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Key West Traffic Circulation Study

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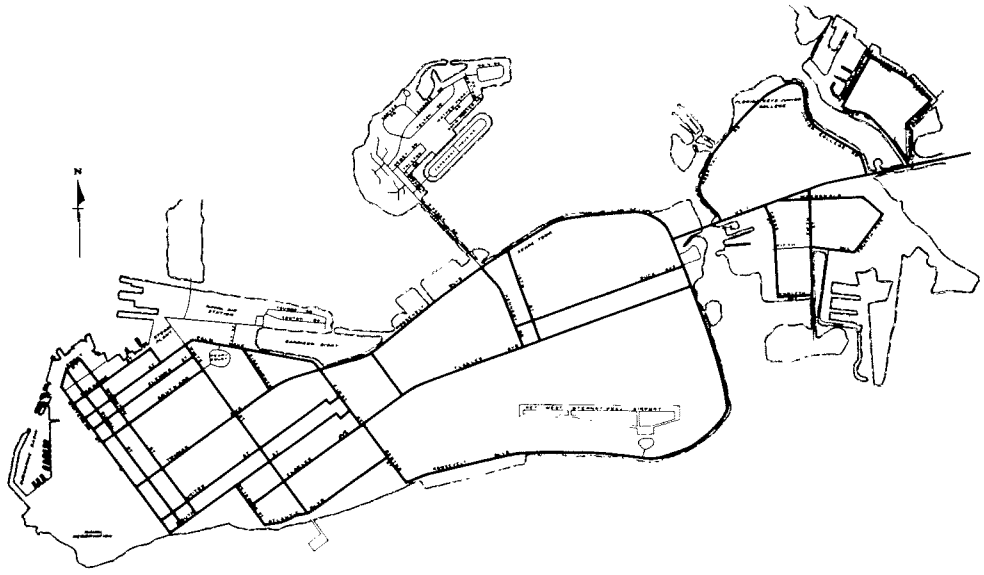

Florida Department of Transportation

1984

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KEY WEST CIRCULATION STUDY

Introduction

In late 1983 the Florida Department of Transportation (FDOT) and the City of Key West initiated a traffic circulation study for Key West. Potential traffic circulation problems were identified by transportation planners from FDOT. The traffic flow on the southern portion of the island experiences few problems; however the western portion, particularly in the downtown area (with its narrow streets), has interrupted flow. The extreme eastern and northern portions, with higher traffic volumes and relatively heavy commercial developments, have the potential for severe problems along the perimeter arterials. Many of the streets on the interior of the island have the physical characteristics of collectors but are forced to function as minor arterials. Many roads, in particular those in the historic district, are narrow and fall below todays traffic engineering design standards. Buildings in the historic district were often constructed with very little setback. This, compounded by on-street parking, causes sight distance problems at intersections and affords few alternatives for roadway expansion. Large trucks coming to the downtown area further complicate this problem.

The items of concern which could contribute to potential traffic circulation problems in Key West include:

(1) Narrow streets

(2) Tight turning radii

(3) Lack of visibility, because of street parking or limited setbacks at intersections

(4) Poor pavement conditions

(5) Substantial tourist traffic in the historic district

(6) Antiquated or substandard traffic signalization equipment

(7) Antiquated or substandard signing

(8) Inadequate pavement markings

(9) Inadequate parking

Data Collection And Inventory

In January of 1984 FDOT, in cooperation with the City of Key West, conducted field inventories of existing conditions. These inventories included streets, intersections, traffic counts, vehicle classification, street surface rideability and traffic accidents. Each of these inventories will be detailed in the following paragraphs.

Street Inventory

A physical inventory was taken of the principal street system (see FIGURE 1). One purpose of gathering the street inventory data was to determine the link capacities of each street (see FIGURE 2). Street lengths were measured by a mobile computer called D.M.I. (Distance Measuring Instrument) with accuracy of less than one foot per mile. These mileage increments were equated to mile posts. The D.M.I. was also set to obtain "on-street parking" for both sides of the street. This was accomplished by manually keying the D.M.I. when painted parking areas were approached, thus recording the corresponding mile post. The pavement surface width was also measured to determine the actual lane geometry between intersections.

