff. The second is to engage road design consultants and construction contractors to undertake a portion of the increased programme. A combination of the two approaches may be the most logical and viable means, given the size of the MGTP.

> **Recommendation:** Once Government has given at least tacit approval to an increased roads budget, and there is some reasonably firm indication of the funding commitments which Government is prepared to make, staff requirements to undertake the likely size of the road programme should be assessed in detail. Although the MGTP proposes about a five-fold increase in the annual roads capital budget, this will not require a proportional increase in staff. Many projects in the current budget are small in scale and require more staff time per budget dollar than the larger scale projects included in the MGTP.
>
> Staff planning for the MGTP initially should proceed on the expectations that PWD roads staff will need to be expanded to take on more in-house work and/or to supervise design consultants and construction contractors. To accomplish this, a new "Major Projects" Unit should be established in PWD as depicted in the recommended organisation chart (see Figure 7-1). The existing Roads Construction unit would continue to undertake on-going construction and maintenance activities.
>
> If PWD chooses to do much of the MGTP work with its own forces, staff planning probably should assume that the roads staff should be doubled in size over the next two to four years. The actual level of staff increase must depend on the level of road funding and the types of projects to be undertaken by PWD roads staff. Doubling the current size of the PWD roads unit possibly would permit the Department to undertake a road capital and maintenance budget of approximately $2.5 to $3 million annually if all work is done in-house. While this is less than the budget required by

the MGTP, even this scale of staff increase over such a short period of time will be difficult to manage efficiently. Depending on the competence and experience of new PWD staff, a more formal management process likely will be appropriate compared to the present situation in which a high level of direct supervision can be achieved by PWD top management.

Staff increases will be needed initially in the Roads Design unit, followed by commensurate increases in the new "Major Projects" unit. This will accommodate a transition period plus provide the lead time for final design and cost estimation of MGTP projects. In the longer term, increased maintenance staff will be required to protect the public investment in road facilities in a cost effective manner.

The PWD headquarters building and other facilities will have to be enlarged to accommodate the proposed expansion in roads staff. Also, an increased budget for office and field equipment, office furnishings and vehicles will be required.

PWD Staff Recruitment - PWD has been able, in recent years, to retain its Senior Superintendent - Roads Construction, Engineer - Roads Design, supervisors and foreman. However, it has been unable to keep the Executive Engineer - Roads position filled and a vacancy exists at the time of this writing. Recruitment at the highest levels of the Roads Section continues to be a problem.

Recommendation: Filling senior engineering positions in the Roads Section of PWD with Caymanians or persons with Caymanian Status will continue to be a problem as long as there are limited numbers of qualified engineers in the Islands. Government should continue to seek bright and motivated nationals and to encourage their pursuit of engineering educations so that this problem can be remedied in the longer term.

While it may be contrary to current policy and is not a long term solution, Government should give serious consideration to recruiting abroad for a person of sufficient experience and skills to fill the Executive Engineer - Roads position in PWD on a contract basis. Nevertheless, it should be recognised that it will be difficult to find qualified engineers who have extensive experience in both road design and construction/ maintenance. In the long run, PWD should provide experience in both areas to senior engineers as a method of eventually filling the Executive Engineer post internally.

Regarding junior roads engineering positions, there appear to be reasonable opportunities to recruit entry level engineers and engineers with brief professional experience from the U.S., U.K. and other countries. Cayman Islands has much to offer young engineers, including the professional experience they require for professional engineering registration. Implementation of the MGTP could provide such young engineers with more indepth and varied experience than could be gained in a comparable time period with larger road organisations.

Design Consultants - One means of quickly expanding the engineering capabilities to undertake the MGTP is to use road design consultants. This permits a more orderly expansion of PWD staff while also moving quickly into accelerated plan implementation. As PWD expands its roads staff and the Department's capabilities increase, it will be possible to reduce reliance on such consultants if Government chooses this approach. Through the use of road design consultants, Government has immediate access to the engineering experience and skills required to undertake significant road projects on an expanded scale.

Recommendation: Serious consideration should be given to the use of road design consultants, particularly during the initial implementation years of the MGTP. This is particularly appropriate in view of the continuing difficulties PWD has experienced in hiring and retaining senior roads engineering staff. Although no road design consultants are based currently in Cayman Islands, there would be no problem to attract consultants to the Islands once Government has adopted the MGTP and announced its funding intentions. The favourable tax situation in the Islands could be a powerful inducement that Government can use to its advantage.

Road Construction Contractors - Use of road contractors also could be a means of quickly expanding the resources available to undertake a substantially increased roads programme. While PWD has concerns about the costs and qualifications of construction contractors presently in the Islands (existing contractors primarily work for the private sector and on land access roads), the large scale construction projects proposed in the MGTP will be an attractive opportunity for foreign contractors.

Recommendation: Government should seriously consider using road construction contractors to supplement PWD equipment and staff resources. The use of contractors is particularly appropriate on large scale, well-defined projects. Even if costs are somewhat higher than if such works were undertaken by PWD forces, it will be possible to undertake a bigger portion of the MGTP, thereby bringing the benefits of the plan forward to an earlier time than would be possible otherwise.

Right-of-Way Unit - Proposed herein are a number of changes in Government's policies and processes regarding right-of-way acquisition. In particular, compensation to land owners is proposed in some cases as discussed in a preceding section.

Government will have to undertake right-of-way acquisition and compensation on a significant scale if these recommendations are adopted and the MGTP is to move ahead vigorously. Currently, Government is not set up to do this.

Recommendation: A unit should be established to undertake the many and varied activities involved in acquiring rights-of-way required by the MGTP on a timely basis. Right-of-way acquisition should be carefully coordinated with the multi-year road programme and annual budget process so that delays to project implementation are minimised. Also, advance acquisition of right-of-way is recommended in land owner hardship cases and these activities must be undertaken.

The unit set up for these purposes probably should be placed in the Department of Lands and Surveys due to the nature of these activities. Consequently, a close and continuing process of coordination between the Department of Lands and Surveys and PWD will be required.

Alternatively, if Government chooses to contain expansion of the Civil Service, consideration should be given to retaining surveyors and property appraisers from the private sector or employing contract staff who would be assigned to a task force to undertake designated MGTP projects.

Other MGTP Impacts - There will be impacts of varying magnitude on other government functions from the activities associated with implementation of the MGTP. One example is possible impacts on the Legal Department due to a heavy case load from right-of-way compensation litigations. RCIP and fire protection also could be impacted.

Roads Responsibilities - Governmental functions regarding road design, construction and maintenance, traffic operations, and transport planning currently are spread through various Portfolios and Departments. No single member of the Executive Council has all roads functions assigned to him; in fact, five of the seven Portfolios have road roles. Government Departments with discernible road roles include the RCIP, Legal, Judicial, Treasury, Mosquito Research and Control, Lands and Surveys, Planning, and PWD. Four of these Departments have major roles, viz: RCIP, Planning, Lands and Surveys and PWD.

> **Recommendation:** PWD should be designated as the principal Government Department for purposes of traffic engineering, transport planning, road design, road construction, and road maintenance. With the exception of RCIP, the other Government Departments should retain their current responsibilities involving ground transport. Traffic engineering functions of RCIP should be transferred to PWD.

Inter-Departmental Coordination - Other than the official channels through the Principal Secretaries, and the unofficial channels maintained by individuals in the departments, there are few mechanisms by which inter-departmental coordination regarding ground transport is mandated or conducted.

Nevertheless, a substantial amount of inter-departmental coordination has been achieved during the process of performing the MGTP Study. The most visible element in this mutual cooperation process is the MGTP Steering Committee. Less visible is the cooperation which has occurred through direct participation of individual members of the Steering Committee and members of their respective departments in connection with specific aspects of the study. Certainly, this has been a very productive approach to ground transport matters. Benefits have accrued to each department through a more thorough appreciation of such matters and the nuances which must be recognised when certain actions, policies, laws and programmes are undertaken. This effort demonstrates that close cooperation can be achieved without the necessity for official mandates and bureaucratic processes.

Recommendation: The concept embodied in the MGTP Steering Committee should be carried forward during the plan implementation phase. Implementation of the MGTP should be coordinated by the Steering Committee. While less frequent meetings will be required, the various departments should attempt to discuss ground transport matters of mutual concern at least every several months.

OTHER LEGISLATION MATTERS

In addition to the various legislation recommendations presented previously in this chapter, there are two other matters that should be presented.

Developments Without Adequate Access to the Road System - Throughout the Islands, there are many land parcels which are "marginally land locked", their access to the public road system consisting only of access easements recorded as rights-of-way during the cadastral survey process. These easements across other land parcels to the public road system were based on the existence of paths and trails at the time of the cadastral survey. Typically, they constitute "rights-of-way" of about 12 feet in width.

The Planning Department has received legal advice that development authority can not be withheld from the owners of "marginally land locked" parcels even though access to such parcels is quite limited. Consequently, there are many instances throughout the Islands where interior land parcels have been subdivided and residential development has occurred. Streets of approved widths have been built within these subdivisions but they terminate at the boundary of the original land parcel. Discontinuities in the road system occur across the abutting properties in those instances where the owners of such properties have chosen not to develop them.

Recommendation: Distinctions need to be made between developments on "marginally land locked" parcels which already have occurred and those where development could occur in the future if current legislation remains unchanged. In the case where development has already occurred, there appears to be little that can be done without violating the rights of the owners of those properties which separate the development parcels from the existing road system. So long as their properties remain undeveloped, these property owners should not be required to provide additional access rights over and above those already required. However, at such time as the property owners elect to develop their land, there should be a requirement that the development plan include a reasonable connection between the interior parcel's roads and the remainder of the public road system. This connection should be constructed to standards adopted pursuant to recommendations made herein.

Existing legislation should be modified so that further development of this type will not be permitted. The rights of each property owner under current conditions should be retained except that owners of "marginally land locked" parcels should no longer have the right to develop subdivisions which have substandard access to the public road system. If the owners of "marginally land locked" parcels can make arrangements with the other land owners so that an access road of acceptable standards is included in the development proposal, then the Central Planning Authority should be empowered to grant development approval if it deems this to be appropriate.

Not withstanding the above, a land owner wishing to construct a single-family residence on a "marginally land locked" parcel should be permitted to do so if he complies with all other requirements.

Tort Liability - In certain jurisdictions abroad, Government can be placed in significant financial liability in connection with road accidents. This is particularly true under the legal systems adopted by many of the state governments in the U.S. Tort liability becomes accentuated in those circumstances where road standards have been adopted officially since all roads are not built to or maintained at such standards. Also, the litigious situation in the U.S has intensified in recent years, increasing the exposure of road authorities to lawsuits in connection with road accidents.

Discussions with Government officers in Cayman Islands indicates that this is not a matter of great concern at present. In part, this is due to the adoption of British Law as the model for Caymanian Law. Additionally, it is reflective of the culture and traditions of the Caymanian people who do not readily resort to litigation.

Recommendation: Although tort liability is not a current concern, Government should reassess the matter if conditions begin to change materially, thereby causing increased exposure to tort litigation.

APPENDIX A

ECONOMIC COSTS

APPENDIX A

ECONOMIC COSTS

This appendix is divided into two parts. The first develops average vehicle operating costs per mile for a range of typical Cayman Islands vehicles, for use in estimating the benefits of proposed transportation improvements. The second section develops similar average costs related to passenger time, truck cargo inventory time and accidents, for use in the same benefit estimation.

VEHICLE OPERATING COSTS

This part of the chapter develops hybrid vehicles whose characteristics approximate those of the Islands current fleet, together with their associated average per mile vehicle operating costs (VOC). The categories of vehicles included are the passenger car, rental car, taxi, light truck, heavy truck and bus. As indicated earlier, individual vehicle VOC developed in this portion of the report will be used later in the estimation of benefits to be derived from proposed improvements in the transportation system.

Vehicle Fleet Size and Composition - The growth in vehicle numbers between 1970 and 1986 is shown by Table A-1. Unfortunately, data on the earlier years are sketchy. The figures shown are for vehicles "inspected and passed as suitable for operation" by police inspectors. This is a different criterion from vehicles "registered", since it indicates an active vehicle. For example, there are a significantly greater number of vehicles still registered than are inspected, every year. Due to the salt corrosion factor, it would appear that a high proportion of these excess vehicles have been junked. This situation could be corrected by a computer crosscheck of vehicle chassis numbers against licence plate numbers. Regulations, which require that an owner clear the

TABLE A-1
VEHICLES INSPECTED AND PASSED
CAYMAN ISLANDS
(SELECTED YEARS 1970-86)

LINE	VEHICLE TYPE (1)	1970	1975	1980	1985	1986	AVG ANNUAL GROWTH RATES 1975-80	1980-86
1	MOTOR CAR	(2) 1668	3208	3890	6649	7175	3.93	10.74
2	TRUCKS		560	860	1346	1495	8.96	9.65
3	RENTAL CARS	320	300	676	668	743	17.63	1.59
4	TAXIS		117	119	112	103	0.34	-2.38
5	SPECIAL VEHICLES		97	114	220	255	3.28	14.36
6	BUSES			44	127	158		23.75
7	MOTORCYCLES							
8	RENTAL			125	324	442		23.43
9	PRIVATE			39	177	229		34.32
10	TRAILERS				67	109		
	TOTAL	1988	4282	5867	9690	10709	6.50	10.55

1. Figures represent vehicles inspected and passed annually, based upon data from Police Traffic Department, Cayman Islands Government.

2. Trucks not shown

record when he abandons or other-wise disposes of a vehicle, are not being observed. It is understood that this purification of vehicle records is on the Police agenda.

In any event, Table A-1 indicates that there were only 1998 vehicles in 1970 compared to 10,709 in 1986, an increase of 536 percent during the period. Average annual growth rates are shown for the periods 1975-1980 and 1980-1986. A heavy growth (18 percent per year) in rental cars is evident during the first period. Taxis decreased in number in both periods. All categories of vehicle evidenced spirited growth during the second period, except for rental cars and taxis. Rental car growth appears to have flattened out, and the number of taxis continues to decline, although the total capacity of the fleet may have increased due to use of minibuses as taxis. Particularly heavy growth is shown in buses and motorcycles. As indicated, the smaller buses are now being used for taxis.

Overall average annual growth rates for vehicles were 6.50 percent for 1975-80 and 10.55 percent for 1980-1986. The implications of such high vehicle growth rates as far as traffic congestion on the limited Grand Cayman road network is concerned, are obvious.

Table A-2 shows each vehicle type as a percent of total vehicles during the year involved. For example, trucks made up a higher proportion of total vehicles in 1980 than in 1986, and the same held true for rental cars. Taxis have declined in percentage of the overall as well as absolutely in number. Significant reductions in proportions of other vehicles were not evident during the year indicated.

Vehicle Distribution - Due to the restricted road network, it would appear that the proportions of vehicles by type on roads in the study area should be similar to those in the national vehicle fleet.

TABLE A-2
VEHICLES INSPECTED AND PASSED BY PERCENT OF TOTAL
CAYMAN ISLANDS
(SELECTED YEARS 1970-86)

		BY PERCENT OF TOTAL				
LINE	VEHICLE TYPE (1)	1970	1975	1980	1985	1986
1	MOTOR CAR	83.98	74.92	66.30	68.62	66.96
2	TRUCKS		13.08	14.66	13.89	13.96
3	RENTAL CARS	16.02	7.01	11.52	6.89	6.94
4	TAXIS		2.73	2.03	1.16	0.96
5	SPECIAL VEHICLES		2.26	1.94	2.27	2.38
6	BUSES			0.75	1.31	1.48
7	MOTORCYCLES					
8	RENTAL			2.13	3.34	4.13
9	PRIVATE			0.67	1.83	2.14
10	TRAILERS				0.69	1.05
	TOTAL	100.00	100.00	100.00	100.00	100.00

1. Based upon Table A-1

However, a survey of 8700 vehicles at eight traffic points in the George Town area on August 27 and 28, 1987 indicated a different distribution of vehicles.

PERCENT OF VEHICLE FLEET

VEHICLE TYPE	Cayman	Study Area
Motor Car	66.96	59.15
Rental Car	6.94	6.13
Trucks	13.96	20.10
Taxi's	0.96	3.28
Buses	1.48	4.05
Motorcycles/Other	9.70	7.29
Total	100.00	100.00

The mix shown is higher in proportions of trucks, taxis and buses than in the national vehicle fleet mix. This is what would be expected of the George Town area, which is the major logistics and population centre in the Islands.

Vehicle Characteristics - In developing typical vehicles for the vehicle operating cost exercise, it is necessary to evaluate the characteristics of the present vehicle fleet and to make assumptions as to the probable future fleet composition. In considering vehicle characteristics, make and model are of significance, as well as numbers, since the object is to develop hybrid vehicles which will adequately represent the wide range of vehicles in the present fleet. The basic source of vehicle data used for developing typical vehicle was records of the Royal Cayman Islands Police.

Private Cars - A five percent sample was taken from the current Police all-vehicle computer printout. The sample was then reduced to 345 vehicles by deleting vehicles other than cars plus passenger cars older than 1980. This weeding out of vehicles was necessary for several reasons. First, the list contained considerably more vehicles than the total (10,709) which was registered and inspected in 1986. The seven -year cutoff was selected because a survey of local passenger car dealers and operators indicates that this was the maximum useful life which could be expected from an Islands vehicle, due to salt corrosion. The average number of cylinders per vehicle for the 345 cars in the sample was 4.7. A study of fifteen of the better selling passenger cars available on the local market (thirteen 4-cylinder and two 3-cylinder) indicated that the average number of cubic centimeters per cylinder was around 411. The engine capacity of the typical passenger car was then calculated at 1931 cc(4.7 cylinders x 411 cc/cylinder). This estimate considers two separate factors, presence of larger vehicles in the overall fleet (4.7 cylinders) and the smaller cylinders in 4 cylinder engine (411 cc/cylinder). It is conservative because there are a considerable number of 6 cylinder autos in the inventory (e.g., the Ford Taurus at 3000 cc) plus some 8 cylinder cars. However, according to the records, the passenger car fleet is principally 4 cylinder, and there is a long-time trend in automobile manufacturing towards smaller and more efficient engines. A study of 16 of the better selling motor car models on the islands market indicated an average vehicle weight of 2158 lbs.

Rental Cars - Police registration records indicate a population of 743 rental cars in 1986. Operator interviews and observations indicate that these are predominantly three and four cylinder vehicles. A composite rental car vehicle of 1395 cc engine capacity and total weight of 2100 lbs was therefore developed, based upon available data.

__Taxis__ - In 1986, there were 103 taxis registered and inspected in the Caymans. A 13 percent sample revealed a predominance of large U.S. cars (including station wagons), averaging 5.7 cylinders per vehicle. These cars are generally imported second-hand from the States. However, between 1980 and 1986, the number of second-hand cars imported dropped from 865 to 237, a decline of 365 percent. Interviews with taxi operators also indicated that the trend now is towards the use of 4-cylinder minibuses which have a capacity of up to 14 passengers. Although more expensive, these vehicles permit the operator to handle a variety of passengers, and are economical to operate. A composite vehicle was therefore made up from a larger American car and a minibus with a 2280 cc capacity engine and a total wight of 3305 lbs. A reduced number of large used American cars will probably continue to be imported for use as taxis simply because they are so much cheaper than the vans.

__Light Trucks__ - The bulk (88 percent) of the 1495 trucks on the Islands do not not exceed one ton in empty (also called kerb or tare) weight. Another 6 percent are in the 1 to 3 ton category. The great majority of the Islands trucks (94 percent) is therefore in the light truck category, defined for the purposes of this study as goods carriers having a total weight of 3 tons or less. A 10 percent sample of the 1 ton and below trucks indicated that four manufacturers (Toyata, Ford, Mitsubishi and Chevrolet) accounted for 86 percent of the total.

A further 10 percent sample of trucks up to 3 tons indicated that 77 percent of those on-hand were made by Ford. A composite light truck was developed based upon pickup_(and up to 3 ton trucks) characteristics. This vehicle has an engine capacity of 2115 cc and a total weight of 2514 lbs. with a gasoline engine.

__Heavy Trucks__ - These vehicles (all over 3 tons), constitute less than one percent of the Islands vehicle fleet. In 1986, they were split almost equally between the up to 5 ton and over 5 ton categories. A hybrid vehicle was therefore developed from typical vehicles in the 5 ton classifications, with an engine capacity of 7768 cc and a tare weight of 10,000 lbs. This selection was based on the assumption that the 5 ton (tare) classification would represent a good average, since the fleet was divided equally above and below that weight category. Special vehicles which also made up less than one percent of total vehicles were included in this category.

As an aside it appears that most heavy trucks (some used) are purchased individually in the U.S. by the operator instead of through local dealers. Many old units are still in operation, e.g., one trucker indicated that he was still running a 1954 model having replaced the salt-corroded cab several times.

Buses - In making up a typical bus, a representative minibus was developed, then a larger bus, and the two were then combined into a hybrid bus vehicle.

* Minibus - a minibus is defined here as a passenger carrying vehicle of 20 persons capacity or less. This classification is compatible with the vehicle registration scheme, which includes bus categories for up to 10, 20 and 30 passengers, plus an "over 30" classification. The 20 passenger bus number is operated on the town bus runs. There were only 112 buses of this classification registered in 1986; seven buses of up to 10 passenger capacity and 105 of up to 20 passenger capacity. A five percent sample of Police registration data on these vehicles indicated a heavy concentration of Japanese models. A vehicle of 1967 cc engine capacity and empty weight of 3600 lbs was selected as representative of the minibus category for this study.