Intersection Inventory

Field observation of the traffic flow patterns on the principal street system was used to determine locations where manual 8-hour turning movements and machine turning movements were required. This investigation identified ten major locations requiring manual counts and twenty additional locations requiring machine counts (See FIGURE 3)

Major Intersections

The City of Key West provided personnel to perform the actual turning movement counts. FDOT provided the training and supervisory personnel. Two people were used at each intersection, each being responsible for two of the

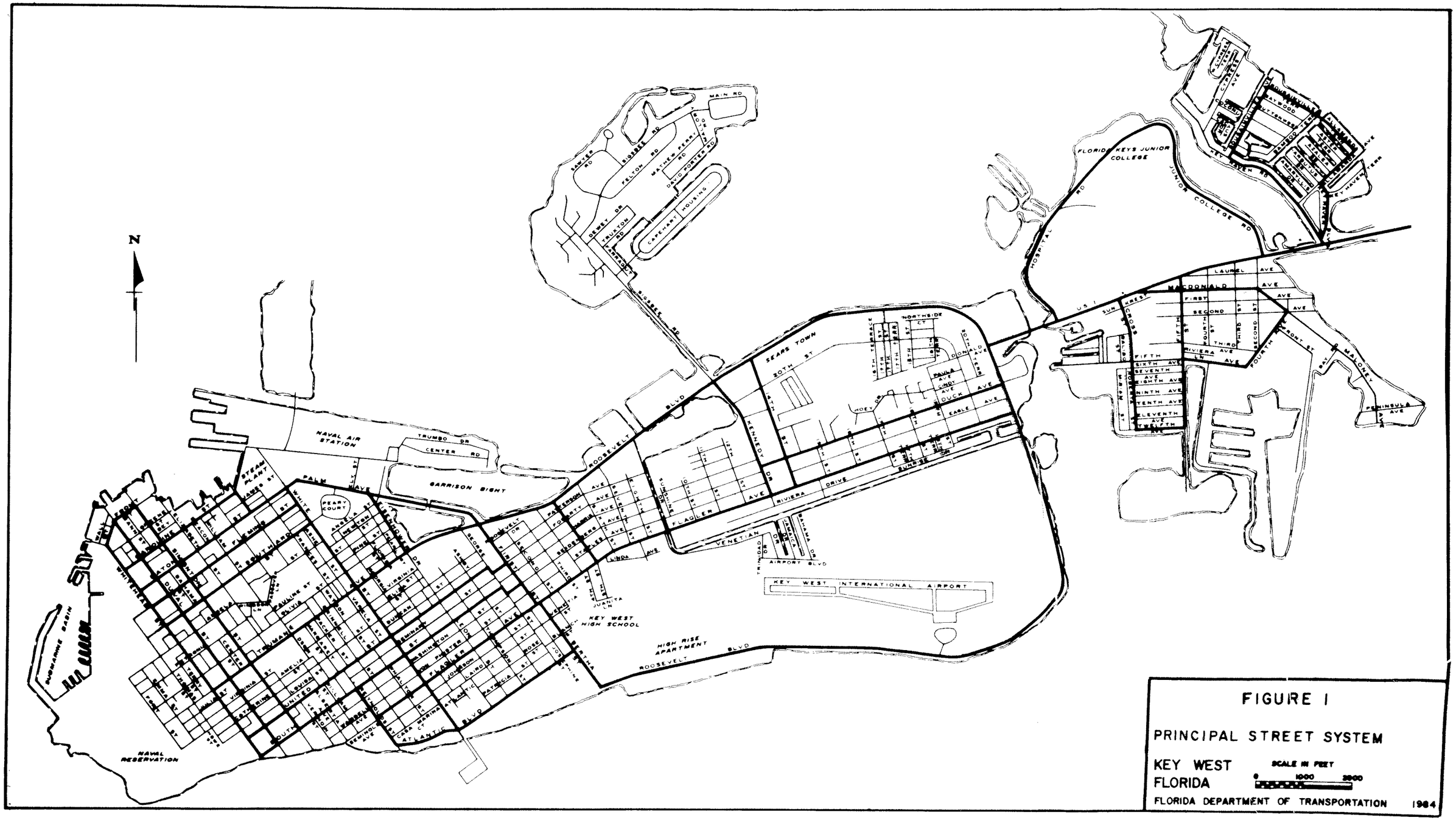


FIGURE 1

PRINCIPAL STREET SYSTEM

KEY WEST
FLORIDA

SCALE IN FEET
0 1000 2000

FLORIDA DEPARTMENT OF TRANSPORTATION 1984

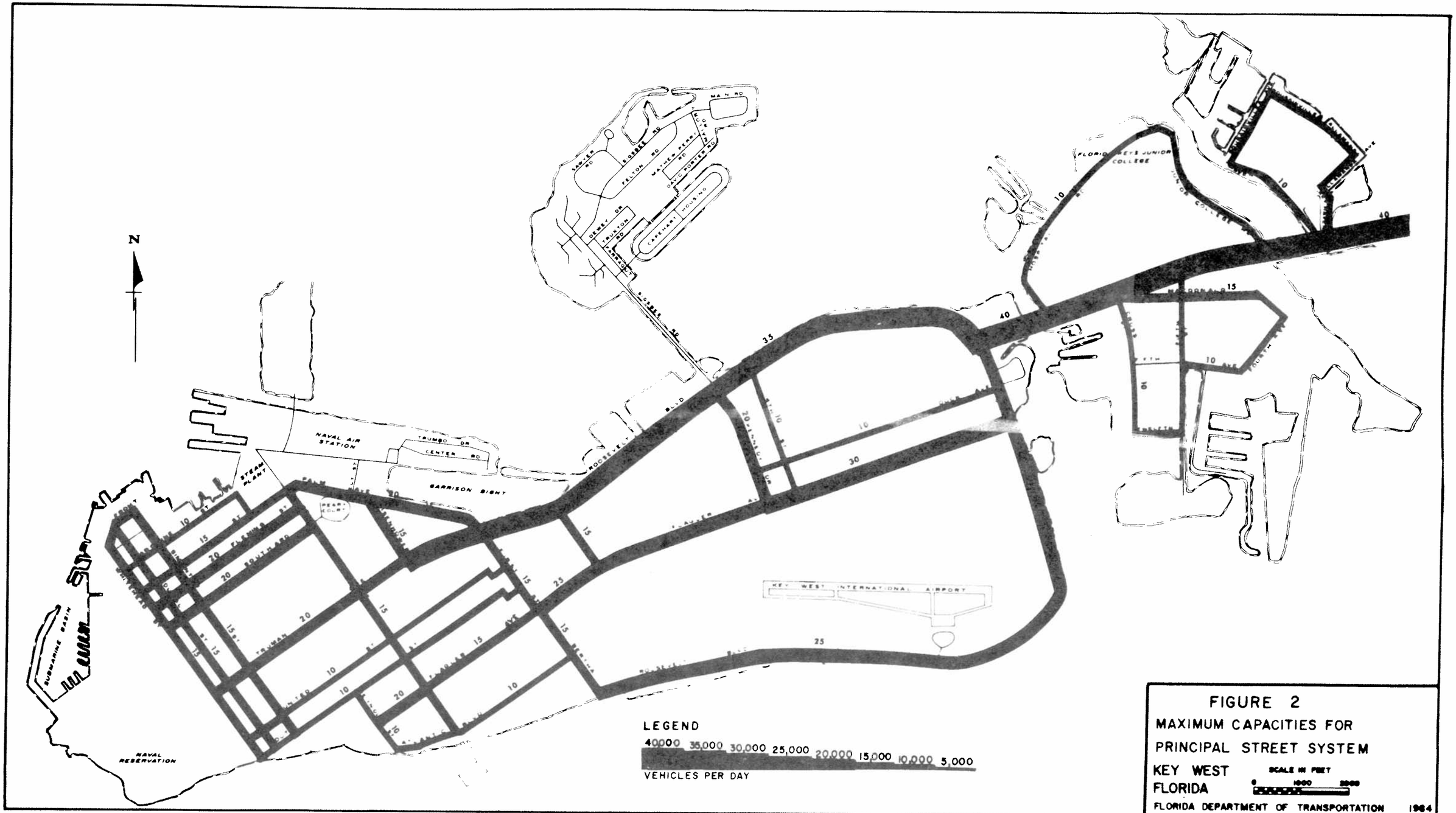


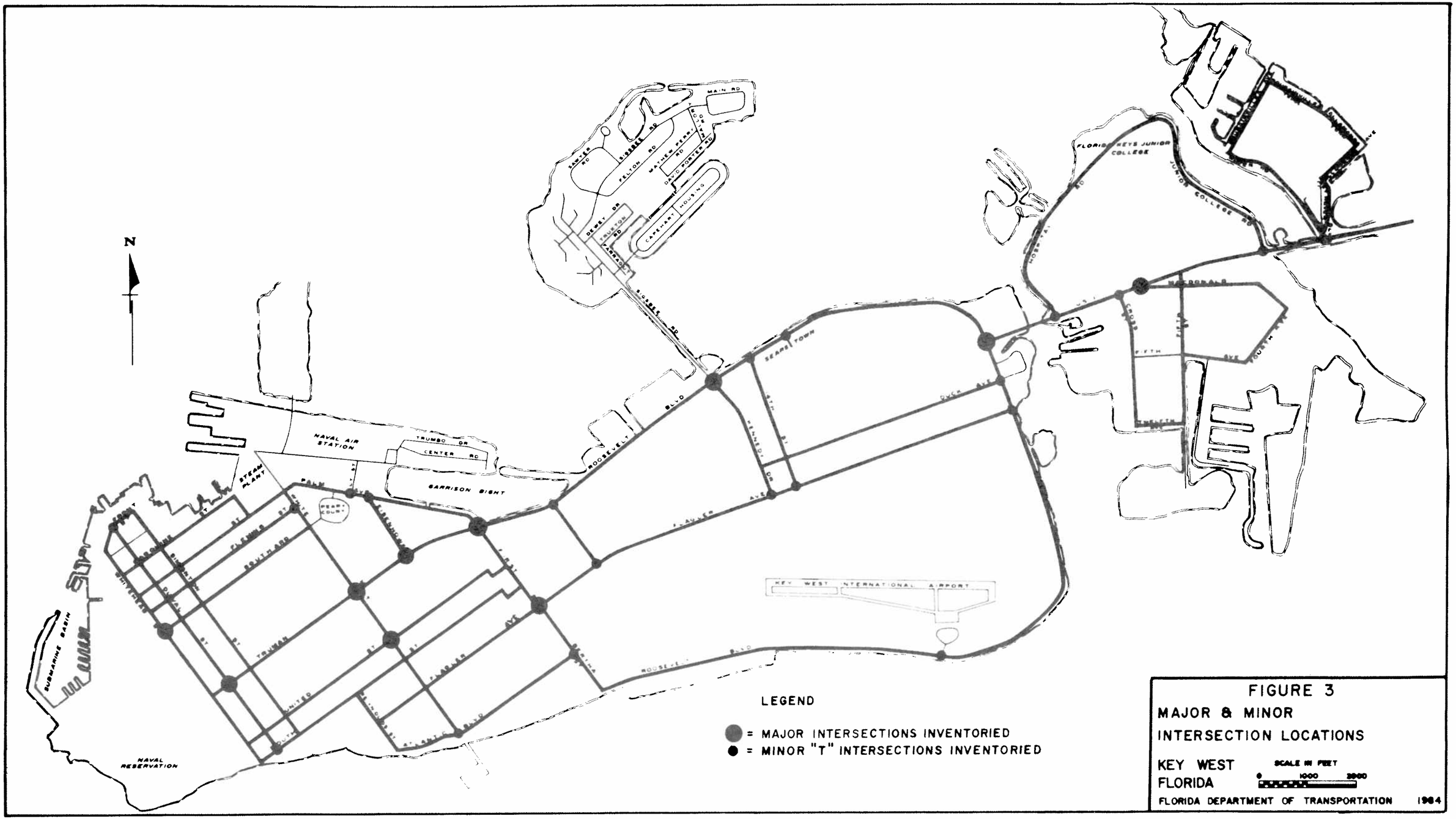
FIGURE 2

MAXIMUM CAPACITIES FOR PRINCIPAL STREET SYSTEM

KEY WEST
FLORIDA

SCALE IN FEET
0 1000 2000

FLORIDA DEPARTMENT OF TRANSPORTATION 1964