* Larger Bus - Passenger carrying vehicles of over 20 capacity are classified as buses, for the purposes of this study. In 1986, there were only 46 of these vehicles registered, or 0.43 percent of the total buses recorded. After deletion of vehicles purchased before 1980, a 13 percent sample from Police records turned into a four percent sample, with an evident concentration in Japanese models. A typical bus with a 3300 cc engine and 6000 lb total weight was selected as representative of this vehicle category.

* Hybrid Bus - a hybrid vehicle was then made up from the two vehicles whose characteristics have been described, based on the present distribution of vehicles in the fleet (71 percent are 20 passengers and below and 29 percent are above 20 passengers). This hybrid vehicle which has an engine capacity of 2354 cc and a total weight of 4296 lbs is referred to subsequently simply as a bus.

* Motorcycles - The engine capacity of motorcycles currently imported onto the Islands is limited to 90 cc, although there are a few older models with larger engines still on hand. As indicated earlier vehicle operating costs are not ordinarily estimated for these vehicles, because the average operating cost per mile is too small to generate significant benefits.

In summary, the vehicle characteristics are summarised on Table A-3. As indicated, these characteristics were developed through interviews with local automobile dealers, as well as from annual Police records on vehicles inspected. Models of vehicles considered included 18 different passenger cars, two taxis, three motorcyles, four minibuses/buses and three trucks.

TABLE A-3
TYPICAL VEHICLES
CAYMAN ISLANDS

LINE	VEHICLE TYPE	ENGINE CAPACITY	AVERAGE WEIGHT TARE	AVERAGE WEIGHT GROSS
		(cc)	(lbs)	
1	PRIVATE CAR	1932	2158	-
2	RENTAL CAR	1395	2110	-
3	TAXIS	2280	3305	4685
4	LIGHT TRUCK	2115	2514	4726
5	HEAVY TRUCK	7768	10000	26500
6	BUS	2354	4296	7671
7	MOTORCYCLE	90	-	-

Source: Sample of vehicles registered with Cayman Islands Police and review of Technical Data on 29 different vehicles currently sold in the Islands

Vehicle Licensing/Inspection Fees- There is a wide range of fees charged for vehicle inspection and licensing, as well as for driver testing and licensing, as indicated by the the following:

FEE BASIS	AMOUNT (CI$)
Driving Test Fee	25.00
Provisional Licence (Valid for six months)	10.00
Full Licence Group four (Valid for three years)	60.00
Visitors Permit (Valid for six months)	2.40
Annual Vehicle Inspection Fee	10.00
Licence Plates, per pair	10.00
Annual Vehicle Licences	
Motorcycle	25.00
Motorcar	130.00
Taxi	150.00
Rental Car	180.00
Omnibus, Over 30 Passengers	200.00
Truck, over five tons	300.00

Basic VOC Data - The basic data from which the vehicle operating cost was developed are shown by Table A-4. Costs are shown as financial and economic. Economic cost is the market price less taxes, import duties and other transfer. Several points are notable from this data. First, rental cars are smaller than the usual size of passenger cars. The taxi vehicle data shows the results of the growing use of minibuses on taxis. The heavy trucks, although few in number are significantly heavier than the light trucks, which are mostly pickups. The hybrid bus data are skewed towards the minibus, because of this higher proportion of such buses to total buses operated. Since gasoline and diesel fuel are sold in Imperial gallons, the cost must be corrected to costs per U.S. gallon, in order to use the FHWA factors. The corrected (economic) cost is CI$0.99 for gasoline and CI$0.89 for diesel, as shown.

Depreciable Value - For the purposes of study calculations, the depreciable value of a vehicle is its economic value, less the economic cost of the tyres and tubes since wear on these items is calculated separately. Depreciable

TABLE A-4
BASIC VOC DATA

LINE	ITEM		UNIT	TYPE COST (1)	CAR	RENTAL CAR	TAXI	LT(8)	HT(8)	BUS
							(CI$)			
1	NEW VEHICLE	(2)	EACH	F E	11000 8700	8074 7200	16700 13100	10300 8100	44825 35157	16100 12600
2	GASOLINE	(3)	GAL (4)	F E	1.33 1.20	1.33 1.20	1.33 1.20	1.33 1.20		1.33 1.20
3	DIESEL	(3)	GAL (4)	F E					1.20 1.07	
4	ENGINE OIL	(3)	QT (5)	F E	2.00 1.67	2.00 1.67	2.00 1.67	2.00 1.67	2.00 1.67	2.00 1.67
5	TYRES	(2)	EACH	E	50 42	40 33	75 63	62 52	187 156	81 68
6	MAINT. LABOUR	(2)	HOUR	E	7.50	7.50	7.50	7.50	8.75	7.50
7	CREW	(2)	HOUR	E	-	-	5.10	6.00	7.00	5.00
8	INTEREST	(2)	PERCENT/YR (6)		13	13	13	13	13	13
9	ANNUAL OVERHEAD	(2)	PERCENT/YR (7)		13	18	15	15	15	18

1. F= Financial costs; E= Economic costs
2. From Dealers and Vehicle Operators
3. From ESSO Standard Oil SA, Ltd
4. Imperial Gallon (1.20094 of a U.S. gallon). Economic cost of U.S. gallon would be CI$ 0.99 for gasoline and CI$ 0.89 for diesel
5. U.S. Quart
6. Percent of Depreciable Cost
7. Percent of total other Cost
8. LT= Light Truck; HT= Heavy Truck

values for the vehicle categories used in this study are shown by Table A-5. The Table also includes the items used in developing depreciable value, e.g., annual and lifetime miles, years of vehicle life, etc.

Average Persons per Vehicle - In order to develop average vehicle passenger loadings, roadside surveys were conducted on August 27 and 28, 1987, at eight traffic points in the George Town area. A total of 8700 vehicles were observed during this survey. The persons-per-vehicle results are as shown on Table A-5 for all vehicles except the bus, where the survey results were adjusted. Here the surveys indicated an average loading of 3.53 passengers per bus. Since the capacity range in these vehicles is from 7 to over 30, these particular survey results showed that the survey points might have been improperly placed to catch bus traffic. Accordingly, a separate estimate was made of the probable average loading of this vehicle. A composite loading of 17.9 persons was developed from a combination of the 20-passenger and below and over 20-passengers vehicle, based upon vehicle proportions in the present vehicle fleet. It was then assumed that half of the trips would be made empty (due to point pick-up of tourists) and that the bus would be loaded to no more than 60 percent capacity on the average. The result was an average loading of 5.37 persons, which was then adopted. In calculating time benefits for all vehicles except private/rental cars, the drivers would be omitted.

VOC By Vehicle Type - The remainder of this portion of the report describes the manner in which vehicle operating costs were developed for each of the six vehicle involved. Basic reliance has been place upon a recent FHWA (Federal Highway Administration, U.S. Department of Transportation) publication for technical costing factors used in the analysis[1]. This reference (which is hereafter referred to as " FHWA Factors") builds upon the pioneering work done

(1) FHWA, Vehicle Operating costs, Fuel Consumption and Pavement Type and Condition Factors, June 1982.

TABLE A-5
DEPRECIABLE VEHICLE VALUE

NO.	ITEM (1)		UNIT	TYPE VEHICLE					
				CARS	RENTAL CAR	TAXI	LT	HT	BUS
1	ANNUAL MILEAGE	(2)	000	12	37	30	20	17	36
2	VEHICLE LIFE	(1)	YEARS	7	4	5	7	7	6
3	LIFETIME MILEAGE	(1)	000	84	148	150	140	119	216
4	AVG PERSONS/VEHICLE	(3)	PERSONS	1.61	1.61	1.85	1.68	1.32	5.37
5	ECONOMIC VEHICLE COST (LESS TYRES,TUBES)		CI$	8729	7160	13078	8083	35157	12596
6	TYRES, EACH	(1)	CI$	42	33	63	52	156	68
7	NO. TYRES PER VEHICLE	(1)		4	4	4	4	10	4
8	TYRE COST (LINE 6 X LINE 7)	(1)	CI$	168	132	252	208	1560	272
9	DEPRECIABLE VALUE (LINE 5 - LINE 8)		CI$	8559	7028	12826	7875	33597	12324

(1) Based on Dealer-Operator interviews, Aug.-Sept. 1987.
(2) Statute miles
(3) Based on Survey of 8750 vehicles in George Town area, Aug. 27-28, 1987

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6	TYRES, EACH	(1)	CI$	42	33	63	52	156	68
7	NO. TYRES PER VEHICLE	(1)		4	4	4	4	10	4
8	TYRE COST (LINE 6 X LINE 7)	(1)	CI$	168	132	252	208	1560	272
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(1) Based on Dealer-Operator interviews, Aug.-Sept. 1987.
(2) Statute miles
(3) Based on Survey of 8750 vehicles in George Town area, Aug. 27-28, 1987

by analysts such as Winfrey[2] and de Weille[3], and improves upon the later works such as the AASHTO Red Book[4]. Due to Islands topography, factors for paved tangent roads are used in all cases. Reliance was placed upon de Weille[3] for interest cost factors, since these were not included in the flow of FHWA reference data. Costs were calculated in increments of five miles per hour (mph) from 5 to 50 mph.

Consumption Factors - The basic FHWA consumption factors upon which the VOC calculations are based are shown in Tables A-6 through A-8. These factors are expressed in terms of usage per 1000 miles, for convenience. If stated on a per mile basis, these factors would represent very small quantities.

Basic Test Vehicle Characteristics - Table A-9 indicates the characteristics of the FHWA test vehicles which are considered most compatible to the three hybrid study vehicles.

The following discussion covers the development of VOC for each typical vehicle which has been selected. In this process, the FHWA consumption factors were adjusted as necessary, based upon differences between the FHWA vehicle characteristics shown, and those indicated by typical study vehicles in Table A-3.

(2) Robley Winfrey , Economic Analysis of Highways, 1968, International Textbook Co., Scraton, PA, U.S.A.

(3) Jan de Weill, Quantification of Road User Savings, World Bank Occasional Paper No. 2, IBRD, 1966.

(4) American Association of State Highway and Transportation Officials, A Manual on User Benefit Analysis of Highway and Bus - Transit Improvement - 1977, 1979, AASHTO, Washington, D.C.

TABLE A-6
CONSUMPTION FACTORS
(PRIVATE/RENTAL CARS)

USE PER 1000 STATUTE MILES (1)

SPEED (MPH)	FUEL (2) (GALLONS)	OIL (3) (QTS)	TYRES (4) (% WEAR)	DEPREC (5) (% DEP VALUE)	MAINT (6) (% AVG COST)	INTEREST (7) (% DEP VALUE)
5	67	3.8	0.06	1.59	46.7	1.620
10	64	2.4	0.07	1.34	47.7	1.350
15	50	1.8	0.08	1.20	49.3	1.104
20	36	1.6	0.10	1.10	51.5	0.832
25	24.5	1.5	0.12	1.02	54.3	0.672
30	27	1.4	0.14	0.95	57.3	0.560
35	24	1.4	0.18	0.90	60.6	0.480
40	24	1.4	0.23	0.85	63.9	0.416
45	24.8	1.4	0.29	0.82	67.5	0.368
50	25.5	1.3	0.37	0.79	71.2	0.336

(1) At Constant speed, zero grade.
(2) FHWA VOC Factors, pg. B-2, Data in U.S. gallons.
(3) Ibid., pg. B-10, Data in U.S. quarts.
(4) Ibid., pg. B-18.
(5) Ibid., pg. B-34.
(6) Ibid., pg. B-26.
(7) J. De Weill, Quantification of Road User Savings, IBRD, 1970, pg.22.

TABLE A-7
CONSUMPTION FACTORS
(TAXIS/LIGHT TRUCKS/BUSES)

USE PER 1000 STATUTE MILES (1)

SPEED (MPH)	FUEL (2) (GALLONS)	OIL (3) (QTS)	TYRES (4) (% WEAR)	DEPREC (5) (% DEP VALUE)	MAINT (6) (% DEP VALUE)	INTEREST (7) (% DEP VALUE)
5	55.4	3.8	0.08	1.22	46.9	2.106
10	55.4	2.4	0.08	1.03	47.8	1.756
15	47.3	1.6	0.09	0.93	49.4	1.435
20	38.7	1.6	0.11	0.85	51.6	1.082
25	36.0	1.5	0.13	0.79	54.4	0.874
30	37.3	1.4	0.16	0.73	57.4	0.728
35	37.6	1.4	0.20	0.66	60.6	0.624
40	38.0	1.4	0.26	0.63	64.0	0.541
45	40.5	1.4	0.32	0.61	67.6	0.478
50	43.0	1.4	0.41	0.59	71.3	0.437

(1) At constant speed, zero grade.
(2) FHWA VOC Factors, pg. B-3. Data in U.S. gallons.
(3) Ibid., pg. B-11.
(4) Ibid., pg. B-19.
(5) Ibid., pg. B-34.
(6) Ibid., pg. B-27.
(7) J. De Weille, Quantification of Road User Savings, IBRD, 1970, pg.22.

TABLE A-8
CONSUMPTION FACTORS
(HEAVY TRUCKS)

USE PER 1000 STATUTE MILES (1)

SPEED (MPH)	FUEL (2) (GALLONS)	OIL (3) (QTS)	TYRES (4) (% WORN)	DEPREC (5) (% DEP VALUE)	MAINT (6) (% AVG COST)	INTEREST (7) (% DEP VALUE)
5	236.0	9.60	0.10	0.74	46.1	1.599
10	217.0	6.20	0.11	0.59	47.1	1.338
15	198.0	4.90	0.13	0.50	48.2	1.082
20	179.0	4.40	0.15	0.44	49.7	0.811
25	168.0	4.10	0.18	0.40	51.4	0.645
30	156.0	3.80	0.21	0.37	53.4	0.541
35	153.0	3.60	0.25	0.34	55.7	0.458
40	149.0	3.40	0.29	0.33	58.5	0.395
45	149.0	3.10	0.34	0.31	61.7	0.354
50	149.0	3.00	0.40	0.30	65.4	0.333

(1) At constant speed, zero grade.
(2) FHWA VOC Factors, pg. B-7.
(3) Ibid., pg. B-15.
(4) Ibid., pg. B-23.
(5) Ibid., pg. B-34.
(6) Ibid., Pg. B-31.
(7) J. De Weille, Quantification of Road User Savings, IBRD, 1970, pg. 22.

TABLE A-9
VEHICLE CHARACTERISTICS
FHWA TEST VEHICLES VS STUDY VEHICLES

		FHWA VEH. A	FHWA VEH. B	FHWA VEH. C
		STUDY VEHICLES		
VEHICLE CHARACTERISTICS (1)	UNIT	PRIVATE/RENTAL CAR	TAXI/BUS/LT TRUCK	HEAVY TRUCK
ENGINE CAPACITY	cc	1967	3770	6548
TARE WEIGHT	lbs	2500	3500	15000
LOADED (GROSS) WEIGHT	lbs	2800	3800	35000
NO. AXLES	EACH	2	2	3
NO. CYLINDERS	EACH	4	6	8
BODY STYLE	-	SEDAN	SEDAN	FLATBED
FUEL	-	GASOLINE	GASOLINE	DIESEL

Source: FHWA VOC Factors, pg.5.

Private Cars - The basic test FHWA vehicle in the category was a 4-cylinder subcompact. The fuel consumption factors were reduced by two percent, to account for the difference in engine size between the FHWA vehicle (1967 cc) and the study vehicle (1932 cc). No increase in the oil consumption factor was made, based upon a comparison of factors for different size vehicles. Since the total weight of the FHWA vehicle was greater than that of the study vehicle (2580 lbs, vs. 2158 lbs). the tyre user factors were reduced to 86 percent of its value. Maintenance factors (percentages applied against average cost per 1000 miles) were reduced by 1.34 percent to account for the difference between the size of engine in the hybrid vehicle (1932 cc) and the FHWA test vehicle (1967 cc). The actual difference in size is two percent, but only 67 percent of the difference was taken, since the difference in size would be only partly reflected in maintenance. Depreciation was calculated by dividing the depreciable values ($8559) by the lifetime mileage (84,000 miles) times 1000, in order to obtain an estimate of depreciation expenses per thousand miles, and FHWA factors were used. Interest costs were developed from De Weille's factors, as varying percentages of depreciable vehicle value.

Interest cost is different from depreciation cost; the former is the cost of the capital invested. In other words, if the automobile user had to borrow the money to buy the vehicle, what would he be charged? Overhead cost for a private car is principally insurance, without which the user could neither borrow the money to buy it, nor operate it after purchase. Estimates in this area are tentative, because the annual premium for an individual vehicle is based on a variety of factors, e.g., the age and claims record of the driver and the make , model and price of the car. There was no concencus among those interviewed as to what an annual average cost would be for a passenger car, but 13 percent of total average user cost appeared to be reasonable. Private car VOC per mile, developed from the factors discussed above are shown on Table A-10. Where three zeroes are shown as the cost for a component, this just means that the cost of that input was less than CI$0.01 at that speed, and that the actual cost was still carried in the computer calculations.

TABLE A-10
VEHICLE OPERATING COSTS
PRIVATE CARS
(PER MILE)

MPH	FUEL	ENGINE OIL	TYRES	DEPREC	SUBTOTAL	MAINT	INTEREST	SUBTOTAL	OVERHEAD	TOTAL
5	$0.07	$0.01	$0.01	$0.14	$0.22	$0.10	$0.00	$0.32	$0.04	$0.36
10	$0.06	$0.00	$0.01	$0.11	$0.19	$0.09	$0.00	$0.29	$0.04	$0.32
15	$0.05	$0.00	$0.01	$0.10	$0.17	$0.08	$0.00	$0.25	$0.03	$0.28
20	$0.04	$0.00	$0.01	$0.09	$0.15	$0.08	$0.00	$0.22	$0.03	$0.25
25	$0.03	$0.00	$0.02	$0.09	$0.14	$0.07	$0.00	$0.21	$0.03	$0.24
30	$0.03	$0.00	$0.02	$0.08	$0.13	$0.08	$0.00	$0.21	$0.03	$0.23
35	$0.02	$0.00	$0.03	$0.08	$0.13	$0.08	$0.00	$0.21	$0.03	$0.23
40	$0.02	$0.00	$0.03	$0.07	$0.13	$0.08	$0.00	$0.22	$0.03	$0.25
45	$0.02	$0.00	$0.04	$0.07	$0.14	$0.09	$0.00	$0.23	$0.03	$0.26
50	$0.03	$0.00	$0.05	$0.07	$0.15	$0.11	$0.00	$0.25	$0.03	$0.29

MGTF Study

multiplied by vehicle depreciable value ($7875) to get depreciation costs. Again, these factors were not adjusted because they are based on depreciable value, which varies with vehicle size, and they are already in per 1000 mile terms. Maintenance factors (applied against total average VOC expense) were decreased by 29 percent or two-thirds of the percentage difference in size between the engines in the two vehicles. Interest costs were developed from De Weille's factors, as varying annual percentage of depreciable vehicle values. Overhead was taken at 15 percent of the remainder of VOC. Table A-14 shows light truck VOC developed as outlined above.

Heavy Trucks - The hybrid heavy truck developed for the study had a 7768cc engine and a tare weight of 10,000 lbs. FHWA fuel consumption factors were increased by 16 percent to account for the fact that the study vehicle engine was larger than that of the FHWA test vehicle (6548cc). However, tyre wear factors were decreased by 33 percent, to account for the heavier FHWA test truck (15,000 lbs). Depreciation factors were applied to the depreciable value of the study vehicle ($33,597) without adjustment. As indicated previously, since the results of using these factors are proportionate to the costs (which vary with vehicle size), adjustment was not considered necessary. Maintenance factors (applied against average VOC per 1000 miles) were increased by 11 percent, two-thirds of the percentage difference in size between the engines of the FHWA test and study hybrid vehicles. Interest costs were developed on varying annual percentages of depreciable vehicle cost, based upon De Weille's factors. Overhead cost was taken at 15 percent of the remainder of the VOC, all of which would be in per 1000 mile terms. The results of the VOC development calculations indicated above are listed in Table A-15.

Buses - The hybrid vehicle developed in the bus category had a 2354cc engine and a total weight of 4296 lbs. As indicated earlier, its characteristics were skewed toward the minibus,

TABLE A-14
VEHICLE OPERATING COSTS
LIGHT TRUCKS
($PER MILE)

MPH	FUEL	ENGINE OIL	TYRES	DEPREC	SUBTOTAL	MAINT	CREW COST	INTEREST	SUBTOTAL	OVERHEAD	TOTAL
5	$0.03	$0.01	$0.00	$0.10	$0.14	$0.05	$1.19	$0.00	$1.37	$0.21	$1.57
10	$0.03	$0.00	$0.00	$0.08	$0.12	$0.04	$0.59	$0.00	$0.75	$0.11	$0.87
15	$0.03	$0.00	$0.00	$0.07	$0.10	$0.04	$0.40	$0.00	$0.54	$0.08	$0.62
20	$0.02	$0.00	$0.00	$0.07	$0.09	$0.03	$0.30	$0.00	$0.42	$0.06	$0.49
25	$0.02	$0.00	$0.00	$0.06	$0.09	$0.03	$0.24	$0.00	$0.36	$0.05	$0.41
30	$0.02	$0.00	$0.00	$0.06	$0.08	$0.03	$0.20	$0.00	$0.31	$0.05	$0.36
35	$0.02	$0.00	$0.00	$0.05	$0.08	$0.03	$0.17	$0.00	$0.28	$0.04	$0.32
40	$0.02	$0.00	$0.00	$0.05	$0.05	$0.03	$0.15	$0.00	$0.26	$0.04	$0.30
45	$0.02	$0.00	$0.00	$0.05	$0.08	$0.04	$0.13	$0.00	$0.24	$0.04	$0.28
50	$0.03	$0.00	$0.00	$0.05	$0.08	$0.04	$0.12	$0.00	$0.23	$0.03	$0.27

Source: MGTP Study

TABLE A-15
VEHICLE OPERATING COSTS
HEAVY TRUCKS
($PER MILE)

MPH	FUEL	ENGINE OIL	TYRES	DEPREC	SUBTOTAL	MAINT	CREW COST	INTEREST	SUBTOTAL	OVERHEAD	TOTAL
5	$0.18	$0.02	$0.00	$0.25	$0.44	$0.23	$1.19	$0.00	$1.86	$0.28	$2.14
10	$0.16	$0.01	$0.00	$0.20	$0.37	$0.20	$0.53	$0.00	$1.10	$0.17	$1.27
15	$0.15	$0.01	$0.00	$0.17	$0.33	$0.18	$0.40	$0.00	$0.90	$0.13	$1.03
20	$0.13	$0.01	$0.00	$0.15	$0.29	$0.16	$0.30	$0.00	$0.75	$0.11	$0.86
25	$0.13	$0.01	$0.00	$0.13	$0.27	$0.15	$0.24	$0.00	$0.66	$0.10	$0.76
30	$0.12	$0.01	$0.00	$0.12	$0.25	$0.15	$0.20	$0.00	$0.60	$0.09	$0.69
35	$0.11	$0.01	$0.01	$0.11	$0.24	$0.15	$0.17	$0.00	$0.56	$0.08	$0.64
40	$0.11	$0.01	$0.01	$0.11	$0.23	$0.15	$0.15	$0.00	$0.54	$0.08	$0.62
45	$0.11	$0.01	$0.01	$0.10	$0.23	$0.16	$0.13	$0.00	$0.51	$0.08	$0.59
50	$0.11	$0.01	$0.01	$0.10	$0.23	$0.16	$0.12	$0.00	$0.51	$0.08	$0.59

Source: MGTP Study

due to the high proportion of these vehicles in the fleet. Gas consumption factors were reduced by 38 percent, to account for the difference between the size of the hybrid vehicle's engine and that of the FHWA test vehicle (3770cc). For reasons indicated earlier, engine oil consumption factors were not adjusted. Tyre wear factors were increased by 19 percent to account for the heavier hybrid vehicle (4296 lbs vs. 3500 lbs. for the FHWA test vehicle). Depreciation factors were used without adjustment, and were multiplied times the depreciable vehicle value ($12,324). These factors were already in terms of cost per 1000 miles of operation. Maintenance factors (applied against average VOC per 1000 miles) were decreased by 25 percent or two-thirds of the percentage difference in size between the engine of the FHWA test vehicle and that of the hybrid vehicle developed for the study. Interest costs were developed on varying annual percentages of depreciable vehicle value, based upon De Weille's factors. Overhead, which is high in bus operations, was taken at 18 percent of the total other VOC. Table A-16 shows bus VOC, developed as outlined above.

<u>Running Costs</u>- Table A-17 summarises the vehicle operating (running) costs which have been developed during this study. These costs will serve as inputs to the computer program which is used to develop benefits from proposed transportation improvements. While the costs shown are for level, paved, tangent roads, the characteristics of the actual roads are also input to the model, which then allows for differences such as grades or curves in the alignment. Further, the model estimates congestion costs where road capacities are taxed or exceeded.

<u>Idling Costs</u> - Congestion costs include the costs of idling and speed cycle changes. In addition to vehicle running costs, which have been summarised in the foregoing, the FHWA model (HIAP - Highway Investment Analysis Package) which will be used in calculating benefits from proposed transportation projects also requires inputs of unit idling and speed cycle change costs, in order to estimate congestion effects.

TABLE A-16
VEHICLE OPERATING COSTS
BUSES
($PER MILE)

MPH	FUEL	ENGINE OIL	TYRES	DEPREC	SUBTOTAL	MAINT	CREW COST	INTEREST	SUBTOTAL	OVERHEAD	TOTAL
5	$0.03	$0.01	$0.00	$0.15	$0.19	$0.07	$1.51	$0.00	$1.77	$0.32	$2.09
10	$0.03	$0.00	$0.00	$0.13	$0.16	$0.06	$0.76	$0.00	$0.98	$0.18	$1.16
15	$0.03	$0.00	$0.00	$0.11	$0.15	$0.05	$0.50	$0.00	$0.70	$0.13	$0.83
20	$0.02	$0.00	$0.00	$0.10	$0.13	$0.05	$0.38	$0.00	$0.56	$0.10	$0.66
25	$0.02	$0.00	$0.00	$0.09	$0.12	$0.05	$0.30	$0.00	$0.47	$0.08	$0.55
30	$0.02	$0.00	$0.00	$0.09	$0.12	$0.05	$0.25	$0.00	$0.42	$0.08	$0.49
35	$0.02	$0.00	$0.00	$0.08	$0.11	$0.05	$0.21	$0.00	$0.37	$0.07	$0.44
40	$0.02	$0.00	$0.00	$0.08	$0.10	$0.05	$0.19	$0.00	$0.34	$0.06	$0.40
45	$0.02	$0.00	$0.00	$0.08	$0.10	$0.05	$0.16	$0.00	$0.32	$0.06	$0.38
50	$0.03	$0.00	$0.00	$0.07	$0.10	$0.05	$0.15	$0.00	$0.31	$0.06	$0.36

Source: MGTP Study

TABLE A-17
SUMMARY-STUDY VEHICLE VOC

MPH	PASSENGER CAR PRIVATE	PASSENGER CAR RENTAL	TAXI	LT TRK	HVY TRK	BUS
			(CI$ per mile)			
5	0.36	0.28	2.06	1.57	2.14	2.09
10	0.32	0.25	1.15	0.87	1.27	1.16
15	0.28	0.22	0.83	0.62	1.03	0.83
20	0.25	0.20	0.66	0.49	0.86	0.66
25	0.24	0.19	0.55	0.41	0.76	0.55
30	0.23	0.18	0.49	0.36	0.69	0.49
35	0.23	0.19	0.44	0.32	0.64	0.44
40	0.25	0.19	0.41	0.30	0.62	0.40
45	0.26	0.21	0.38	0.28	0.59	0.38
50	0.29	0.23	0.37	0.27	0.59	0.36

Source: MGIP Study

The development of idling costs is shown by Table A-18. Ratios were calculated between idling and running costs (the latter at 30 mph) for a 4000 lb U.S. automobile and a single unit truck. As shown by Table A-18, all study vehicles were considered as most comparable to the 4000 lb automobile except the heavy truck, which was compared to the 12,000 lb U.S. truck. These ratios were then multiplied by the VOC at 30 mph for study vehicles, with and without wages included, in order to get idling costs for each type of vehicle.

Speed Cycle Change Costs - While during any particular trip, motor vehicle running costs and travel time are affected by changes in speed, the total effect depends upon the number of such changes which are made and the range of miles in such changes. The HIAP model calculates the total cost of excess speed change cycles for a particular road and traffic volume but requires the initial costs as inputs. Tables A-19 through A-21 develop factors by which these speed change cycle costs can be derived from running costs at the same initial speed. The factors were developed by dividing the cost of speed change cycles (in U.S.$) by the VOC per 1000 vehicle miles (also in U.S.$). Both of these items are from FHWA data, as indicated. The resulting decimal (adjusted for CI vehicle charactistics) x the VOC per mile which are calculated in CI$ for CI running costs, (times 1000) equals the cost of 1000 speed change cycles in CI$. Table A-19 includes factors for the private and rental passenger cars, Table A-20 has factors for the taxi, light truck and bus, and Table A-21 covers the heavy truck.

The factors indicated above were then used in developing excess costs per 1000 speed change cycles for the various types of hybrid study vehicles, as shown by Tables A-22 through A-27, which follow:

TABLE A-18
IDLING COSTS

LINE	VEHICLE	US$ COSTS (1) IDLING	US$ COSTS (1) @ 30 MPH (1000 hrs)	I/R RATIO Col b/c	VOC/MILE @ 30 MPH (2) WITH WAGES	VOC/MILE @ 30 MPH (2) WITHOUT WAGES	IDLING COST/HR (CI$) WITH WAGES (5)	IDLING COST/HR (CI$) WITHOUT WAGES (6)
	(a)	(b)	(c)	(d)	(e) CI$	(f) CI$	(g) CI$	(h) CI$
1	PASSENGER CAR (4 Kip)	0.129	0.448	2.899 (3)				
2	SINGLE UNIT TRK (12 Kip)	0.231	0.8864	2.601 (4)				
3	PRIVATE CAR				-	0.23	-	0.67
4	RENTAL CAR					0.18		0.52
5	TAXI				0.49	0.24	1.42	0.69
6	LT TRUCK				0.36	0.20	1.04	0.58
7	HVY TRUCK				0.69	0.49	1.79	1.27
8	BUS				0.49	0.24	1.42	0.69

(1) FHWA Report no. FHWA-PL-29-014, Vol. II Technical Manual, HIAP, June, 1979.
(2) All data from study tables.
(3) Ratio applies to vehicles on lines 3,4,5,6 and 8.
(4) Ratio applies to vehicle on line 7.
(5) Col (e) costs * applicable ratio.
(6) Col (f) costs * applicable ratio.

TABLE A-19
CONVERSION FACTORS - EXCESS COST OF SPEED CHANGE CYCLES
FHWA VEHICLE A
(SMALL AUTOMOBILE)

INITIAL RUNNING SPEED	VOC PER 1000 VEH MILES		SPEED (MPH) REDUCED TO AND RETURNED FROM 0	5	10	15	20	25	30	35	40	45
			(US$ per 1000 Speed Change Cycles)									
5	194 (1)		0.8 (2)									
		F	0.004 (3)									
10	173		1.5	0.8								
		F	0.009	0.005								
15	148		2.4	1.6	0.90							
		F	0.016	0.011	0.007							
20	126		3.5	2.7	2.0	1.1						
		F	0.028	0.021	0.016	0.009						
25	115		4.8	4.1	3.3	2.4	1.3					
		F	0.042	0.036	0.029	0.021	0.011					
30	108		6.3	5.6	4.8	3.9	2.8	1.5				
		F	0.058	0.052	0.044	0.036	0.026	0.014				
35	104		8.2	7.4	6.7	7.8	4.7	3.4	1.9			
		F	0.079	0.071	0.064	0.075	0.045	0.033	0.018			
40	101		10.2	9.5	8.7	7.8	6.7	5.4	3.9	2.1		
		F	0.101	0.094	0.086	0.077	0.066	0.053	0.039	0.021		
45	101		12.5	11.7	11.0	10.1	9.0	7.7	6.2	4.3	2.3	
		F	0.124	0.116	0.109	0.100	0.089	0.762	0.061	0.426	0.023	
50	100		15.1	14.3	13.5	12.7	11.6	10.3	8.7	6.9	4.8	2.6
		F	0.151	0.143	0.135	0.127	0.116	0.103	0.087	0.069	0.048	0.0

(1) FHWA, USDOT "VOC Operating Costs, Fuel Consumption and Pavement Type and Condition Factors", June 82, pg. A-2.
(2) Ibid., pg. A-66.
(3) This Factor (0.004) is the result of dividing the excess cost per 1000 speed change cycles (0.8) by the VOC for 1000 miles at the speed indicated (194). This factor may be used to develop the excess cost of speed change cycles for CI vehicles by substituting CI data for a particular vehicle for Item (1) and multiplying it by Item (3), to produce Item (2).
(4) To adjust for CI use, reduce speed change cycle cost by 2 percent for private automobiles, 29 percent for rental cars.

TABLE A-20
CONVERSION FACTORS - EXCESS COST OF SPEED CHANGE CYCLES
FHWA VEHICLE B
(MEDIUM AUTOMOBILE)

INITIAL RUNNING SPEED	VOC PER 1000 VEH MILES		SPEED (MPH) REDUCED TO AND RETURNED FROM 0	5	10	15	20	25	30	35	40	45
			(US$ per 1000 Speed Change Cycles)									
5	175 (1)		1.4 (2)									
		F	0.008 (3)									
10	158		2.8	1.4								
		F	0.018	0.009								
15	141		4.4	3.1	1.6							
		F	0.031	0.022	0.011							
20	126		6.4	5.0	3.6	2.0						
		F	0.051	0.039	0.029	0.016						
25	122		8.6	7.2	5.8	4.1	2.2					
		F	0.070	0.059	0.048	0.034	0.018					
30	118		11.0	9.7	8.2	6.6	4.7	2.5				
		F	0.093	0.082	0.069	0.056	0.039	0.021				
35	114		14.0	12.7	11.3	9.6	7.6	5.4	3.0			
		F	0.123	0.111	0.099	0.084	0.067	0.047	0.026			
40	114		17.2	15.8	14.5	12.8	10.9	8.7	6.2	3.2		
		F	0.151	0.139	0.127	0.112	0.096	0.076	0.054	0.028		
45	116		20.9	19.5	17.9	16.2	14.3	12.1	9.7	6.7	3.5	
		F	0.180	0.166	0.154	0.139	0.123	0.104	0.084	0.058	0.030	
50	119		24.6	23.3	21.9	20.1	18.1	16.0	13.6	10.6	7.4	3.9
		F	0.207	0.196	0.184	0.169	0.152	0.134	0.114	0.089	0.062	0.033

(1) FHWA, VOC Factors, pg. A-3.
(2) Ibid., pg. A-67.
(3) The Factor (3) results from dividing the speed change cycle cost (2) by the applicable VOC at the speed indicated (1).
(4) To adjust for CI, use CI costs for (1) & (3) to produce (2). Reduce (2)- speed change cycle costs as follows:

Vehicle	Percent Change
Taxi	-31
Light Truck	-44
Bus	-38

TABLE A-21
CONVERSION FACTORS - EXCESS COST OF SPEED CHANGE CYCLES
FHWA VEHICLE C
(3A, SU TRUCK)

INITIAL RUNNING SPEED	VOC PER 1000 VEH MILES		SPEED (MPH) REDUCED TO AND RETURNED FROM 0	5	10	15	20	25	30	35	40	45
			(US$ per 1000 Speed Change Cycles)									
5	598 (1)		6.7 (2)									
		F	0.011 (3)									
10	515		15.5	8.8								
		F	0.030	0.017								
15	461		27.5	20.6	11.8							
		F	0.059	0.045	0.026							
20	421		42.5	35.7	26.9	15.2						
		F	0.101	0.085	0.064	0.036						
25	397		61.2	54.5	45.8	33.9	18.8					
		F	0.154	0.137	0.115	0.085	0.047					
30	377		84.1	77.5	68.7	56.9	41.7	22.9				
		F	0.223	0.206	0.182	0.151	0.111	0.061				
35	366		107.0	100.0	91.5	79.8	64.6	45.7	22.8			
		F	0.292	0.273	0.250	0.218	0.177	0.125	0.062			
40	364		134.0	126.0	118.0	107.0	91.3	72.5	49.5	26.7		
		F	0.368	0.346	0.324	0.294	0.251	0.199	0.136	0.073		
45	361		165.0	158.0	149.0	137.0	123.0	104.0	80.8	57.8	31.0	
		F	0.457	0.438	0.413	0.379	0.341	0.289	0.224	0.160	0.086	
50	364		200.0	193.0	184.0	172.0	156.0	139.0	116.0	92.6	65.8	34.[illegible]
		F	0.549	0.530	0.505	0.473	0.429	0.382	0.319	0.257	0.181	0.[illegible]

(1) FHWA, VOC Factors, pg. A-7.
(2) Ibid., pg. A-71.
(3) The factor (3) results from dividing the speed change cycle cost (2) by the applicable VOC at the speed indicated (1).
(4) To adjust for CI, use CI costs for (1) & (3) to produce (2). Increase (2) speed cycle change costs by 16 percent (for heavy trucks).

TABLE A-22

EXCESS COST - SPEED CHANGE CYCLES
(Rental Car)

INITIAL (1) RUNNING SPEED (mph)	SPEED (MPH) REDUCED TO AND RETURNED FROM									
	0	5	10	15	20	25	30	35	40	45
	(CI $ per 1000 speed change cycles)									
5	0.79									
10	1.60	0.89								
15	2.49	1.72	1.09							
20	3.98	2.98	2.27	1.28						
25	5.67	4.86	3.92	2.84	1.49					
30	7.42	6.66	5.63	4.61	3.33	1.79				
35	10.67	9.59	8.64	7.43	6.08	4.46	2.43			
40	13.64	12.69	11.61	10.39	8.91	7.16	5.27	2.84		
45	18.48	17.28	16.24	14.90	13.26	11.32	9.09	6.41	3.43	
50	24.61	23.31	22.01	20.70	18.91	16.79	14.18	11.25	7.82	4.24

Source: Wilbur Smith Associates

(1) Derived from Table A-19.

TABLE A-23

EXCESS COST - SPEED CHANGE CYCLES
(Passenger Car)

INITIAL (1) RUNNING SPEED (mph)	0	5	10	15	20	25	30	35	40	45
	SPEED (MPH) REDUCED TO AND RETURNED FROM (Cl $ per 1000 speed change cycles)									
5	1.41									
10	2.83	1.57								
15	4.38	3.01	1.92							
20	6.86	5.15	3.92	2.21						
25	9.87	8.46	6.82	4.94	2.59					
30	13.05	11.70	9.90	8.10	5.85	3.15				
35	17.78	15.98	14.40	12.38	10.13	7.43	4.05			
40	24.75	23.03	21.07	18.87	16.17	12.99	9.55	5.15		
45	31.49	29.46	27.69	25.40	22.61	19.30	15.49	10.92	5.84	
50	42.88	40.61	38.34	36.07	32.94	29.25	24.71	19.59	13.63	7.38

Source: Wilbur Smith Associates

(1) Derived from Table A-19.

TABLE A-24

EXCESS COST - SPEED CHANGE CYCLES
(Taxi)

INITIAL (1) RUNNING SPEED (mph)	SPEED (MPH) REDUCED TO AND RETURNED FROM									
	0	5	10	15	20	25	30	35	40	45
	(CI $ per 1000 speed change cycles)									
5	11.36									
10	14.22	7.11								
15	17.67	12.54	6.27							
20	23.46	17.94	13.34	7.36						
25	26.60	22.42	18.24	12.92	6.84					
30	31.62	27.88	23.46	19.04	13.26	7.14				
35	36.90	33.30	29.70	25.20	18.90	14.10	7.80			
40	42.28	38.92	35.56	31.36	26.88	21.28	15.12	7.84		
45	46.80	43.68	40.04	36.14	31.98	27.04	21.84	15.08	7.80	
50	53.82	50.96	43.84	43.94	39.52	34.84	29.64	23.14	15.12	8.58

Source: Wilbur Smith Associates

(1) Derived from Table A-20.

TABLE A-25

EXCESS COST - SPEED CHANGE CYCLES
(Light Truck)

INITIAL (1) RUNNING SPEED (mph)	SPEED (MPH) REDUCED TO AND RETURNED FROM 0	5	10	15	20	25	30	35	40	45
	(CI $ per 1000 speed change cycles)									
5	7.84									
10	15.93	7.97								
15	24.30	17.25	8.62							
20	36.01	27.53	20.47	11.29						
25	47.81	40.29	32.78	23.22	12.29					
30	61.47	54.20	45.61	37.02	25.78	13.88				
35	78.47	70.82	63.16	53.59	42.75	29.99	16.59			
40	96.34	88.68	81.03	71.46	62.30	48.49	34.45	17.86		
45	116.82	109.03	99.95	90.21	79.83	57.49	54.52	37.64	19.47	
50	134.34	127.20	119.42	109.68	98.65	86.97	73.98	57.76	40.24	21.42

Source: Wilbur Smith Associates

(1) Derived from Table A-20.

TABLE A-26

EXCESS COST - SPEED CHANGE CYCLES
(Heavy Truck)

INITIAL (1) RUNNING SPEED (mph)	SPEED (MPH) REDUCED TO AND RETURNED FROM (CI $ per 1000 speed change cycles)									
	0	5	10	15	20	25	30	35	40	45
5	27.28									
10	44.10	24.99								
15	64.31	49.05	28.34							
20	99.99	84.15	63.36	35.64						
25	135.52	120.56	101.20	74.80	41.36					
30	178.00	164.80	145.60	120.80	88.80	48.80				
35	216.66	202.57	185.50	161.76	131.33	92.75	46.00			
40	264.59	248.77	232.96	211.39	180.47	143.08	97.78	52.49		
45	312.59	299.59	282.49	259.24	233.24	197.68	153.22	109.44	58.82	
50	375.52	362.52	345.42	323.53	293.44	261.29	218.19	175.79	123.80	64.98

Source: Wilbur Smith Associates

(1) Derived from Table A-21.