N
MAIN RD
SAWYER RD
GIBBS RD
FELTON RD
MATHEW PERRY RD
DAVID PORTER RD
CAPEHART HOUSING
DEWEY DR
TRUMAN RD
EISENHOWER RD
FLORIDA KEYS JUNIOR COLLEGE
JUNIOR COLLEGE RD
SEARS TOWN
ROOSEVELT BLVD
NAVAL AIR STATION
TRUMBO DR
CENTER RD
GARRISON BIGHT
STEAM PLANT
PEARY COURT
KEY WEST INTERNATIONAL AIRPORT
SUBMARINE BASIN
NAVAL RESERVATION
LEGEND
= MAJOR INTERSECTIONS INVENTORIED
= MINOR "T" INTERSECTIONS INVENTORIED
FIGURE 3
MAJOR & MINOR
INTERSECTION LOCATIONS
KEY WEST
FLORIDA
SCALE IN FEET
0 1000 2000
FLORIDA DEPARTMENT OF TRANSPORTATION 1984

four approach legs. An approach leg is defined as one of the entrance roadways into an intersection. The FDOT field crew positioned a counter on the approach lane or lanes of each entrance roadway. These traffic counters count continuously for a 24-hour period. The 8-hour manual counts were projected to 24-hour volumes called an "ADT" (Average Daily Traffic). As part of the intersection inventory, a count of heavy trucks, as well as