TABLE A-27

EXCESS COST - SPEED CHANGE CYCLES
(Bus)

INITIAL (1) RUNNING SPEED (mph)	SPEED (MPH) REDUCED TO AND RETURNED FROM									
	0	5	10	15	20	25	30	35	40	45
	(CI $ per 1000 speed change cycles)									
5	10.37									
10	12.94	6.47								
15	15.97	11.33	5.67							
20	20.86	15.95	11.86	6.54						
25	23.87	20.12	16.37	11.59	6.14					
30	28.27	24.93	20.98	17.02	11.86	6.38				
35	33.58	30.30	27.03	22.93	18.29	12.83	7.10			
40	37.45	34.47	31.49	27.78	23.81	18.85	13.39	6.94		
45	42.48	39.65	36.34	32.80	29.03	24.54	19.82	13.69	7.08	
50	46.16	43.17	41.03	37.69	33.89	29.88	25.42	19.85	13.83	7.36

Source: Wilbur Smith Associates

(1) Derived from Table A-20.

OTHER TRANSPORTATION RELATED COSTS

This part of the chapter develops average costs related to passenger time, truck inventories and accidents, for use in benefit estimation.

Passenger Time - In a study such as this, the estimation of passenger time costs represents a particularly onerous task, because of the economic ground rules which must be applied. For example, only adult work trips are usually counted and these at only 40 percent of the hourly wage rates involved. Bus and passenger car and taxi passenger time savings are generally figured separately, because the passengers involved are of different income levels.

These rules are difficult to apply in a tourist-oriented economy such as the Caymans. For example, the last (1979) Census showed an Islands population of 16,677, 90 percent on Grand Cayman. (6) For the same year, 5600 vehicles were registered, for a ratio of 2.97 persons per vehicle. By 1986, the number of vehicles had increased to 10,540 (7), of which seven percent was rental cars. The average annual rate of increase for vehicles between 1979 and 1986 was 9.69 percent. Obviously, population increases during the same period would be at a much lower rate, so the ratio of persons per vehicle is now considerably lower. With so many cars owned by residents the bus passengers also include a high proportion of tourists. At the same time, a high proportion of the vehicles on the road in the George Town area are rental cars which are also driven by tourists.

(6) Government Statistics Unit, Department of Finance and Development, Cayman Islands, Statistical Abstract of the Cayman Islands, 1985 pp. 30,22.

(7) Ibid., p.50. Other totals for same year show 10,700 vehicles.

A computer model forecasts work trips traffic for each road, and average passenger loadings by type vehicle have been obtained by roadside survey. This simplified the task of allocating passenger time savings to work trips, by ruling out tourist traffic. In developing average hourly wage rates to allocate to these work trips, separate estimates were made initially for employees paid by the month and by the week, because the pay of the former is higher.

According to the CI Statistical Abstract (8), 10,034 persons were employed in the Islands, in 1985. Of these, 12 percent were self employed, 43 percent were monthly-paid and 45 percent were weekly-paid. Average earnings for monthly-paid employees were $1,553/month, and for weekly paid employees $216/week. For the purposes of the study, self-employed persons were considered as monthly paid. In reducing monthly pay to an hourly rate, 21 days of 7.5 hours each were assumed. The result (157.5 hours) divided into the monthly salary ($1553), gave an average of $9.86/hour. A 44 hour week was assumed in converting the $216 average weekly salary to an hourly rate of $4.91/hour. These 1985 hourly rates were raised to June 1987 levels by use of CI Consumer Price Index, in which September 1984 = 100. Comparison of index readings, (Dec . 1985 -103.5, June 1987 - 108.8) indicated a 5.3 percent average between the dates involved. (9) The revised average hourly rates were therefore $10.38 and $5.17 respectively, for monthly and weekly-paid employees.

Vehicle Accidents - In developing economic benefits which would accrue from reductions in vehicle accidents due to road improvements, it was necessary to review past Island experience, in order to gain a perspective. The experience is summarised in Table A-28 for the 5-year period ending in 1986.

(8) Ibid., p.41

(9) Government Information Services Release, "Moderate Price Rise in June over March", July 30, 1987.

TABLE A-28
CAYMAN ISLANDS ROAD ACCIDENTS
1982-1986

ACCIDENT FACTORS	1982	1983	1984	1985	1986	TOTAL	PERCENT OF TOTAL	ANNUAL AVERAGE
ACCIDENTS:								
FATALITY	8	5	3	15	10	41	1.15	8.2
SERIOUS INJURY	20	24	36	40	31	151	4.25	30.2
SLIGHT INJURY	103	166	155	160	157	741	20.88	148.2
DAMAGE ONLY	640	564	546	452	414	2616	73.52	523.2
TOTAL	771	759	740	667	612	3549	100.00	709.8
PERSONS:								
KILLED	13	6	7	21	10	57	4.58	11.4
SERIOUSLY INJURED	30	34	40	57	36	197	15.83	39.4
SLIGHTLY INJURED	136	206	214	237	198	991	79.59	198.2
TOTAL	179	246	261	315	244	1245	100.00	249.0
VEHICLES:								
MOTOR CARS	999	904	928	856	764	4451	76.62	810.2
MOTORCYCLES	61	68	78	84	75	366	6.30	73.2
TRUCKS	191	200	160	115	142	812	13.98	162.4
BUSES	8	9	18	19	8	62	1.07	12.4
BICYCLES	22	27	26	22	8	105	1.81	21.0
FORKLIFTS	-	2	2	3	6	13	0.22	2.6
TOTAL	1281	1210	1212	1103	1003	5809	100.00	1161.8
PEDESTRIANS:	19	37	25	21	21	123	-	24.6
LOCATIONS:								
GEORGE TOWN	373	418	360	337	297	1785	50.25	357.0
WEST BAY	74	55	55	64	53	301	8.47	60.2
WEST BAY ROAD	100	77	106	102	102	487	13.71	97.4
BODDEN TOWN	31	24	19	27	18	119	3.35	23.8
BREAKERS	5	4	8	7	6	30	0.84	6.0
RED BAY	22	23	17	14	13	89	2.51	17.8
NORTH SIDE	12	17	22	18	12	81	2.28	16.2
FRANK SOUND	7	9	10	9	8	43	1.21	8.6
EAST END	24	27	25	11	18	105	2.96	21.0
SAVANNAH	24	19	24	13	21	101	2.84	20.2
PROSPECT	7	4	8	6	4	29	0.82	5.8
LOWER VALLEY	20	13	12	12	15	72	2.03	14.4
PEDRO	11	15	12	5	8	51	1.44	10.2
SPOTTS	15	23	22	21	8	89	2.51	17.8
CAYMAN BRAC	45	31	43	20	29	168	4.72	33.6
LITTLE CAYMAN	1	0	0	1	0	2	0.06	0.4
TOTAL	771	759	743	667	612	3552	100.00	710.4

Source: Police Traffic Department, Cayman Islands Government.

* Accident Severity - Although only 1.5 percent of the 3549 accidents during the period resulted in fatalities, an additional 25 percent caused injuries.

* Accident Reduction - It is noteworthy that while the number of vehicles registered and inspected in the Islands rose by 16 percent during the period 1982-1986, the annual number of accidents dropped from 771 (in 1982) to 612 (in 1986) or by 21 percent. This improvement was attributable to a special Police program which has emphasised tougher enforcement of Island traffic laws and regulations against speeding, careless driving, driving under the influence, etc. Support by the courts and improvements in road surface marking and signing were also cited as factors contributing to this significant advance.

* Persons Injured - Some 57 people were killed and 1188 more were injured in automobile accidents, during the period.

* Vehicle Involved - The most numerous vehicle (the motor car) was also involved in most (77 percent) of the accidents during the period. Trucks were involved in 14 percent of the accidents, and motorcyles in 6 percent.

* Pedestrians Accidents - Pedestrians were involved in an average of 25 accidents per year, during the period.

* Accident Locations - The subject of vehicle accident location is treated in more detail elsewhere in the report.

  Suffice it is to say here that over half of all motor vehicle accidents occurred in George Town, 14 percent on West Bay Road and 8 percent in West Bay. The remaining 18 percent of the accidents was spread over 13 different Cayman locations.

* Accident Costs - In order to determine the benefits of road improvements through reduction in accidents, it is necessary to be able to attribute

average accident costs to various types of accidents. Unfortunatley, such information is not available from government sources. The Police do not mantain these data, and annual submissions to the Superintendent of Insurance by insurance brokers are in total. However, based on informal information from Cayman insurance industry sources, the following tentative estimation of average road accident settlement costs are made:

ACCIDENT CATEGORY	CI$
Property Damage Only	2,500
Injury	18,000
Fatality	80,000

Truck Cargo Inventory Savings - When a road is improved, travel times between points on the length are usually reduced. In evaluating the economic feasibility of the improvements, such reductions can be translated into savings in inventory time of cargo carried over the road.

As indicated earlier, the August 27 and 28, 1987 survey showed that trucks made up about 20 percent of the 8700 vehicles observed, with the split at 16 percent light trucks (LT), and four percent heavy trucks (HT). This is a higher proportion of trucks than that found in the overall Cayman Islands vehicle fleet (14 percent). However, this is to be expected since the major port, and logistics and population centres of the Islands are at George Town.

Cargo Mix - Based upon information from the Port Authority, Customs and other area sources, a typical composite mix of cargo in loaded area trucks was developed as follows:

COMMODITY	TRUCK Heavy	TRUCK Light
Food Products	20	30
Manufactured Products	30	20
Petroleum Products	40	--
Other	10	50
TOTAL	100	100

Since the standard Island tank truck is of 5,000 gallons capacity with a loading of at least 17.5 short tons (ST) no petroleum products are shown as included in the light truck cargo. However, solid petroleum products are included with "Other" commodities for both trucks.

Cargo Cost - In 1985, the last complete year for which Cayman Islands Trade Statistics are available, the CI$ value of all imports was CI$119,995.000, of which 74.8 percent (or CI$89.76 million) was attributable to the George Town Docks. (10) According to the Port Authority, cargo landed at the Docks in 1985, totaled 77,963 long ton (11). This would mean that the average cost of cargo landed at the Docks was approximately $1151 per long ton. This cost is described as "Approximate", because the $119.9 million in CI$ value also included receipts at Owen Roberts Airport (21.7 percent of the total) and air

(10) Government Statistics Unit, Overseas Trade Statistics of the Cayman Islands, Jan. - June, 1986.

(11) Government Statistics Unit, Statistical Abstract of the Cayman Islands, - 1985, p.51.

cargo is generally of higher value than sea cargo. The average CI$ value per ton for 1985 cargo handled at the Docks is therefore somewhat less than the $1151 shown. At 1987 levels (12) the $1151 would become $1228/long ton in $1097 per 2000 lb. (short) ton. Since 84.6 percent of the cargo received at the Docks was in containers in 1985, it was difficult for the Port Authority to break out cargo by type. For example, bagged cement is received both in containers and as break-bulk cargo. The 1985 cargo also included 1954 (13) motor vehicles and tractors, most of which arrived on roll-on/roll-off ships from Jamaica. Obviously, these are not truck cargo.

In view of the difficulty in attributing cost to commodities as indicated above, a separate evaluation was made of commodities which were considered suitable Grand Cayman truck cargo. Data for the follwing costs were obtained from local commodity dealers and were adjusted, based on the following:

COMMODITY	CI$/2000 lb. TON
Food Products	700
Manufactured Products	2,100
Petrochemicals	320
Other	750

Using the percentages shown for the composite mix of cargo and the unit prices indicated above, weighted average costs per ton were developed for the light truck of CI$ 1005 and for the heavy truck of CI$ 973.

(12) Government Information Service, Moderate Price Raise in June Over March, July 30, 1987, Table 1.

(13) Statistical Abstract - 1985, op. cit., p.48.

Cargo Assumptions - In estimating truck cargo inventory benefits which might accrue from reduced travel time resulting from road improvements, the following assumptions were made:

1. Half of all trucks were empty.
2. Loaded trucks were carrying the four products shown.
3. Loaded trucks were carrying 70 percent of the difference between their tare and gross weights.
4. Commodity costs used were averages.
5. The interest rate was 13 percent.

Inventory Costs - Per minute inventory costs were calculated, using the following equation:

$$\frac{Cp(t)i}{m} = Cm$$

Where:

Cp = Weighted average cost per ST of products handled (LT-CI$ 1005/ST and Hvy T-CI$ 973)

t = ST of lading (Lt-0.8T, Hvy-5.8T)

i = Interest rate (13 percent per annum).

m = No. of minutes per year ($25,600)

Cm = Inventory cost per minute

Based upon the above factors, inventory costs were calculated for light truck cargo of CI$ 0.00019 per minute and for heavy truck cargo of CI$ 0.0014 per minute.

Use of Costs - The economic costs which were developed in this appendix were used, as applicable, in the economic analysis of road construction alternatives which appear in the main report.

However, as stated in the benefit-cost analysis, preliminary evaluation indicated that traffic in the Phase 1 and 2 roads was such that it appeared advisable not to consider time benefits. Then only VOC benefits were used, and this is a very conservative approach.

APPENDIX B

BENEFIT/COST ANALYSIS TABLES

APPENDIX B
BENEFIT/COST ANALYSIS TABLES

This appendix contains the computer tables which back up Table 5-9 (Results, B/C Analysis, Phases 1 and 2) in the main report, as follows:

TIME FRAME	PHASE	TABLE NO.	ALIGNMENT	PERIOD (Years)	COVERAGE B/C RATIO	NPV	IRR
1988-92	1-1	5-B-1	N-S Arterial	15	*	*	
		5-B-2	"	15			*
		5-B-3	"	20	*	*	
		5-B-4	"	20			*
		5-B-5	"	25	*	*	
		5-b-6	"	25			*
1992-97	2-2	5-B-7	N-S Arterial/2 Lane	25	*	*	
		5-B-8	"	25			*
		5-B-9	N-S-Arterial/4 Lane	15	*	*	
		5-B-10	"	15			*
		5-B-11	"	20	*	*	
		5-B-12	"	20			*
		5-B-13	"	25	*	*	
		5-B-14	"	25			*
	2-3	5-B-15	E-W Arterial	25	*	*	
		5-B-16	"	25			*
	2-4	5-B-17	N. Sound Arterial	25	*	*	
		5-B-18	"	25			*

TABLE B-1

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 1-1 VOC BENEFITS FROM MID-1992 TO MID-2007 (15 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 262 TO 470 AND 426

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=22 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	3253.0	2315.4	0.0	0.0	0.0	0.0	0.0	0.0
1991	6506.0	4134.7	0.0	0.0	0.0	0.0	0.0	0.0
1992	3253.0	1845.8	0.0	2516.0	0.0	0.0	2516.0	1427.6
1993	82.0	41.5	0.0	5341.0	0.0	0.0	5341.0	2705.9
1994	82.0	37.1	0.0	5668.9	0.0	0.0	5668.9	2564.3
1995	82.0	33.1	0.0	6016.8	0.0	0.0	6016.8	2430.1
1996	82.0	29.6	0.0	6386.2	0.0	0.0	6386.2	2302.9
1997	82.0	26.4	0.0	6778.2	0.0	0.0	6778.2	2182.4
1998	82.0	23.6	0.0	7194.3	0.0	0.0	7194.3	2065.[illegible]
1999	82.0	21.0	0.0	7635.9	981.0	0.0	8616.9	2211.7
2000	82.0	18.8	0.0	8104.6	0.0	0.0	8104.6	1857.4
2001	82.0	16.8	0.0	8602.1	0.0	0.0	8602.1	1760.2
2002	82.0	15.0	0.0	9130.2	0.0	0.0	9130.2	1668.1
2003	82.0	13.4	0.0	9690.6	0.0	0.0	9690.6	1580.8
2004	82.0	11.9	0.0	10285.5	0.0	0.0	10285.5	1498.0
2005	82.0	10.7	0.0	10916.9	0.0	0.0	10916.9	1419.6
2006	82.0	9.5	0.0	11587.0	981.0	0.0	12568.0	1459.2
2007	82.0	8.5	0.0	6149.0	0.0	0.0	6149.0	637.4
2008	0.0	0.0	0.0	0.0	10624.0	0.0	10624.0	983.4
TOT	14242.0	8612.8	0.0	122003.1	12586.0	0.0	134589.1	30757.3

BENEFIT/COST RATIO= 3.57
NET PRESENT VALUE= 22144.4
CI$ 1987 (THOUSANDS)

TABLE B-2

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 1-1 VOC BENEFITS FROM MID-1992 TO MID-2007 (15 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 262 TO 470 AND 426

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=22

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	3253.0	1219.2	0.0	0.0	0.0	0.0	0.0	0.0
1991	6506.0	1758.1	0.0	0.0	0.0	0.0	0.0	0.0
1992	3253.0	633.8	0.0	2516.0	0.0	0.0	2516.0	490.2
1993	82.0	11.5	0.0	5341.0	0.0	0.0	5341.0	750.3
1994	82.0	8.3	0.0	5668.9	0.0	0.0	5668.9	574.2
1995	82.0	6.0	0.0	6016.6	0.0	0.0	6016.6	439.4
1996	82.0	4.3	0.0	6386.2	0.0	0.0	6386.2	336.2
1997	82.0	3.1	0.0	6778.2	0.0	0.0	6778.2	257.3
1998	82.0	2.2	0.0	7194.3	0.0	0.0	7194.3	196.5
1999	82.0	1.6	0.0	7635.9	981.0	0.0	8616.9	170.0
2000	82.0	1.2	0.0	8104.6	0.0	0.0	8104.6	115.3
2001	82.0	0.9	0.0	8602.1	0.0	0.0	8602.1	88.2
2002	82.0	0.6	0.0	9130.2	0.0	0.0	9130.2	67.5
2003	82.0	0.4	0.0	9690.6	0.0	0.0	9690.6	51.7
2004	82.0	0.3	0.0	10285.5	0.0	0.0	10285.5	39.5
2005	82.0	0.2	0.0	10916.9	0.0	0.0	10916.9	30.3
2006	82.0	0.2	0.0	11587.0	981.0	0.0	12568.0	25.1
2007	82.0	0.1	0.0	6149.0	0.0	0.0	6149.0	8.9
2008	0.0	0.0	0.0	0.0	10624.0	0.0	10624.0	11.0
TOT	14242.0	3652.2	0.0	122003.1	12586.0	0.0	134589.1	3652.2

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 38.7 PERCENT
CI$ 1987 (THOUSANDS)
(THOUSANDS)OK, FLIST LP.CAY11Y20C

TABLE B-3

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 1-1 VOC BENEFITS FROM MID-1992 TO MID-2012 (20 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 262 TO 470 AND 426

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=27 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	3253.0	2315.4	0.0	0.0	0.0	0.0	0.0	0.0
1991	6506.0	4134.7	0.0	0.0	0.0	0.0	0.0	0.0
1992	3253.0	1845.8	0.0	2516.0	0.0	0.0	2516.0	1427.6
1993	82.0	41.5	0.0	5341.0	0.0	0.0	5341.0	2705.9
1994	82.0	37.1	0.0	5668.8	0.0	0.0	5668.8	2564.3
1995	82.0	33.1	0.0	6016.8	0.0	0.0	6016.8	2430.1
1996	82.0	29.6	0.0	6386.1	0.0	0.0	6386.1	2302.9
1997	82.0	26.4	0.0	6778.1	0.0	0.0	6778.1	2182.4
1998	82.0	23.6	0.0	7194.2	0.0	0.0	7194.2	2068.2
1999	82.0	21.0	0.0	7635.8	981.0	0.0	8616.8	2211.7
2000	82.0	18.8	0.0	8104.5	0.0	0.0	8104.5	1857.3
2001	82.0	16.8	0.0	8602.0	0.0	0.0	8602.0	1760.1
2002	82.0	15.0	0.0	9130.0	0.0	0.0	9130.0	1668.0
2003	82.0	13.4	0.0	9690.4	0.0	0.0	9690.4	1580.7
2004	82.0	11.9	0.0	10285.3	0.0	0.0	10285.3	1498.0
2005	82.0	10.7	0.0	10916.6	0.0	0.0	10916.6	1419.6
2006	82.0	9.5	0.0	11586.7	981.0	0.0	12567.7	1459.2
2007	82.0	8.5	0.0	12297.9	0.0	0.0	12297.9	1274.9
2008	82.0	7.6	0.0	13052.8	0.0	0.0	13052.8	1208.2
2009	82.0	6.8	0.0	13854.0	0.0	0.0	13854.0	1144.9
2010	82.0	6.1	0.0	14704.4	0.0	0.0	14704.4	1085.0
2011	82.0	5.4	0.0	15607.0	0.0	0.0	15607.0	1028.2
2012	82.0	4.8	0.0	8282.0	0.0	0.0	8282.0	4[illegible]
2013	0.0	0.0	0.0	0.0	10624.0	0.0	10624.0	558.0
TOT	14652.0	8643.5	0.0	193650.4	12586.0	0.0	206236.4	35922.5

BENEFIT/COST RATIO= 4.16

NET PRESENT VALUE= 27279.0

CI$ 1987 (THOUSANDS)

TABLE B-4

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 1-1 VOC BENEFITS FROM MID-1992 TO MID-2012 (20 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 262 TO 470 AND 426

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=27

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	3253.0	1210.8	0.0	0.0	0.0	0.0	0.0	0.0
1991	6506.0	1742.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	3253.0	626.5	0.0	2516.0	0.0	0.0	2516.0	484.6
1993	82.0	11.4	0.0	5341.0	0.0	0.0	5341.0	740.3
1994	82.0	8.2	0.0	5668.8	0.0	0.0	5668.8	565.0
1995	82.0	5.9	0.0	6016.8	0.0	0.0	6016.8	431.4
1996	82.0	4.2	0.0	6386.1	0.0	0.0	6386.1	327.3
1997	82.0	3.0	0.0	6778.1	0.0	0.0	6778.1	251.4
1998	82.0	2.2	0.0	7194.2	0.0	0.0	7194.2	192.0
1999	82.0	1.6	0.0	7635.8	981.0	0.0	8616.8	163.4
2000	82.0	1.1	0.0	8104.5	0.0	0.0	8104.5	111.9
2001	82.0	0.8	0.0	8602.0	0.0	0.0	8602.0	85.4
2002	82.0	0.6	0.0	9130.0	0.0	0.0	9130.0	65.2
2003	82.0	0.4	0.0	9690.4	0.0	0.0	9690.4	49.8
2004	82.0	0.3	0.0	10285.3	0.0	0.0	10285.3	38.0
2005	82.0	0.2	0.0	10916.6	0.0	0.0	10916.6	29.0
2006	82.0	0.2	0.0	11586.7	981.0	0.0	12567.7	24.0
2007	82.0	0.1	0.0	12297.9	0.0	0.0	12297.9	16.9
2008	82.0	0.1	0.0	13052.8	0.0	0.0	13052.8	12.9
2009	82.0	0.1	0.0	13854.0	0.0	0.0	13854.0	9.9
2010	82.0	0.0	0.0	14704.4	0.0	0.0	14704.4	7.5
2011	82.0	0.0	0.0	15607.0	0.0	0.0	15607.0	5.8
2012	82.0	0.0	0.0	8282.0	0.0	0.0	8282.0	2.2
2013	0.0	0.0	0.0	0.0	10624.0	0.0	10624.0	2.0
TOT	14652.0	3619.8	0.0	193650.4	12586.0	0.0	206236.4	3619.8

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 39.0 PERCENT
CI$ 1987 (THOUSANDS)
(THOUSANDS)OK, FLIST LP.CAY11Y25C

TABLE B-5

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 1-1   VOC BENEFITS FROM MID-1992 TO MID-2017 (25 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 262 TO 470 AND 426

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=32   DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	3253.0	2315.4	0.0	0.0	0.0	0.0	0.0	0.0
1991	6506.0	4134.7	0.0	0.0	0.0	0.0	0.0	0.0
1992	3253.0	1845.8	0.0	2516.0	0.0	0.0	2516.0	1427.6
1993	82.0	41.5	0.0	5341.0	0.0	0.0	5341.0	2705.9
1994	82.0	37.1	0.0	5668.8	0.0	0.0	5668.8	2564.3
1995	82.0	33.1	0.0	6016.8	0.0	0.0	6016.8	2430.1
1996	82.0	29.6	0.0	6386.1	0.0	0.0	6386.1	2302.9
1997	82.0	26.4	0.0	6778.1	0.0	0.0	6778.1	2182.4
1998	82.0	23.6	0.0	7194.2	0.0	0.0	7194.2	2068.2
1999	82.0	21.0	0.0	7635.8	981.0	0.0	8616.8	2211.7
2000	82.0	18.8	0.0	8104.5	0.0	0.0	8104.5	1857.3
2001	82.0	16.8	0.0	8602.0	0.0	0.0	8602.0	1760.1
2002	82.0	15.0	0.0	9130.0	0.0	0.0	9130.0	1668.0
2003	82.0	13.4	0.0	9690.4	0.0	0.0	9690.4	1580.7
2004	82.0	11.9	0.0	10285.2	0.0	0.0	10285.2	1498.0
2005	82.0	10.7	0.0	10916.5	0.0	0.0	10916.5	1419.6
2006	82.0	9.5	0.0	11586.6	981.0	0.0	12567.6	1459.2
2007	82.0	8.5	0.0	12297.8	0.0	0.0	12297.8	1274.9
2008	82.0	7.6	0.0	13052.7	0.0	0.0	13052.7	1208.2
2009	82.0	6.8	0.0	13853.9	0.0	0.0	13853.9	1144.9
2010	82.0	6.1	0.0	14704.3	0.0	0.0	14704.3	1085.0
2011	82.0	5.4	0.0	15606.8	0.0	0.0	15606.8	1028.2
2012	82.0	4.8	0.0	16564.8	0.0	0.0	16564.8	974.4
2013	82.0	4.3	0.0	17581.6	981.0	0.0	18562.6	974.9
2014	82.0	3.8	0.0	18660.8	0.0	0.0	18660.8	875.1
2015	82.0	3.4	0.0	19806.2	0.0	0.0	19806.2	829.3
2016	82.0	3.1	0.0	21022.0	0.0	0.0	21022.0	785.9
2017	82.0	2.7	0.0	11156.0	0.0	0.0	11156.0	372.4
2018	0.0	0.0	0.0	0.0	10624.0	0.0	10624.0	316.6
TOT	15062.0	8660.9	0.0	290158.7	13567.0	0.0	303725.7	40005.7

BENEFIT/COST RATIO=   4.62
NET PRESENT VALUE= 31344.9
CI$ 1987 (THOUSANDS)

TABLE B-6

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 1-1 VOC BENEFITS FROM MID-1992 TO MID-2017 (25 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 262 TO 470 AND 426

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=32

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	3253.0	1208.6	0.0	0.0	0.0	0.0	0.0	0.0
1991	6506.0	1737.7	0.0	0.0	0.0	0.0	0.0	0.0
1992	3253.0	624.6	0.0	2516.0	0.0	0.0	2516.0	483.1
1993	82.0	11.3	0.0	5341.0	0.0	0.0	5341.0	737.2
1994	82.0	8.1	0.0	5668.8	0.0	0.0	5668.8	562.6
1995	82.0	5.8	0.0	6016.8	0.0	0.0	6016.8	429.2
1996	82.0	4.2	0.0	6386.1	0.0	0.0	6386.1	327.5
1997	82.0	3.0	0.0	6778.1	0.0	0.0	6778.1	249.9
1998	82.0	2.2	0.0	7194.2	0.0	0.0	7194.2	190.7
1999	82.0	1.6	0.0	7635.8	981.0	0.0	8616.8	164.2
2000	82.0	1.1	0.0	8104.5	0.0	0.0	8104.5	111.0
2001	82.0	0.8	0.0	8602.0	0.0	0.0	8602.0	84.7
2002	82.0	0.6	0.0	9130.0	0.0	0.0	9130.0	64.6
2003	82.0	0.4	0.0	9690.4	0.0	0.0	9690.4	49.3
2004	82.0	0.3	0.0	10285.2	0.0	0.0	10285.2	37.6
2005	82.0	0.2	0.0	10916.5	0.0	0.0	10916.5	28.7
2006	82.0	0.2	0.0	11586.6	981.0	0.0	12567.6	23.8
2007	82.0	0.1	0.0	12297.8	0.0	0.0	12297.8	16.7
2008	82.0	0.1	0.0	13052.7	0.0	0.0	13052.7	12.8
2009	82.0	0.1	0.0	13853.9	0.0	0.0	13853.9	9.7
2010	82.0	0.0	0.0	14704.3	0.0	0.0	14704.3	7.4
2011	82.0	0.0	0.0	15606.8	0.0	0.0	15606.8	5.7
2012	82.0	0.0	0.0	16564.8	0.0	0.0	16564.8	4.3
2013	82.0	0.0	0.0	17581.6	981.0	0.0	18562.6	3.5
2014	82.0	0.0	0.0	18660.8	0.0	0.0	18660.8	2.5
2015	82.0	0.0	0.0	19806.2	0.0	0.0	19806.2	1.9
2016	82.0	0.0	0.0	21022.0	0.0	0.0	21022.0	1.5
2017	82.0	0.0	0.0	11156.0	0.0	0.0	11156.0	0.6
2018	0.0	0.0	0.0	0.0	10624.0	0.0	10624.0	0.4
TOT	15062.0	3611.2	0.0	290158.7	13567.0	0.0	303725.7	3611.2

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 39.1 PERCENT
CI$ 1987 (THOUSANDS)
(THOUSANDS)
OK, FLIST LP.CAY21Y25C

TABLE B-7

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-1 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 504 TO 514

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=37 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	2685.0	1084.4	0.0	0.0	0.0	0.0	0.0	0.0
1996	5368.0	1935.8	0.0	0.0	0.0	0.0	0.0	0.0
1997	2685.0	864.5	0.0	266.0	0.0	0.0	266.0	85.6
1998	61.0	17.5	0.0	555.0	0.0	0.0	555.0	159.5
1999	61.0	15.7	0.0	579.9	0.0	0.0	579.9	148.8
2000	61.0	14.0	0.0	605.8	0.0	0.0	605.8	138.8
2001	61.0	12.5	0.0	632.9	0.0	0.0	632.9	129.5
2002	61.0	11.1	0.0	661.3	0.0	0.0	661.3	120.8
2003	61.0	10.0	0.0	690.9	0.0	0.0	690.9	112.7
2004	61.0	8.9	0.0	721.8	741.0	0.0	1462.8	213.1
2005	61.0	7.9	0.0	754.2	0.0	0.0	754.2	98.1
2006	61.0	7.1	0.0	787.9	0.0	0.0	787.9	91.5
2007	61.0	6.3	0.0	823.2	0.0	0.0	823.2	85.3
2008	61.0	5.6	0.0	860.1	0.0	0.0	860.1	79.6
2009	61.0	5.0	0.0	898.6	0.0	0.0	898.6	74.3
2010	61.0	4.5	0.0	938.8	0.0	0.0	938.8	69.3
2011	61.0	4.0	0.0	980.9	741.0	0.0	1721.9	113.4
2012	61.0	3.6	0.0	1024.8	0.0	0.0	1024.8	60.3
2013	61.0	3.2	0.0	1070.7	0.0	0.0	1070.7	56.2
2014	61.0	2.9	0.0	1118.6	0.0	0.0	1118.6	52.5
2015	61.0	2.6	0.0	1168.7	0.0	0.0	1168.7	48.9
2016	61.0	2.3	0.0	1221.0	0.0	0.0	1221.0	45.6
2017	61.0	2.0	0.0	1275.7	0.0	0.0	1275.7	42.6
2018	61.0	1.8	0.0	1332.8	741.0	0.0	2073.8	61.8
2019	61.0	1.6	0.0	1392.5	0.0	0.0	1392.5	37.1
2020	61.0	1.4	0.0	1454.9	0.0	0.0	1454.9	34.6
2021	61.0	1.3	0.0	1520.0	0.0	0.0	1520.0	32.2
2022	61.0	1.2	0.0	794.0	0.0	0.0	794.0	15.0
2023	0.0	0.0	0.0	0.0	9041.0	0.0	9041.0	152.9
TOT	12263.0	4038.7	0.0	24130.8	11264.0	0.0	35394.8	2360.1

BENEFIT/COST RATIO= 0.58
NET PRESENT VALUE= -1678.6
CI$ 1987 (THOUSANDS)

TABLE B-8

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-1 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
NEW NORTH - SOUTH ARTERIAL (2-LANE) FROM 504 TO 514

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=37

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	2685.0	1542.2	0.0	0.0	0.0	0.0	0.0	0.0
1996	5368.0	2876.9	0.0	0.0	0.0	0.0	0.0	0.0
1997	2685.0	1342.6	0.0	266.0	0.0	0.0	266.0	133.0
1998	61.0	28.5	0.0	555.0	0.0	0.0	555.0	258.9
1999	61.0	26.6	0.0	579.9	0.0	0.0	579.9	252.4
2000	61.0	24.5	0.0	605.8	0.0	0.0	605.8	246.1
2001	61.0	23.1	0.0	632.9	0.0	0.0	632.9	239.9
2002	61.0	21.6	0.0	661.3	0.0	0.0	661.3	233.8
2003	61.0	20.1	0.0	690.9	0.0	0.0	690.9	227.9
2004	61.0	18.8	0.0	721.8	741.0	0.0	1462.8	450.3
2005	61.0	17.5	0.0	754.2	0.0	0.0	754.2	216.6
2006	61.0	16.3	0.0	787.9	0.0	0.0	787.9	211.2
2007	61.0	15.3	0.0	823.2	0.0	0.0	823.2	205.8
2008	61.0	14.2	0.0	860.1	0.0	0.0	860.1	200.7
2009	61.0	13.3	0.0	898.6	0.0	0.0	898.6	195.6
2010	61.0	12.4	0.0	938.8	0.0	0.0	938.8	190.7
2011	61.0	11.6	0.0	980.9	741.0	0.0	1721.9	326.3
2012	61.0	10.8	0.0	1024.8	0.0	0.0	1024.8	181.2
2013	61.0	10.1	0.0	1070.7	0.0	0.0	1070.7	176.6
2014	61.0	9.4	0.0	1118.6	0.0	0.0	1118.6	172.2
2015	61.0	8.8	0.0	1168.7	0.0	0.0	1168.7	167.9
2016	61.0	8.2	0.0	1221.0	0.0	0.0	1221.0	163.6
2017	61.0	7.6	0.0	1275.7	0.0	0.0	1275.7	159.5
2018	61.0	7.1	0.0	1332.8	741.0	0.0	2073.8	241.9
2019	61.0	6.6	0.0	1392.5	0.0	0.0	1392.5	151.6
2020	61.0	6.2	0.0	1454.9	0.0	0.0	1454.9	147.8
2021	61.0	5.8	0.0	1520.0	0.0	0.0	1520.0	144.0
2022	61.0	5.4	0.0	794.0	0.0	0.0	794.0	70.2
2023	0.0	0.0	0.0	0.0	9041.0	0.0	9041.0	745.9
TOT	12263.0	6111.6	0.0	24130.8	11264.0	0.0	35394.8	6111.7

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 7.2 PERCENT
CI$ 1987 (THOUSANDS)OK, FLIST LP.CAY22Y15C

TABLE B-9

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-2 VOC BENEFITS FROM MID-1997 TO MID-2012 (15 YEARS)
WIDEN NORTH - SOUTH ARTERIAL BETWEEN 271 AND 501 FROM 2-LANES TO 4-LANES

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=27 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	440.0	177.7	0.0	0.0	0.0	0.0	0.0	0.0
1996	879.0	317.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	440.0	141.7	0.0	281.0	0.0	0.0	281.0	90.3
1998	24.0	6.9	0.0	603.0	0.0	0.0	603.0	173.3
1999	24.0	6.2	0.0	647.6	0.0	0.0	647.6	166.2
2000	24.0	5.5	0.0	695.5	0.0	0.0	695.5	159.4
2001	24.0	4.9	0.0	747.0	0.0	0.0	747.0	152.8
2002	24.0	4.4	0.0	802.2	0.0	0.0	802.2	146.6
2003	24.0	3.9	0.0	861.6	0.0	0.0	861.6	140.5
2004	24.0	3.5	0.0	925.3	0.0	0.0	925.3	134.8
2005	24.0	3.1	0.0	993.8	0.0	0.0	993.8	129.2
2006	24.0	2.8	0.0	1067.3	0.0	0.0	1067.3	123.9
2007	24.0	2.5	0.0	1146.3	0.0	0.0	1146.3	118.8
2008	24.0	2.2	0.0	1231.1	0.0	0.0	1231.1	113.9
2009	24.0	2.0	0.0	1322.1	0.0	0.0	1322.1	109.3
2010	24.0	1.8	0.0	1420.0	0.0	0.0	1420.0	104.9
2011	24.0	1.6	0.0	1525.0	0.0	0.0	1525.0	100.5
2012	24.0	1.4	0.0	819.0	0.0	0.0	819.0	48.2
2013	0.0	0.0	0.0	0.0	1296.0	0.0	1296.0	68.1
TOT	2119.0	689.0	0.0	15087.8	1296.0	0.0	16383.8	2080.9

BENEFIT/COST RATIO= 3.02
NET PRESENT VALUE= 1391.9
CI$ 1987 (THOUSANDS)

TABLE B-10

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-2 VOC BENEFITS FROM MID-1997 TO MID-2012 (15 YEARS)
WIDEN NORTH - SOUTH ARTERIAL BETWEEN 271 AND 501 FROM 2-LANES TO 4-LANES

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=27

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	440.0	42.6	0.0	0.0	0.0	0.0	0.0	0.0
1996	879.0	63.6	0.0	0.0	0.0	0.0	0.0	0.0
1997	440.0	23.8	0.0	281.0	0.0	0.0	281.0	15.3
1998	24.0	1.0	0.0	603.0	0.0	0.0	603.0	24.3
1999	24.0	0.7	0.0	647.6	0.0	0.0	647.6	19.5
2000	24.0	0.5	0.0	695.5	0.0	0.0	695.5	15.7
2001	24.0	0.4	0.0	747.0	0.0	0.0	747.0	12.6
2002	24.0	0.3	0.0	802.2	0.0	0.0	802.2	10.1
2003	24.0	0.2	0.0	861.6	0.0	0.0	861.6	8.1
2004	24.0	0.2	0.0	925.3	0.0	0.0	925.3	6.5
2005	24.0	0.1	0.0	993.8	0.0	0.0	993.8	5.2
2006	24.0	0.1	0.0	1067.3	0.0	0.0	1067.3	4.2
2007	24.0	0.1	0.0	1146.7	0.0	0.0	1146.7	3.3
2008	24.0	0.1	0.0	1231.1	0.0	0.0	1231.1	2.7
2009	24.0	0.0	0.0	1322.1	0.0	0.0	1322.1	2.2
2010	24.0	0.0	0.0	1420.0	0.0	0.0	1420.0	1.7
2011	24.0	0.0	0.0	1525.0	0.0	0.0	1525.0	1.4
2012	24.0	0.0	0.0	819.0	0.0	0.0	819.0	0.6
2013	0.0	0.0	0.0	0.0	1296.0	0.0	1296.0	0.7
TOT	2119.0	133.7	0.0	15087.8	1296.0	0.0	16383.8	133.7

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 33.9 PERCENT
CI$ 1987 (THOUSANDS)OK, FLIST LP.CAY22Y20C

TABLE B-11

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-2 VOC BENEFITS FROM MID-1997 TO MID-2017 (20 YEARS)
WIDEN NORTH - SOUTH ARTERIAL BETWEEN 271 AND 501 FROM 2-LANES TO 4-LANES

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=32 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	440.0	177.7	0.0	0.0	0.0	0.0	0.0	0.0
1996	879.0	317.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	440.0	141.7	0.0	281.0	0.0	0.0	281.0	90.5
1998	24.0	6.9	0.0	603.0	0.0	0.0	603.0	173.3
1999	24.0	6.2	0.0	647.6	0.0	0.0	647.6	166.2
2000	24.0	5.5	0.0	695.5	0.0	0.0	695.5	159.4
2001	24.0	4.9	0.0	747.0	0.0	0.0	747.0	152.8
2002	24.0	4.4	0.0	802.2	0.0	0.0	802.2	146.6
2003	24.0	3.9	0.0	861.6	0.0	0.0	861.6	140.5
2004	24.0	3.5	0.0	925.3	0.0	0.0	925.3	134.8
2005	24.0	3.1	0.0	993.8	0.0	0.0	993.8	129.2
2006	24.0	2.8	0.0	1067.3	0.0	0.0	1067.3	123.9
2007	24.0	2.5	0.0	1146.3	0.0	0.0	1146.3	118.8
2008	24.0	2.2	0.0	1231.1	0.0	0.0	1231.1	113.9
2009	24.0	2.0	0.0	1322.1	0.0	0.0	1322.1	109.3
2010	24.0	1.8	0.0	1420.0	0.0	0.0	1420.0	104.8
2011	24.0	1.6	0.0	1525.0	0.0	0.0	1525.0	100.5
2012	24.0	1.4	0.0	1637.8	0.0	0.0	1637.8	96.3
2013	24.0	1.3	0.0	1759.0	0.0	0.0	1759.0	92.4
2014	24.0	1.1	0.0	1889.1	0.0	0.0	1889.1	88.6
2015	24.0	1.0	0.0	2028.9	0.0	0.0	2028.9	84.9
2016	24.0	0.9	0.0	2179.0	0.0	0.0	2179.0	81.5
2017	24.0	0.8	0.0	1170.0	0.0	0.0	1170.0	39.1
2018	0.0	0.0	0.0	0.0	1296.0	0.0	1296.0	38.6
TOT	2239.0	694.1	0.0	24932.7	1296.0	0.0	26228.7	2486.0

BENEFIT/COST RATIO= 3.58
NET PRESENT VALUE= 1791.9
CI$ 1987 (THOUSANDS)

TABLE B-12

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-2 VOC BENEFITS FROM MID-1997 TO MID-2017 (20 YEARS)
WIDEN NORTH - SOUTH ARTERIAL BETWEEN 271 AND 501 FROM 2-LANES TO 4-LANES