busses, was collected on each approach leg. The geometry of the intersection was sketched, and cross-sectional data, including lane width, was measured. The traffic signal time phasing information was obtained from the Monroe County Engineering Department. Peak hour factors were calculated from control count stations that were set three weeks prior to starting the Traffic Circulation Study in Key West. The peak hour factor was defined as the ratio of the volume occurring during the "peak hour" (usually 5-6 PM) to the maximum 15-minute rate for that given hour. It is a measure of peaking characteristics, whose maximum attainable value is one. The peak hour factor for Key West was found to be 0.9 (see Appendix A).

The purpose of obtaining the above data was to determine the capacity of the intersection. This was accomplished by a process called C.M.A. (Critical Movement Analysis) using a microcomputer program. This program computes a "Critical Sum", which is a measure of the highest traffic volumes observed during the peak hour. This "Critical Sum" was then equated to level-of-service. The relationship between "Critical Sum" and level-of-service is defined in the Circular 212, "Interim Materials on Highway Capacity" published by the Transportation Research Board and is the currently accepted method for determining intersection capacity (See Table 1). There

Table I

LEVEL OF SERVICE RANGES

Operations application (Pch)

Level of Service	Maximum Sum of Critical Volumes		
	Two Phase	Three Phase	Four/More Phases
A	0 - 1000	0 - 950	0 - 900
B	1001 - 1200	951 - 1140	901 - 1080
C	1201 - 1400	1141 - 1340	1081 - 1270
D	1401 - 1600	1341 - 1530	1271 - 1460
E	1601 - 1800	1531 - 1720	1461 - 1650
F	not applicable		

Pch - Passenger cars per hour.

are six levels of Service (levels "A" through "F"), relating to driving conditions ranging from best to worse respectively. The characteristics of traffic flow for these various levels-of-service are summarized in Table 2.