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=32

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	440.0	41.3	0.0	0.0	0.0	0.0	0.0	0.0
1996	879.0	61.3	0.0	0.0	0.0	0.0	0.0	0.0
1997	440.0	22.8	0.0	281.0	0.0	0.0	281.0	14.6
1998	24.0	0.9	0.0	603.0	0.0	0.0	603.0	23.3
1999	24.0	0.7	0.0	647.6	0.0	0.0	647.6	18.6
2000	24.0	0.5	0.0	695.5	0.0	0.0	695.5	14.9
2001	24.0	0.4	0.0	747.0	0.0	0.0	747.0	11.9
2002	24.0	0.3	0.0	802.2	0.0	0.0	802.2	9.5
2003	24.0	0.2	0.0	861.6	0.0	0.0	861.6	7.6
2004	24.0	0.2	0.0	925.3	0.0	0.0	925.3	6.1
2005	24.0	0.1	0.0	993.8	0.0	0.0	993.8	4.8
2006	24.0	0.1	0.0	1067.3	0.0	0.0	1067.3	3.9
2007	24.0	0.1	0.0	1146.3	0.0	0.0	1146.3	3.1
2008	24.0	0.0	0.0	1231.1	0.0	0.0	1231.1	2.5
2009	24.0	0.0	0.0	1322.1	0.0	0.0	1322.1	2.0
2010	24.0	0.0	0.0	1420.0	0.0	0.0	1420.0	1.6
2011	24.0	0.0	0.0	1525.0	0.0	0.0	1525.0	1.3
2012	24.0	0.0	0.0	1637.8	0.0	0.0	1637.8	1.0
2013	24.0	0.0	0.0	1759.0	0.0	0.0	1759.0	0.8
2014	24.0	0.0	0.0	1889.1	0.0	0.0	1889.1	0.6
2015	24.0	0.0	0.0	2028.9	0.0	0.0	2028.9	0.5
2016	24.0	0.0	0.0	2179.0	0.0	0.0	2179.0	0.4
2017	24.0	0.0	0.0	1170.0	0.0	0.0	1170.0	0.2
2018	0.0	0.0	0.0	0.0	1296.0	0.0	1296.0	0.1
TOT	2239.0	129.0	0.0	24932.7	1296.0	0.0	26228.7	129.0

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 34.4 PERCENT
CI$ 1987 (THOUSANDS)OK, FLIST LP.CAY22Y25C

TABLE B-13

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-2 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
WIDEN NORTH - SOUTH ARTERIAL BETWEEN 271 AND 501 FROM 2-LANES TO 4-LANES

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=37 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	440.0	177.7	0.0	0.0	0.0	0.0	0.0	0.0
1996	879.0	317.0	0.0	0.0	0.0	0.0	0.0	0.0
1997	440.0	141.7	0.0	281.0	0.0	0.0	281.0	90.5
1998	24.0	6.9	0.0	603.0	0.0	0.0	603.0	173.3
1999	24.0	6.2	0.0	647.6	0.0	0.0	647.6	166.2
2000	24.0	5.5	0.0	695.5	0.0	0.0	695.5	159.4
2001	24.0	4.9	0.0	746.9	0.0	0.0	746.9	152.8
2002	24.0	4.4	0.0	802.2	0.0	0.0	802.2	146.6
2003	24.0	3.9	0.0	861.5	0.0	0.0	861.5	140.5
2004	24.0	3.5	0.0	925.2	0.0	0.0	925.2	134.8
2005	24.0	3.1	0.0	993.6	0.0	0.0	993.6	129.2
2006	24.0	2.8	0.0	1067.1	0.0	0.0	1067.1	123.9
2007	24.0	2.5	0.0	1146.1	0.0	0.0	1146.1	118.8
2008	24.0	2.2	0.0	1230.8	0.0	0.0	1230.8	113.9
2009	24.0	2.0	0.0	1321.9	0.0	0.0	1321.9	109.2
2010	24.0	1.8	0.0	1419.6	0.0	0.0	1419.6	104.2
2011	24.0	1.6	0.0	1524.6	0.0	0.0	1524.6	100.4
2012	24.0	1.4	0.0	1637.4	0.0	0.0	1637.4	96.3
2013	24.0	1.3	0.0	1758.5	0.0	0.0	1758.5	92.4
2014	24.0	1.1	0.0	1888.5	0.0	0.0	1888.5	88.6
2015	24.0	1.0	0.0	2028.2	0.0	0.0	2028.2	84.9
2016	24.0	0.9	0.0	2178.2	0.0	0.0	2178.2	81.4
2017	24.0	0.8	0.0	2339.3	0.0	0.0	2339.3	78.1
2018	24.0	0.7	0.0	2512.3	0.0	0.0	2512.3	74.9
2019	24.0	0.6	0.0	2698.1	0.0	0.0	2698.1	71.8
2020	24.0	0.6	0.0	2897.7	0.0	0.0	2897.7	68.8
2021	24.0	0.5	0.0	3112.0	0.0	0.0	3112.0	66.0
2022	24.0	0.5	0.0	1671.0	0.0	0.0	1671.0	31.6
2023	0.0	0.0	0.0	0.0	1296.0	0.0	1296.0	21.9
TOT	2359.0	697.0	0.0	38987.9	1296.0	0.0	40283.9	2821.1

BENEFIT/COST RATIO= 4.05
NET PRESENT VALUE= 2124.2
CI$ 1987 (THOUSANDS)

TABLE B-14

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-2 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
WIDEN NORTH - SOUTH ARTERIAL BETWEEN 271 AND 501 FROM 2-LANES TO 4-LANES

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=37

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	440.0	40.8	0.0	0.0	0.0	0.0	0.0	0.0
1996	879.0	60.6	0.0	0.0	0.0	0.0	0.0	0.0
1997	440.0	22.5	0.0	281.0	0.0	0.0	281.0	14.4
1998	24.0	0.9	0.0	603.0	0.0	0.0	603.0	23.0
1999	24.0	0.7	0.0	647.6	0.0	0.0	647.6	18.3
2000	24.0	0.5	0.0	695.5	0.0	0.0	695.5	14.6
2001	24.0	0.4	0.0	746.9	0.0	0.0	746.9	11.7
2002	24.0	0.3	0.0	802.2	0.0	0.0	802.2	9.3
2003	24.0	0.2	0.0	861.5	0.0	0.0	861.5	7.4
2004	24.0	0.2	0.0	925.2	0.0	0.0	925.2	5.9
2005	24.0	0.1	0.0	993.6	0.0	0.0	993.6	4.7
2006	24.0	0.1	0.0	1067.1	0.0	0.0	1067.1	3.8
2007	24.0	0.1	0.0	1146.1	0.0	0.0	1146.1	3.0
2008	24.0	0.0	0.0	1230.8	0.0	0.0	1230.8	2.4
2009	24.0	0.0	0.0	1321.9	0.0	0.0	1321.9	1.9
2010	24.0	0.0	0.0	1419.6	0.0	0.0	1419.6	1.5
2011	24.0	0.0	0.0	1524.6	0.0	0.0	1524.6	1.2
2012	24.0	0.0	0.0	1637.4	0.0	0.0	1637.4	1.0
2013	24.0	0.0	0.0	1758.5	0.0	0.0	1758.5	0.8
2014	24.0	0.0	0.0	1888.5	0.0	0.0	1888.5	0.6
2015	24.0	0.0	0.0	2028.2	0.0	0.0	2028.2	0.5
2016	24.0	0.0	0.0	2178.2	0.0	0.0	2178.2	0.4
2017	24.0	0.0	0.0	2339.3	0.0	0.0	2339.3	0.3
2018	24.0	0.0	0.0	2512.3	0.0	0.0	2512.3	0.3
2019	24.0	0.0	0.0	2698.1	0.0	0.0	2698.1	0.2
2020	24.0	0.0	0.0	2897.7	0.0	0.0	2897.7	0.2
2021	24.0	0.0	0.0	3112.0	0.0	0.0	3112.0	0.1
2022	24.0	0.0	0.0	1671.0	0.0	0.0	1671.0	0.1
2023	0.0	0.0	0.0	0.0	1296.0	0.0	1296.0	0.0
TOT	2359.0	127.6	0.0	38987.9	1296.0	0.0	40283.9	127.6

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 34.6 PERCENT
CI$ 1987 (THOUSANDS)OK, FLIST LP.CAY23Y25C

TABLE B-15

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-3 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
NEW EAST - WEST ARTERIAL (2-LANE) FROM 600 TO 602

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=37 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	743.0	300.1	0.0	0.0	0.0	0.0	0.0	0.0
1996	1484.0	535.1	0.0	0.0	0.0	0.0	0.0	0.0
1997	743.0	239.2	0.0	102.0	0.0	0.0	102.0	32.8
1998	31.0	8.9	0.0	207.0	0.0	0.0	207.0	59.5
1999	31.0	8.0	0.0	210.8	0.0	0.0	210.8	54.1
2000	31.0	7.1	0.0	214.7	0.0	0.0	214.7	49.2
2001	31.0	6.3	0.0	218.7	0.0	0.0	218.7	44.7
2002	31.0	5.7	0.0	222.7	0.0	0.0	222.7	40.7
2003	31.0	5.1	0.0	226.8	0.0	0.0	226.8	37.0
2004	31.0	4.5	0.0	231.0	403.0	0.0	634.0	92.3
2005	31.0	4.0	0.0	235.2	0.0	0.0	235.2	30.6
2006	31.0	3.6	0.0	239.5	0.0	0.0	239.5	27.8
2007	31.0	3.2	0.0	244.0	0.0	0.0	244.0	25.3
2008	31.0	2.9	0.0	248.5	0.0	0.0	248.5	23.0
2009	31.0	2.6	0.0	253.0	0.0	0.0	253.0	20.9
2010	31.0	2.3	0.0	257.7	0.0	0.0	257.7	19.0
2011	31.0	2.0	0.0	262.4	403.0	0.0	665.4	43.8
2012	31.0	1.8	0.0	267.3	0.0	0.0	267.3	15.7
2013	31.0	1.6	0.0	272.2	0.0	0.0	272.2	14.3
2014	31.0	1.5	0.0	277.2	0.0	0.0	277.2	13.0
2015	31.0	1.3	0.0	282.3	0.0	0.0	282.3	11.8
2016	31.0	1.2	0.0	287.5	0.0	0.0	287.5	10.7
2017	31.0	1.0	0.0	292.8	0.0	0.0	292.8	9.8
2018	31.0	0.9	0.0	298.2	403.0	0.0	701.2	20.9
2019	31.0	0.8	0.0	303.7	0.0	0.0	303.7	8.1
2020	31.0	0.7	0.0	309.3	0.0	0.0	309.3	7.3
2021	31.0	0.7	0.0	315.0	0.0	0.0	315.0	6.7
2022	31.0	0.6	0.0	161.0	0.0	0.0	161.0	3.0
2023	0.0	0.0	0.0	0.0	2278.0	0.0	2278.0	38.5
TOT	3745.0	1152.7	0.0	6440.5	3487.0	0.0	9927.5	760.8

BENEFIT/COST RATIO= 0.66
NET PRESENT VALUE= -391.9
CI$ 1987 (THOUSANDS)

TABLE B-16

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-3 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
NEW EAST - WEST ARTERIAL (2-LANE) FROM 600 TO 602

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=37

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	743.0	411.0	0.0	0.0	0.0	0.0	0.0	0.0
1996	1484.0	762.3	0.0	0.0	0.0	0.0	0.0	0.0
1997	743.0	354.4	0.0	102.0	0.0	0.0	102.0	48.7
1998	31.0	13.7	0.0	207.0	0.0	0.0	207.0	91.7
1999	31.0	12.8	0.0	210.8	0.0	0.0	210.8	86.7
2000	31.0	11.8	0.0	214.7	0.0	0.0	214.7	82.0
2001	31.0	11.0	0.0	218.7	0.0	0.0	218.7	77.6
2002	31.0	10.2	0.0	222.7	0.0	0.0	222.7	73.4
2003	31.0	9.5	0.0	226.8	0.0	0.0	226.8	69.4
2004	31.0	8.8	0.0	231.0	403.0	0.0	634.0	180.1
2005	31.0	8.2	0.0	235.2	0.0	0.0	235.2	62.1
2006	31.0	7.6	0.0	239.5	0.0	0.0	239.5	58.7
2007	31.0	7.1	0.0	244.0	0.0	0.0	244.0	55.5
2008	31.0	6.6	0.0	248.5	0.0	0.0	248.5	52.5
2009	31.0	6.1	0.0	253.0	0.0	0.0	253.0	49.7
2010	31.0	5.6	0.0	257.7	0.0	0.0	257.7	47.0
2011	31.0	5.2	0.0	262.4	403.0	0.0	665.4	112.6
2012	31.0	4.9	0.0	267.3	0.0	0.0	267.3	42.0
2013	31.0	4.5	0.0	272.2	0.0	0.0	272.2	39.7
2014	31.0	4.2	0.0	277.2	0.0	0.0	277.2	37.6
2015	31.0	3.9	0.0	282.3	0.0	0.0	282.3	35.5
2016	31.0	3.6	0.0	287.5	0.0	0.0	287.5	33.6
2017	31.0	3.4	0.0	292.8	0.0	0.0	292.8	31.8
2018	31.0	3.1	0.0	298.2	403.0	0.0	701.2	70.7
2019	31.0	2.9	0.0	303.7	0.0	0.0	303.7	28.4
2020	31.0	2.7	0.0	309.3	0.0	0.0	309.3	26.9
2021	31.0	2.5	0.0	315.0	0.0	0.0	315.0	25.4
2022	31.0	2.3	0.0	161.0	0.0	0.0	161.0	12.1
2023	0.0	0.0	0.0	0.0	2278.0	0.0	2278.0	156.6
TOT	3745.0	1689.9	0.0	6440.5	3487.0	0.0	9927.5	1690.0

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 7.7 PERCENT
CI$ 1987 (THOUSANDS)OK, FLIST LP.CAY24Y25C

TABLE B-17

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-4 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
NEW SOUTH SOUND ARTERIAL (2-LANE) FROM 317 TO 347

NET PRESENT VALUE AND BENEFIT/COST RATIO CALCULATION

NUMBER OF YEARS=37 DISCOUNT RATE=12.0 PERCENT

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	1489.0	601.4	0.0	0.0	0.0	0.0	0.0	0.0
1996	2977.0	1073.5	0.0	0.0	0.0	0.0	0.0	0.0
1997	1489.0	479.4	0.0	60.0	0.0	0.0	60.0	19.3
1998	31.0	8.9	0.0	124.0	0.0	0.0	124.0	35.6
1999	31.0	8.0	0.0	129.7	0.0	0.0	129.7	33.3
2000	31.0	7.1	0.0	135.6	0.0	0.0	135.6	31.1
2001	31.0	6.3	0.0	141.8	0.0	0.0	141.8	29.0
2002	31.0	5.7	0.0	148.2	0.0	0.0	148.2	27.1
2003	31.0	5.1	0.0	155.0	0.0	0.0	155.0	25.3
2004	31.0	4.5	0.0	162.1	396.0	0.0	558.1	81.3
2005	31.0	4.0	0.0	169.5	0.0	0.0	169.5	22.0
2006	31.0	3.6	0.0	177.2	0.0	0.0	177.2	20.6
2007	31.0	3.2	0.0	185.3	0.0	0.0	185.3	19.2
2008	31.0	2.9	0.0	193.7	0.0	0.0	193.7	17.9
2009	31.0	2.6	0.0	202.6	0.0	0.0	202.6	16.7
2010	31.0	2.3	0.0	211.8	0.0	0.0	211.8	15.6
2011	31.0	2.0	0.0	221.5	396.0	0.0	617.5	40.7
2012	31.0	1.8	0.0	231.6	0.0	0.0	231.6	13.6
2013	31.0	1.6	0.0	242.1	0.0	0.0	242.1	12.7
2014	31.0	1.5	0.0	253.2	0.0	0.0	253.2	11.9
2015	31.0	1.3	0.0	264.7	0.0	0.0	264.7	11.1
2016	31.0	1.2	0.0	276.8	0.0	0.0	276.8	10.3
2017	31.0	1.0	0.0	289.4	0.0	0.0	289.4	9.7
2018	31.0	0.9	0.0	302.7	396.0	0.0	698.7	20.8
2019	31.0	0.8	0.0	316.5	0.0	0.0	316.5	8.4
2020	31.0	0.7	0.0	330.9	0.0	0.0	330.9	7.9
2021	31.0	0.7	0.0	346.0	0.0	0.0	346.0	7.3
2022	31.0	0.6	0.0	181.0	0.0	0.0	181.0	3.4
2023	0.0	0.0	0.0	0.0	5439.0	0.0	5439.0	92.0
TOT	6730.0	2232.6	0.0	5452.7	6627.0	0.0	12079.7	643.9

BENEFIT/COST RATIO= 0.29
NET PRESENT VALUE= -1588.7
CI$ 1987 (THOUSANDS)

TABLE B-18

CAYMAN ISLANDS MASTER GROUND TRANSPORTATION STUDY
ALTERNATIVE 2-4 VOC BENEFITS FROM MID-1997 TO MID-2022 (25 YEARS)
NEW SOUTH SOUND ARTERIAL (2-LANE) FROM 317 TO 347

INTERNAL RATE OF RETURN CALCULATION

NUMBER OF YEARS=37

YEAR	COSTS	PRESENT VALUE	TIME BENEFITS	VOC BENEFITS	MAINT BENEFITS	ACCINV BENEFITS	TOTAL BENEFITS	PRESENT VALUE
1987	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1988	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1989	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1993	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1994	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1995	1489.0	1156.6	0.0	0.0	0.0	0.0	0.0	0.0
1996	2977.0	2240.6	0.0	0.0	0.0	0.0	0.0	0.0
1997	1489.0	1085.8	0.0	60.0	0.0	0.0	0.0	0.0
1998	31.0	21.9	0.0	124.0	0.0	0.0	60.0	43.8
1999	31.0	21.2	0.0	129.7	0.0	0.0	124.0	87.6
2000	31.0	20.6	0.0	135.6	0.0	0.0	129.7	88.8
2001	31.0	19.9	0.0	141.8	0.0	0.0	135.6	89.9
2002	31.0	19.3	0.0	148.2	0.0	0.0	141.8	91.1
2003	31.0	18.7	0.0	155.0	0.0	0.0	148.2	92.3
2004	31.0	18.1	0.0	162.1	396.0	0.0	155.0	93.5
2005	31.0	17.6	0.0	169.5	0.0	0.0	558.1	326.3
2006	31.0	17.0	0.0	177.2	0.0	0.0	169.5	96.0
2007	31.0	16.5	0.0	185.3	0.0	0.0	177.2	97.2
2008	31.0	16.0	0.0	193.7	0.0	0.0	185.3	98.5
2009	31.0	15.5	0.0	202.6	0.0	0.0	193.7	99.8
2010	31.0	15.0	0.0	211.8	0.0	0.0	202.6	101.1
2011	31.0	14.5	0.0	221.5	396.0	0.0	211.8	102.5
2012	31.0	14.1	0.0	231.6	0.0	0.0	617.5	289.4
2013	31.0	13.6	0.0	242.1	0.0	0.0	231.6	105.2
2014	31.0	13.2	0.0	253.2	0.0	0.0	242.1	106.5
2015	31.0	12.8	0.0	264.7	0.0	0.0	253.2	107.9
2016	31.0	12.4	0.0	276.8	0.0	0.0	264.7	109.4
2017	31.0	12.0	0.0	289.4	0.0	0.0	276.8	110.8
2018	31.0	11.6	0.0	302.7	396.0	0.0	289.4	112.2
2019	31.0	11.3	0.0	316.5	0.0	0.0	698.7	262.5
2020	31.0	10.9	0.0	330.9	0.0	0.0	316.5	115.2
2021	31.0	10.6	0.0	346.0	0.0	0.0	330.9	116.7
2022	31.0	10.3	0.0	181.0	0.0	0.0	346.0	118.3
2023	0.0	0.0	0.0	0.0	5439.0	0.0	181.0	59.9
							5439.0	1745.2
TOT	6730.0	4867.7	0.0	5452.7	6627.0	0.0	12079.7	4867.7

BENEFIT/COST RATIO= 1.00
NET PRESENT VALUE= 0.0
INTERNAL RATE OF RETURN= 3.2 PERCENT
CI$ 1987 (THOUSANDS)OK,
End of file. Cominput. (Input from terminal.)

APPENDIX C

VEHICLE SIZE AND WEIGHT RESTRICTIONS

APPENDIX C

VEHICLE SIZE AND WEIGHT RESTRICTIONS

Currently, there are no legal restrictions on the size and weights of vehicles which can be registered and operated in the Cayman Islands. Fortunately, conditions are such that there are few large trucks in the Islands at present. Neverthless, the MGTP Study has concluded that legislation should be adopted which places limits on the size and weight of vehicles so that problems do not develop in the future. It would be most unfortunate if actions were not taken and the road system later was required to accommodate excessive numbers of large, heavy vehicles which exceed the system's design features.

MGTP STUDY RECOMMENDATION

It is recommended that a thorough study be made of the Island trucking industry in order to develop a sound basis for establishing specific values for vehicle size and weight restrictions. This study would include interviews with firms that utilise large trucks in the course of their operations in order to understand the needs of industry. Also, information regarding the dimensions of existing vehicles and vehicle/axle weights would be obtained. The operating features of existing large, heavy vehicles would then be related to the geometrics and pavement designs on the existing and future road system. From this structured approach, it would be possible to reach informed and well considered conclusions regarding the specific values for vehicle dimensions and vehicle/axle weights that should be set as the upper limit in new legislation.