Other Intersections

There were an additional twenty "T" intersections where turning movements were taken by a technique utilizing traffic counters. "T" intersections are defined as one street intersecting another without crossing it. Some of the intersections inventoried were not true "T" intersections but due to the small traffic volume on one leg functioned as a "T" intersection (see FIGURE 3). Since turning movement data at these intersections was obtained using traffic counters, field personnel were not required. This was accomplished by setting a traffic count machine and hose across both lanes of traffic at each approach, thus obtaining total 2-way 24-hour counts. A mathematical formula was applied to these 2-way volumes to obtain their respective quadrant turning volumes. Design hour factors were derived and multiplied by the 2-way volumes to obtain the Design Hour Volumes. Those volumes were entered into the C.M.A. (Critical Movement Analysis) Program, to obtain level-of-service. The results of all C.M.A. analyses appear in Appendix B.

TABLE 2

LEVEL-OF-SERVICE CONCEPT

Level-of-Service A

* Free flow conditions
* Low volumes
* High operating speed
* No restriction on maneuvering

Level-of-Service B

* Stable flow condition
* Operating speeds beginning to be restricted

Level-of-Service C

* Drivers may have to wait through more than one signal indication
* Backups may develop behind turning vehicles
* Drivers feel somewhat restricted

Level-of-Service D

* Delays to approaching vehicles may be substantial during short peaks within the peak period, but enough cycles with lower demand occur to permit periodic clearance of developing queues
* Increasing restriction approaching instability

Level-of-Service E

* Delays may be up to several signal cycles
* Volumes at or near capacity
* Unstable flow
* Major delays and stoppages

Level-of-Service F

* Forced flow conditions
* Low speeds
* Volumes below capacity, may be zero
* Stoppages for long periods because of downstream congestion

Traffic Count Inventory

Traffic counts inventories were conducted to gather data for control, screenline/cutline, and provide count information on other important locations.

Control Counts

In January 1984, the Department set three control stations in the study area (see FIGURE 4). The data from these control stations was used to establish certain traffic characteristics prior to the data gathering field effort and to develop an adjustment process for the 24 hour counts that were taken of the individual road segments on the principle street system. The traffic control count data was collected to:

(1) Develop a peak hour factor for use in capacity and intersection analysis (see Appendix A).

(2) Determine the hour that the peak traffic conditions occurred in both the morning and evening.[1]

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[1] These hours were determined to be 8:00-9:00 AM and 5:00-6:00 PM. In order to insure that these hours were covered during the 8-hour manual turning movements, the morning movement counts were scheduled for 7:00 - 11:00 AM and 3:00 - 7:00 PM.