INTERIM GUIDELINES

During the MGTP Study, attention necessarily has focused upon development of the road plan itself, including needed changes in policies, organisation and legislation to facilitate to achievement. The MGTP Study has not been responsible for activities associated with actual implementation of the plan and its supporting institutional recommendations.

Nevertheless, Government requested quidelines which could be considered in establishing specific values regarding vehicle dimension and weight criteria. The discussion which follows provides these guidelines. Clearly, more refinement could be provided after a more thorough study of the trucking industry. Accordingly, the values reported herein should be considered only as interim guidelines which may need adjustment after either additional investigation or as future experience may dictate.

Government should recognise that there always will be pressures to increase vehicle size and weight restrictions. This is the experience of other jurisdictions and there is no reason to believe that the Cayman Islands can avoid similar pressures. It often is in the interest of more efficient truck operations to use larger vehicles and to carry heavier loads. However, these private sector efficiencies conflict with road design features and the shortage of public funds to build and maintain the roads required by large, heavy trucks. Additionally, there are conflicts with road safety considerations. Further, continuing increases in vehicle size and weight restriction inherently render more of the road system to be obsolete in geometric and structural features.

VEHICLE CHARACTERISTICS TO BE REGULATED

Care must be taken to not adopt unnecessary controls regarding vehicle characteristics unless they are important in relation to road system features and public safety. To do otherwise would unduly and adversely impact road transport costs which have implications for the whole economy. Accordingly, these interim guidelines address critical features only, viz:

* Vehicle width
* Vehicle length
* Vehicle height

* Vehicle gross weight
* Vehicle axle weights

Operating characteristics are not addressed such as braking characteristics or power/speed capabilities. Conditions are not such in the Cayman Islands to require vehicle performance features in excess of those typically associated with standard vehicles imported from abroad. The annual vehicle inspection programme appears to be adequate to deal with mechanical standards required for road worthiness certification.

VEHICLE WIDTH

Vehicle width should be controlled because of road safety implications. This is particularly important in the Islands because of the often narrow lane widths and physical encroachments, sometimes almost up to the pavement edge.

Standards proposed in the MGTP for new roads provide 12 foot lanes. If an 8-foot wide truck occupies the centre of a 12 foot lane, there will be 4 feet separating it from a similar size vehicle in adjacent lanes. Since vehicles do no stay precisely in the middle of a lane, the 4 foot clearance varies both up and down. Typically, however, vehicles will move towards the outside edge of a roadway when approaching an object or vehicle which appears to be close to the side of the vehicle. Thus, in vehicle passing situations (on-coming traffic as well as traffic moving in the same direction), the 4 foot clearance typically is increased on a 12-foot lane.

Unfortunately, the existing roadway network does not always provide modern lane widths of 12 feet. Therefore, the lateral clearance between two 8-feet wide vehicles is most likely less than 4 feet in many locations. On the other hand, vehicle speeds are slow relative to the high speed intercity travel in other countries. Lower speeds justify less lateral clearance since better vehicle control is possible.

If an 8-foot vehicle width restriction is adopted, it has implications about truck loadings for some kinds of shipments. While 8-feet will accommodate vehicles hauling shipping containers, it does not provide an inside width of a full 8 feet on box body trucks, etc. Therefore, there is some loss in loading efficiency for 4-ft x 4-ft and 4-ft x 8-ft pallettes, 8-ft wide building panels, etc.

For many years in the U.S., an 8-foot width restriction was the general norm. However, an $8^1/2$ width was introduced with passage of the 1982 Surface Transportation Assistance Act (STAA). Nevertheless, road system design and operating conditions are very different in the U.S. compared with the Cayman Islands, particularly with regard to intercity truck operations.

While there are no data which indicate the width of vehicles currently operating in the Cayman Islands, observations suggest that few, if any, would exceed 8 feet. Therefore, the 8 feet maximum width appears to be a reasonable limit to be considered in new legislation.

As noted subsequently, vehicles which exceed 8 feet in width can be accommodated if the proposed special permit system is adopted. However, care must be taken to approve special permits only in special cases, not universally as a matter of right. Since many vehicle imports are from the U.S., it can be expected that pressures will increase to allow $8^1/2$ feet wide vehicles, the new standard in the U.S.

VEHICLE LENGTH

Justifications for controlling vehicle lengths relate to concerns regarding offtracking although there also are concerns regarding vehicle control such as braking, stability and swaying. Offtracking is the lateral distance between the tracks made by the rear wheels of a vehicle and the front wheels.

Offtracking is dependant on the distance between axles and body overhang and varies significantly between straight (i.e. single-unit) trucks and combination (articulated) vehicles. The major concerns with offtracking is the encroachment into other lanes as well as difficulties in negotiating turns, particularly those with short turning radii. Obviously, offtracking is more of a concern where road widths are narrow and turning radii are constricted, a condition that frequently prevails in the Islands.

The mathematical expression for computing offtracking is as follows:

$$MOT = R_1 - \quad \overline{R_1^{2} -} \quad (L)^2$$

where:

- MOT = maximum off-tracking;
- R_1 = turning radius of outside front wheel;
- L_1 = wheelbase of tractor;
- L_2 = wheelbase of first trailer or semitrailer
- L_3 = distance between rear axle and articulation point (pintle hook);
- L_4 = distance between articulation point and front axle of next trailer; and
- L_5 = wheelbase of trailer.

Source: Wilbur Smith Associates, "Changes in Legal Vehicle Weights and Dimensions - Some Economic Effects on Highways", NCHRP Report 141.

Field tests have supported the equation except where the turning radii is less than the sum of the squares of the wheelbases. The equation does not account for front or rear overhangs between wheels and bumpers or projections outside the wheel tread.

Offtracking for a 40-foot long single-unit truck for a 165 foot curve radius is 3.4 feet. For a 40-foot long three-axle articulated vehicle, offtracking is

$$VGW = 500 \{(LN/N-1) + 12N + 36\}$$

where:

VGW = vehicle gross weight
L = centre to centre distance between any group of axles in feet
N = number of axles in the group

Because the main impact of vehicle gross weight is on bridges, of which there are none at present in the Cayman Islands, there appears to be no strong reason to adopt restrictions on vehicle gross weight.

AXLE WEIGHTS

Heavy axle weights have a profound influence on the performance and service life of road pavements. Pavement damage is a direct reflection of the number and weight of axle loadings to which a pavement is subjected. Modern pavement design procedures involve estimation of the number and weight distribution of axle loads as the basis for determining the thickness of the pavement that is required.

The effect of axle loads varies significantly, depending upon the weight of the axle. Also, tandem axles affect pavements differently than do single axles because of the way deflections occur and pavement stress are distributed.

The relationship between axle load repetitions is not arithmetically proportional to the axle loading. Typically, axle loads are translated into equivalent 18,000 pound (18 Kip) single axle loads using equivalency factors derived from pavement life research. Table A present axle load equivalencies derived from the AASHO Road Test.

Design of the new roads included in the MGTP can take into account appropriate consideration of forecast axle loadings.

However, it is not likely that many existing roads were designed with large numbers of heavy axles in mind. Consequently, pavement deterioration can be expected to accelerate rapidly if steps are not taken to limit the weight of axles which are permitted.

Prior to the 1982 STAA in the U.S., most state governments restricted single axle loads to 20,000 pounds, while 34,000 pounds was the most commonly imposed limit for tandem axles. These limits directly correlated with provisions in the Federal-Aid Highway Act of 1975 regarding travel on the Interstate System.

Again, it is emphasised that U.S. conditions differ markedly from those in the Cayman Islands. The U.S. limits must be considered as being too generous for adoption in the Islands, given road design practices in the past.

Reference to Table C-1 will indicate that a modest reduction in the maximum axle weight limits can greatly reduce the pavement damage impact. For instance, in the case of single axles, a 16,000 pound axle has only an 18 kip equivalence factor of 0.60, compared to a factor of 1.57 for a 20,000 pound single axle. Regarding tandem axles, a load of 28,000 pounds has an equivalency factor of 0.64 compared to a factor of 1.45 for a 34,000 pound tandem axle.

Based on available vehicle registration data, most trucks in the Cayman Islands will not be affected by axle weight limits. Only those which regularly haul heavy loads will be required to make adjustments to comply with axle load limits. Probably the heaviest vehicles operating in the Islands are petrol tankers, excavation material hauliers and perhaps concrete trucks. With regard to trucks transporting shipping containers, the maximum loading of a container may be quite heavy, but containers typically weigh far less than this maximum. Containers tend to reach their volume capacity before they reach their weight capacity. For instance, 20-foot containers typically have a maximum total weight of about 45,000 pounds (in the case of a 8 x 8 x 20 containers) but the

TABLE C-1

EQUIVALENT 18-KIP SINGLE-AXLE LOAD FACTORS

SINGLE AXLES Load, kips	Factor	TANDEM AXLES Load, kips	Factor
2	0.0002	4	0.0004
3	0.0008	6	0.0014
4	0.002	8	0.004
5	0.005	10	0.01
6	0.01	12	0.02
7	0.02	14	0.04
8	0.03	16	0.06
10	0.08	18	0.10
12	0.18	20	0.15
14	0.34	22	0.23
16	0.60	24	0.33
18	1.00	26	0.46
20	1.57	28	0.64
22	2.37	30	0.85
24	3.45	32	1.12
26	4.88	34	1.45
28	6.73	36	1.85
30	9.09	38	2.33
32	12.05	40	2.99
34	15.72	42	3.57
36	20.23	44	4.35
38	25.70	46	5.26
40	32.29	48	6.31

Source: U.S. Senate, 93rd, 2nd session, Committee on Public Works, hearings on Transportation and New Energy Policies (Truck Sizes and Weights), February 20, 21, and March 26 1974, Washington, D.C., U.S. Government Printing Office, 1974. p.72.

average weight is often about one-half or less of this maximum. A 40-foot container has less than twice the maximum weight of a 20-foot container due to bending stresses.

Most travel distances in the Islands are quite short. Therefore, the consequences of setting a fairly low axle load limit will not adversely affect truckers as much as if long distance travel was involved. In some cases, more trips may be required to transport commodities from one place to another but the travel time consumed by the extra trips will not be excessive. Similarly, truck operating costs will not be significantly impacted.

Consequently, it is suggested that Government consider setting a weight limit of 16,000 pounds for single axles and 28,000 pounds for tandem axles.

A system of overweight permits should be adopted for loads which are indivisible and which result in excess axle loading. A fee could be charged for such permits to recoup Government costs for the damage caused to pavements by over-limit loads.

ENFORCEMENT

If Government adopts MGTP Study recommendations to impose limits on vehicle size and weight, it must also institute an enforcement process.

Regarding vehicle size limits, all that is required is to deny registration for any vehicle which exceeds the maximum length or width stipulations. As indicated, a special permit system may be required to cope with vehicles already registered which exceed these maximums and to accommodate special hardship cases.

With respect to axle load limits, it would be advisable at first to undertake an educational phase since truck operations typically do not have facilities to determine the weight of their vehicles when loaded. It is often possible to provide volumetric guidelines which allow the truck operator to gauge the load that can be carried without violating the axle road restrictions. Some example weighings of trucks at the PWD weigh bridge installations could be helpful in this respect.

Because of the narrow road confines, it is not desirable to pull trucks over alongside the road to weigh them. Therefore, a weigh-in-motion (WIM) system could be employed at strategic locations to identify those vehicles which should be required to proceed to static scales for more precise weighing. Obviously, a police escort will be required for vehicles which are suspected to be overloaded.

A fixed penalty schedule should be developed for axle load violations. Penalties should be set at high levels to serve as an effective deterrent. Operators should be given the perception that it is far better to obey the law than to take a chance on being caught while operating overweight. The savings in pavement damage costs warrant stringent enforcement/penalty measures.

APPENDIX D

HORIZONTAL ALIGNMENT

APPENDIX D

HORIZONTAL ALIGNMENT
NORTH-SOUTH ARTERIAL

PI COORDINATES

POINT	NORTHING	EASTING
BOP	7 035 261	1 505 405
TIE IN	34 055	505 695
PI1	33 867	505 735
PI2	31 710	506 550
PI3	28 810	506 045
PI4	21 700	507 740
PI5	18 570	509 235
PI6	14 574	510 341
PI7	10 550	508 790
PI8	01 096	511 941
PI9	00 100	512 167
P10	6 998 845	512 132
EOP	6 998 540	511 918

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO TIE IN	EXISTING MNT PLEASANT TO BOTABANO RD.	
TIE IN TO PI1	168° 00′	192′
PI1 TO PI2	159° 18′	2306′
PI2 TO PI3	189° 53′	2944′
PI3 TO PI4	166° 35′	7309′
PI4 TO PI5	154° 28′	3469′
PI5 TO PI6	164° 32′	4147′
PI6 TO PI7	201° 05′	4312′
PI7 TO PI8	163° 34′	9966′
PI8 TO PI9	167° 14′	1021′
PI9 TO PI10	181° 36′	1255′
PI10 TO EOP	215° 03′	373′

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	573′	10° 00′	8° 42′	87′	44′	2′
2	5730′	1° 00′	30° 35′	3058′	1566′	210′
3	2865′	2° 00′	23° 17′	1164′	590′	60′
4	5730′	1° 00′	12° 07′	1212′	608′	32′
5	5730′	1° 00′	10° 03′	1006′	504′	22′
6	7639′	0° 45′	36° 33′	4874′	2523′	406′
7	1910′	3° 00′	39° 31′	1317′	686′	119′
8	5730′	1° 00′	3° 40′	367′	184′	3′
9	637′	9° 00′	14° 22′	160′	80′	5′
10	955′	6° 00′	33° 27′	558′	287′	42′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP		7 035 261	1 505 405
TIE IN	5 + 57	34 055	505 695
PC1	7 + 05	33 910	505 726
PT1	7 + 92	33 826	505 750
PC2	23 + 15	33 092	506 028
PT2	53 + 73	30 247	506 338
PC3	61 + 60	29 392	506 146
PT3	73 + 24	28 236	506 182
PC4	134 + 35	22 292	507 599
PT4	146 + 47	21 151	508 002
PC5	170 + 03	19 025	509 017
PT5	180 + 09	18 084	509 370
PC6	191 + 28	17 006	509 668
PT6	240 + 02	12 219	509 434
PC7	251 + 05	11 190	509 037
PT7	264 + 23	9 899	509 007
PC8	355 + 19	1 272	511 890
PT8	358 + 86	0 916	511 982
PC9	366 + 43	0 178	512 149
PT9	368 + 02	0 020	512 165
PC10	376 + 91	6 998 827	511 926
PT10	382 + 48	6 998 305	511 753
EOP	383 + 33	6 998 540	1 511 918

HORIZONTAL ALIGNMENT
FORT STREET EXTENSION

PI COORDINATES

POINT	NORTHING	EASTING
BOP	7 000 205	1 508 990
PI1	7 002 560	1 510 410
EOP	7 002 876	1 511 348

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	31° 05′	2750′
PI1 TO EOP	71° 23′	990′

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	1910′	3° 00′	40° 17′	1343′	701′	124′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	7 000 205	1 508 990
PC1	20 + 49	7 001 960	1 510 048
PT1	33 + 92	7 002 784	1 511 074
EOP	36 + 82	7 002 876	1 511 348

HORIZONTAL ALIGNMENT
INNER BYPASS

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 994 047	1 506 695
PI1	94 090	7 270
PI2	95 550	9 688
PI3	97 900	9 985
EOP	99 510	10 580

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	85° 43′	577′
PI1 TO PI2	58° 53′	2825′
PI2 TO PI3	7° 12′	2369′
PI3 TO EOP	20° 17′	1716′

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	1432′	4° 00′	26° 51′	671′	342′	40′
2	1432′	4° 00′	51° 40′	1292′	694′	159′
3	5730′	1° 00	13° 05′	1308′	657′	38′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 994 047	1 506 695
PC1	2 + 35	94 065	6 929
PT1	9 + 06	94 267	7 563
PC2	26 + 95	95 191	9 094
PT2	39 + 87	96 238	9 774
PC3	50 + 05	97 248	9 903
PT3	63 + 13	98 516	10 213
EOP	73 + 73	99 510	10 580

HORIZONTAL ALIGNMENT
SOUTH SOUND ARTERIAL

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 992 005	1 506 705
PI1	91 920	9 620
PI2	94 385	9 920
EOP	95 110	11 545

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	91° 30'	3256'
PI1 TO PI2	6° 56'	2483'
PI2 TO EOP	65° 57'	1779'

CURVE DATA

@ PI	R	D	DELTA	L	T	E
1	1432'	4° 00'	84° 33'	2114'	1302'	504'
2	1146'	5° 00'	59° 01'	1180'	649'	171'

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 992 005	1 506 705
PC1	19 + 54	91 954	8 318
PT1	40 + 68	93 213	9 777
PC2	46 + 00	93 741	9 842
PT2	57 + 80	94 649	10 512
EOP	69 + 11	95 110	11 545

HORIZONTAL ALIGNMENT
OUTER BYPASS

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 998 540	1 511 918
PI1	97 770	11 300
PI2	97 500	11 270
PI3	96 575	11 505
EOP	95 110	11 545

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	218° 45′	987′
PI1 TO PI2	186° 20′	272′
PI2 TO PI3	165° 45′	954′
PI3 TO EOP	178° 26′	1466′

CURVE DATA

@ PI	R	D	DELTA	L	T	E
1	ROUNDABOUT		32° 25′			
2	521′	11° 00′	20° 36′	187′	95′	9′
3	ROUNDABOUT		12° 41′			

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 998 540	1 511 918
PI1	9 + 87	97 770	11 300
PC2	11 + 64	97 594	11 280
PT2	13 + 52	97 408	11 293
PI3	22 + 11	96 575	11 505
EOP	36 + 77	95 110	11 545

HORIZONTAL ALIGNMENT
EAST-WEST ARTERIAL

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 995 110	1 511 545
PI1	94 260	17 165
PI2	95 340	20 400
PI3	95 410	23 658
PI4	96 508	28 660
PI5	96 150	35 896
PI6	97 960	40 765
PI7	97 600	59 060
EOP	98 270	60 810

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	98° 13′	5684′
PI1 TO PI2	71° 32′	3411′
PI2 TO PI3	88° 46′	3259′
PI3 TO PI4	77° 37′	5121′
PI4 TO PI5	92° 50′	7245′
PI5 TO PI6	69° 36′	5195′
PI6 TO PI7	91° 08′	18299′
PI7 TO EOP	69° 03′	1874′

CURVE DATA

@ PI	R	D	DELTA	L	T	E
1	5730′	1° 00′	27° 04′	2706′	1379′	164′
2	2865′	2° 00′	17° 14′	862′	434′	33′
3	5730′	1° 00′	11° 09′	1115′	559′	27′
4	5730′	1° 00′	15° 13′	1521′	765′	51′
5	5730′	1° 00′	23° 13′	2322′	1177′	120′
6	5730′	1° 00′	21° 31′	2152′	1089′	103′
7	5730′	1° 00′	22° 05′	2208′	1118′	108′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 995 110	1 511 545
PC1	43 + 05	94 466	15 802
PT1	70 + 11	94 697	18 473
PC2	86 + 09	95 203	19 988

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
PT2	94 + 70	95 349	20 834
PC3	117 + 36	95 398	23 099
PT3	128 + 51	95 530	24 204
PC4	166 + 48	96 344	27 913
PT4	181 + 69	96 470	29 424
PC5	234 + 71	96 208	34 720
PT5	257 + 94	96 560	37 000
PC6	287 + 22	97 581	39 744
PT6	308 + 74	97 939	41 854
PC7	469 + 66	97 622	57 943
PT7	491 + 74	98 000	60 104
EOP	499 + 30	98 270	60 810

HORIZONTAL ALIGNMENT
EAST-WEST DEVELOPMENT ROAD

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 997 000	1 513 195
PI1	6 275	13 390
PI2	5 875	13 580
PI3	6 130	14 135
PI4	6 000	14 865
PI5	6 180	16 215
PI6	6 210	17 300
PI7	5 790	18 780
EOP	6 000	20 245

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	164° 57′	750′
PI1 TO PI2	154° 36′	442′
PI2 TO PI3	65° 19′	611′
PI3 TO PI4	100° 06′	741′
PI4 TO PI5	82° 24′	1362′
PI5 TO PI6	88° 25′	1085′
PI6 TO PI7	105° 51′	11538′
PI7 TO EOP	81° 51′	1480′

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	1910′	3° 00′	10° 21′	345′	173′	8′
2		N O C U R V E				
3	1146′	5° 00′	34° 46′	695′	359′	55′
4	1146′	5° 00′	17° 41′	354′	178′	14′
5	5730′	1° 00′	6° 01′	601′	301′	8′
6	1146′	5° 00′	17° 26′	349′	176′	13′
7	1146′	5° 00′	24° 00′	480′	244′	26′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 996 000	1 513 195
PC1	5 + 78	95 442	13 345
PT1	9 + 23	95 119	13 404
PI2	11 + 93	95 875	13 585
PC3	14 + 45	95 980	13 809

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
PT3	21 + 40	95 067	14 488
PC4	23 + 45	96 031	14 690
PT4	26 + 98	96 024	15 042
PC5	35 + 81	96 140	15 917
PT5	41 + 82	96 188	16 516
PC6	47 + 91	96 205	17 124
PT6	51 + 40	96 162	17 469
PC7	62 + 59	95 856	18 546
PT7	67 + 39	95 825	19 021
EOP	79 + 75	96 000	20 245

HORIZONTAL ALIGNMENT
NEW NORTH SOUND ROAD

PI COORDINATES

POINT	NORTHING	EASTING
BOP	7 000 502	1 509 169
PI1	0 370	9 535
PI2	0 355	9 760
PI3	0 055	10 585
EOP	0 819	12 039

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	109° 51'	389'
PI1 TO PI2	93° 49'	225'
PI2 TO PI3	109° 59'	878'
PI3 TO EOP	67° 15'	1977'

CURVE DATA

@ PI	R	D	DELTA	L	T	E
1	573'	10° 00'	16° 02'	160'	81'	6'
2	573'	10° 00'	16° 10'	160'	81'	6'
3	1432'	4° 00	42° 43'	1068'	560'	106'

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	7 000 502	1 509 169
PC1	3 + 08	0 397	9 459
PT1	4 + 69	0 365	9 616
PC2	5 + 32	0 360	9 679
PT2	6 + 94	0 327	9 836
PC3	9 + 30	0 246	10 059
PT3	19 + 98	0 272	11 102
EOP	34 + 15	0 819	12 408

HORIZONTAL ALIGNMENT
SCHOOL AREA ACCESS ROAD

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 991 983	1 507 530
PI1	2 165	7 533
PI2	2 625	7 440
PI3	3 435	7 840
EOP	4 215	7 435

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	0° 57′	182′
PI1 TO PI2	348° 34′	469′
PI2 TO PI3	26° 17′	903′
PI3 TO EOP	332° 34′	879′

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	1146′	5° 00′	12° 23′	248′	124′	7′
2	382′	15° 00′	37° 43′	251′	130′	22′
3	382′	15° 00	53° 43′	358′	193′	46′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 991 983	1 507 530
PC1	0 + 57	2 041	7 531
PT1	3 + 05	2 287	7 508
PC2	5 + 19	2 497	7 466
PT2	7 + 71	2 742	7 498
PC3	13 + 50	3 262	7 754
PT3	17 + 08	3 607	7 751
EOP	23 + 94	4 215	7 435

HORIZONTAL ALIGNMENT
JENNETT STREET EXTENSION

PI COORDINATES

POINT	NORTHING	EASTING
BOP 1	6 999 547	1 509 072
EOP 1	9 639	9 392
BOP 2	9 263	9 482
PI1	9 530	9 375
EOP 2	9 975	9 445

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP1 TO EOP1	74° 05'	331'
BOP2 TO PI1	338° 16'	288'
PI1 TO EOP2	8° 56'	450'

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	382'	15° 00'	30° 40'	204'	105'	14'

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP 1	0 + 00	6 999 547	1 509 072
EOP 1	3 + 31	9 639	9 392
BOP 2	0 + 00	9 263	9 482
PC 1	1 + 83	9 433	9 414
PT 1	3 + 88	9 633	9 391
EOP 2	7 + 33	9 975	9 445

HORIZONTAL ALIGNMENT
AIRPORT DRIVE

PI COORDINATES

POINT	NORTHING	EASTING
BOP	7 000 240	1 511 017
PI1	6 999 617	11 218
PI2	9 562	12 755
PI3	9 100	13 715
EOP	9 095	14 830

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	162° 07'	655'
PI1 TO PI2	92° 03'	1538'
PI2 TO PI3	115° 42'	1065'
PI3 TO EOP	90° 15'	1115'

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	881'	6° 30'	70° 04'	1078'	618'	195'
2	1146'	5° 00'	23° 39'	473'	240'	25'
3	1146'	5° 00	25° 26'	509'	259'	29'

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	7 000 240	1 511 017
PC 1	0 + 37	7 000 205	11 028
PT 1	11 + 15	6 999 595	11 836
PC 2	17 + 95	9 571	12 515
PT 2	22 + 68	9 458	12 971
PC 3	28 + 34	9 212	13 482
PT 3	33 + 43	9 099	13 974
EOP	42 + 00	9 095	14 830

HORIZONTAL ALIGNMENT
AIRPORT DRIVE TO CREWE ROAD ACCESS ROAD

PI COORDINATES

POINT	NORTHING	EASTING
BOP	6 999 610	1 511 640
PI1	9 400	11 565
PI2	8 795	11 623
EOP	8 660	11 575

AZIMUTHS AND HORIZONTAL DISTANCES

LINE	AZIMUTH	HD
BOP TO PI1	199° 39′	223′
PI1 TO PI2	174° 31′	608′
PI2 TO EOP	199° 34′	143′

CURVE DATA

@ P1	R	D	DELTA	L	T	E
1	521′	11° 00′	25° 08′	228′	116′	13′
2	521′	11° 00′	25° 03′	228′	116′	13′

COORDINATES AND STATIONING

POINT	STATION	NORTHING	EASTING
BOP	0 + 00	6 999 610	1 511 640
PC 1	1 + 07	9 509	11 604
PT 1	3 + 35	9 284	11 576
PC 2	7 + 11	8 910	11 612
PT 2	9 + 39	8 686	11 584
EOP	9 + 67	8 660	11 575

APPENDIX E

MATHEMATICAL MODELS

APPENDIX E

MATHEMATICAL MODELS

The analysis of existing and future vehicle trips in Grand Cayman was facilitated by computer developed transportation models of current conditions and forecasts. These models simulated travel on the existing road network in order to ensure that it accurately reflected current travel patterns. It then utilised projections of socioeconomic data to distribute forecasts of future trips to the existing road system and to alternative future road networks.

Trip Production Models - Study area trip production was stratified into three basic trip purposes: Homebased Work, Homebased Other, and Non-Homebased. Cross classification models were then developed for vehicle trips based on different levels of household size. Categories defined were households with one or two persons, three to four, and five or more. For each trip purpose, the total number of trips in each household size group were divided by the corresponding number of households to derive an average trip rate. Table E-1 contains the study area trip rates by household size and trip purpose.

Table E-1

TRIP PRODUCTION RATES BY TRIP PURPOSE

	DAILY VEHICLE TRIPS/HOUSEHOLD(1)		
TRIP PURPOSE	I	II	III
Homebased Work	1.246	2.091	2.889
Homebased Other	1.802	3.832	6.311
Non-Homebased	2.248	4.505	5.488

Source: Wilbur Smith Associates

(1) I = 1-2 persons, II = E-4 persons, III = 5 or more

Household-Size Model - To apply the cross-classification models for estimating trip productions, the number of households in each traffic analysis zone were stratified according to each specified household size group. Figure E-1 shows the curves developed from this model. The percentage distributions for each group, as determined by average household-size, are tabulated in Table E-2. For each transportation zone, the population is divided by total dwelling units to determine zonal average persons per dwelling unit. The appropriate percentages from the household-size curves are then applied, resulting in the number of dwelling units in each household-size group. The trip rates per household by household-size group for each trip purpose are applied to develop total zonal productions.

Table E-2

HOUSEHOLD-SIZE MODEL

PERCENT DISTRIBUTION OF HOUSEHOLD-SIZE GROUPS

ZONAL AVERAGE HOUSEHOLD-SIZE	1 or 2 persons	3 or 4 persons	5 or more persons
1.50	91.65	8.35	0.00
1.75	81.80	16.17	2.03
2.00	74.66	20.48	4.86
2.25	67.18	25.68	7.14
2.50	60.87	29.21	9.92
2.75	54.37	32.24	13.39
3.00	48.76	34.08	17.16
3.25	43.04	35.14	21.82
3.50	37.63	36.28	26.09
3.75	33.00	35.75	31.25
4.00	28.57	34.73	36.70
4.25	25.12	33.22	41.66
4.50	21.67	31.61	46.72
4.75	18.71	28.71	52.58
5.00	15.76	25.71	58.53
5.25	12.80	22.52	64.68
5.50	10.05	18.53	71.42
5.75	7.78	14.15	78.07
6.00	4.92	10.76	84.32

Source: Wilbur Smith Associates

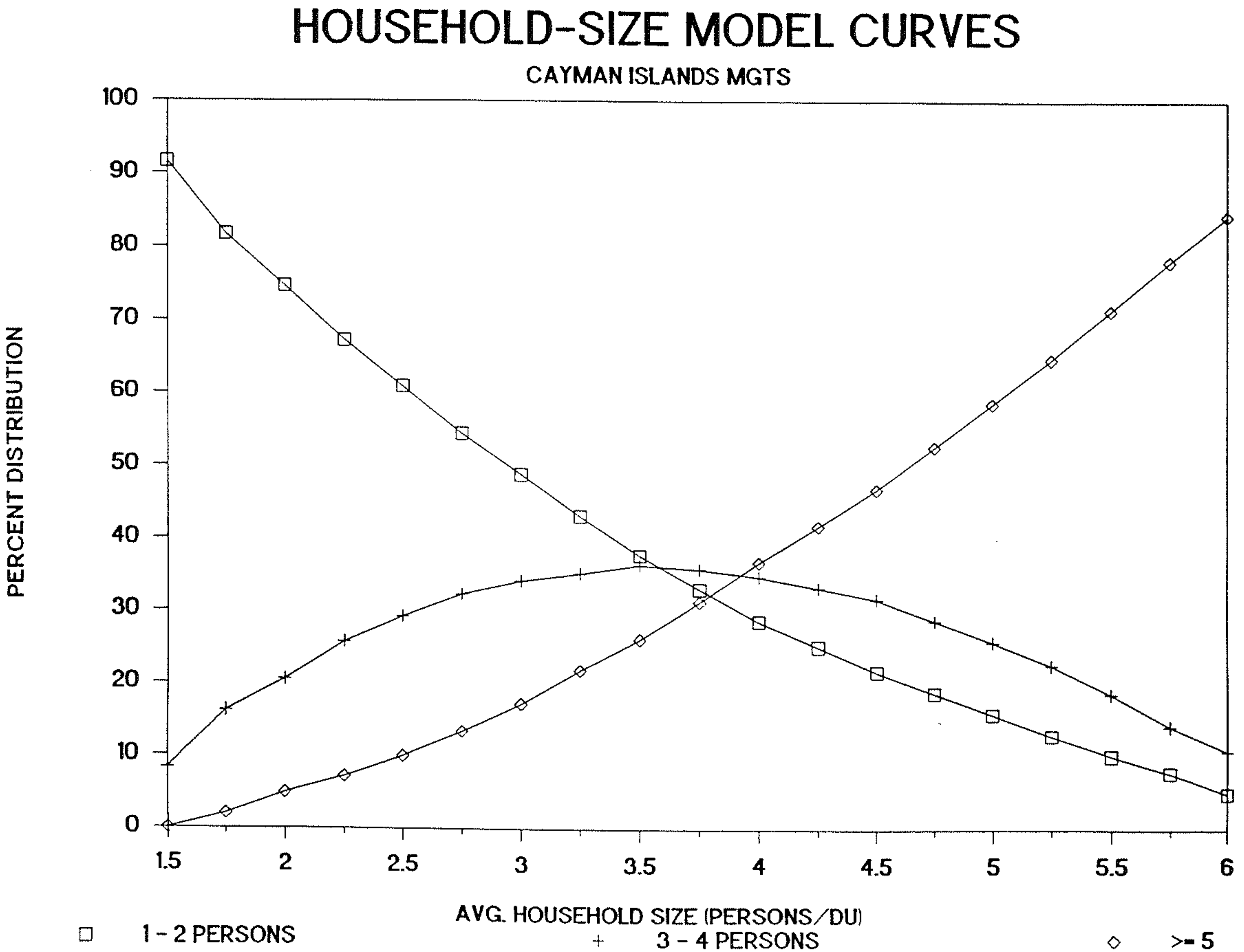
HOUSEHOLD-SIZE MODEL CURVES
CAYMAN ISLANDS MGTS
PERCENT DISTRIBUTION
100
90
80
70
60
50
40
30
20
10
0
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
AVG. HOUSEHOLD SIZE (PERSONS/DU)
1 - 2 PERSONS
3 - 4 PERSONS
>= 5

FIGURE E-1

Trip Attraction Models - Trip attraction models for vehicle trips were developed for four trip purposes: Homebased Work, Homebased Other, Non-Homebased, and Commercial Vehicles. The final equations developed for the Cayman Islands study area are shown in Table E-3. Homebased Work trip attractions were simply defined as being equal to total employment. The balancing of Homebased Work attractions with Homebased Work productions automatically adjusts for any differences between employment figures and related vehicle trips.

Table E-3

TRIP ATTRACTION MODELS

TRIP PURPOSE	EQUATION(1)
Homebased Work	1.00 TOT EMP
Homebased Other	0.403 DUS + 2.18 RET EMP + 0.703 OTH EMP + 1.20 SCH ATT
Non-Homebased	0.709 DUS + 6.672 RET EMP + 1.29 OTH EMP + 0.137 SCH ATT + 1.7 H. RMS
Commercial Vehicles	0.27 DUS + 0.52 RET EMP + 0.16 OTH EMP + 0.27 H. RMS

Source: Wilbur Smith Associates

(1) TOT EMP = Total Employment; RET EMP = Retail Employment; OTH EMP = Other Employment; DUS = Dwelling Units; SCH ATT = Total School Attendance; and H. RMS = Hotel Rooms

Trip Distribution Models - Once the number of trips emanating from a zone were estimated by the trip production models, new models were developed to distribute them among the trip attractions in all other zones. Gravity models were utilised for this purpose. The general form of these models is as follows:

$$T_{i-j} = (P_i) \frac{(A_j)(F_{i-j})}{\sum_{j-l}^{n} (A_j)(F_{i-j})}$$

Where T_{i-j} = Trip interchange from trip productions at i to trip attractions at j; P_i = Trip productions at i; A_j = Trip attractions at j; F_{i-j} = Relative distribution rate, reflecting the travel-time separation between zones i and j; and n = Total number of zones in the study area.

The relative distribution rates, the only unknown in the equation, were taken directly from previous studies and modified as necessary for the Cayman Islands. Due to the small size of the traffic analysis zones, the intrazonal and terminal times were utilised as a means to limit the number of intrazonal trips (trips that begin and end within a traffic zone) generated by the gravity models. The relative distribution rates are shown in Table E-4.

Model Validation - Mathematical models for this study were derived by synthetic methods, and were validated using the following procedure:

1. Apply trip generation models to 1987 socioeconomic data to obtain zonal productions and attractions.
2. Distribute zonal productions and attractions with gravity models.
3. Assign trips to 1987 network and compare to ground counts.
4. Modify trip generation models as necessary.
5. Modify gravity model distribution rates as necessary.
6. Repeat step 1 through 5 until models are calibrated.

Following that procedure, the models were applied with 1987 data. To facilitate the comparison of model results to existing counts, links on the network were separated into two areas, those links outside of the CBD and links within the CBD. Comparisons of the first model application to existing counts indicated that the models were underestimating on a total basis by over 130 percent.

Table E-4

RELATIVE RATES FOR TRIP DISTRIBUTION MODELS

	TRIP PURPOSE			
TRAVEL TIME (minutes)	Homebased Work	Homebased Other	Non-Homebased	Commercial Vehicles
1	3,300	6,102	2,765	3,797
2	2,875	8,266	3,379	4,877
3	2,525	5,651	3,034	3,536
4	2,200	3,676	1,545	2,511
5	1,900	2,485	2,099	1,870
6	1,625	1,767	1,729	1,468
7	1,425	1,318	1,430	1,208
8	1,200	1,024	1,191	1,033
9	1,000	824	1,000	913
10	860	683	845	839
11	720	581	719	788
12	630	505	615	750
13	545	448	530	722
14	475	403	459	702
15	420	368	400	688
16	365	341	350	677
17	320	315	300	620
18	285	290	265	600
19	255	270	230	590
20	225	250	200	580
21	205	235	175	570
22	188	220	155	560
23	170	210	135	550
24	155	200	115	540

Source: Wilbur Smith Associates

Intrazonal travel time was set at 24 minutes each for zones 1 through 88. Terminal travel time was established as two minutes in zone 20, and one minute in all other zones.

Based on the initial results, it was obvious that adjustments to the trip production and attraction models were required. Review of the trip generation models indicated that previous use was for a limited area. Also, the models included a separate category of trips that had only one end within the study area. These trips previously accounted for approximately 70 percent of all trips. Trip generation rates were therefore increased, and the models applied a second time. Comparisons of the results to existing counts were better, however, some "fine tuning" to the models were still required ,such as minor speed changes and trip rate adjustments for several zones. Several more applications of the models were made resulting in trip rate adjustments to the following traffic analysis zones:

1. Zones 1-13 - West Bay zones where assigned volumes were over estimated. Production rates for Homebased Other and Non-Homebased were reduced by 35 and 25 percent respectively Trip attractions for Homebased Other, Non-Homebased and Commercial Vehicles were reduced by 50 percent.

2. Zones 3E-44, 50-52, 54-57 - Zones are located in the CBD. Due to circulating traffic, the models were underestimating in this area. Trip attractions, with the exception of Zone 52, were increased by 100 percent for Homebased Other, Non-Homebased and Commercial Vehicles. The same trip purposes in Zone 52 were increased by 200 percent.

3. Zone 46 - Owen Roberts Airport - It was assumed that 90 percent of the 1987 ground count (5,900 vehicles) were Non-Homebased trips. Trip generation results were then replaced by the figure 5,310. For 1997 model runs, 6 to 7 percent annual growth was assumed for airport trips. Therefore, 1992 trips were 8,100 and in 1997 reached 11,200.

4. Zone 48 - A major food store is located in this zone. Homebased Other and Non-Homebased attractions were increased by 50 percent.

5. Zones 58-59, 65-72 - South of George Town, an upper income area. Trip productions and attractions were increased by 100 percent for Homebased Other and Non-Homebased trips.

6. Zones 8E-86 - Bodden Town vicinity. Productions of Homebased Other trips were reduced by 50 percent.

7. Zone 88 - Eastern half of the Island. Trip productions and attractions for Homebased Other were reduced by 70 percent.

Comparison of observed and estimated volumes for the first, second, and final model applications are shown in Table E-5. Final application of the model resulted in 119,799 trips as compared with 117,000 observed for non-CBD links, an over estimation of only 2 percent. For CBD links, the model produced 127,791 trips versus 139,200 observed, an underestimation of approximately 8 percent. Overall, the estimated trips are within three percent of the observed (248,590 versus 256,200) with a correlation of (R^2) 0.97.

It was concluded that further attempts to refine the models would be unproductive. Comparisons of estimated trips with observed ground counts across various sections of the transportation network indicate excellent results. Therefore, the transportation models developed were considered calibrated and appropriate to provide reliable forecasts of future travel in the study area.

Model Development - To obtain reliable estimates of future travel patterns, both the travel simulation models and the projected socioeconomic and land-use data were prepared to reflect the various conditions in the study area. Therefore, it was necessary that transportation models be sensitive to the many quantitative and qualitative parameters influencing the generation and distribution of trips.

Planning Approach - Development of travel demand models was accomplished by using synthetic methods. It was determined that this procedure would be the adopted planning approach for the MGTP Study, given the experience record of this type of model.

Table E-5

OBSERVED VERSUS ESTIMATED 24-HOUR VOLUMES

LOCATION	LINK	MODEL APPLICATION 1	MODEL APPLICATION 2	MODEL APPLICATION FINAL	OBSERVED COUNTS
NON-CBD	252-254	3,391	10,746	8,238	8,100
	262-264	5,560	14,019	13,505	13,400
	264-276	9,490	23,952	22,975	20,700
	288-290	4,421	12,499	10,769	10,400
	328-400	2,222	3,056	5,671	5,700
	324-332	3,176	4,948	8,379	8,200
	314-316	2,803	5,046	6,727	6,000
	310-470	7,305	13,519	12,583	13,200
	309-312	6,219	5,061	9,684	10,000
	046-309	5,421	5,619	5,768	5,900
	367-368	4,672	14,152	10,958	11,300
	382-384	1,951	7,644	4,547	4,100
Subtotal		56,631	120,261	119,799	117,000
CBD	420-422	1,671	4,912	4,226	4,000
	418-420	6,650	14,571	16,839	15,800
	426-430	1,547	5,018	4,601	4,200
	416-434	2,703	5,101	7,889	6,700
	414-416	4,455	10,674	10,673	11,000
	440-442	1,619	4,842	4,521	8,400
	438-448	1,143	2,563	3,045	2,500
	446-448	2,249	5,499	6,035	6,700
	445-460	3,993	9,897	9,634	15,900
	459-460	3,431	8,701	8,572	11,200
	462-464	2,924	8,152	8,383	8,100
	410-454	1,830	3,814	3,698	6,000
	408-410	5,330	13,642	13,775	10,100
	490-492	6,060	13,216	13,128	12,500
	482-486	7,520	10,757	12,318	13,200
	470-472	245	1,620	1,454	2,900
Subtotal		53,370	122,979	128,791	139,200
TOTAL		110,001	243,240	248,590	256,200

Source: Wilbur Smith Associates