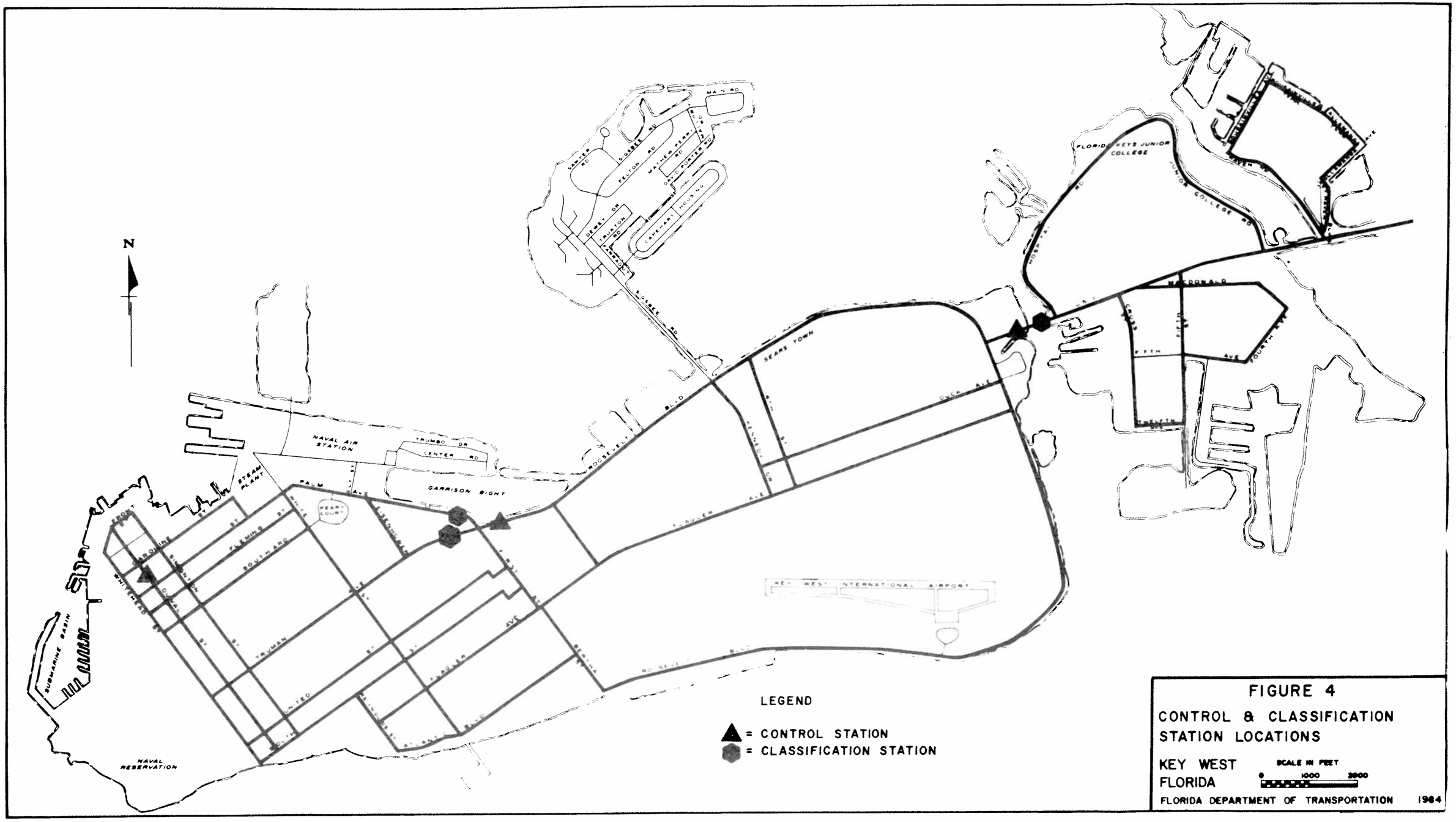

FIGURE 4

CONTROL & CLASSIFICATION STATION LOCATIONS

KEY WEST
FLORIDA

SCALE IN FEET
0 1000 2000

FLORIDA DEPARTMENT OF TRANSPORTATION 1964

(3) Monitor the total 24-hour 2-way volume that moved on and off the island of Key West.

Screenline/Cutline Counts

A series of screen lines/cut lines were established to intersect or measure traffic movement within the study area. Traffic counters were located on this imaginary line and 24 hour 2-way counts were taken (see FIGURE 5). The purpose of obtaining these counts was to study the volume movements through designated corridors and to evaluate traffic flow on the parallel streets which comprise those corridors.

Other Counts

Counts were also taken at other important locations for continuity. Each link in the major street system was counted. A summary of 24 hour 2-way counts is shown in Figure 6.

Truck Classification Inventory

At three locations within the study area a 24-hour classification was conducted of all traffic (see Figure 4). In this inventory all vehicles were classified by the following categories:

(1) passenger cars and pickups/panel

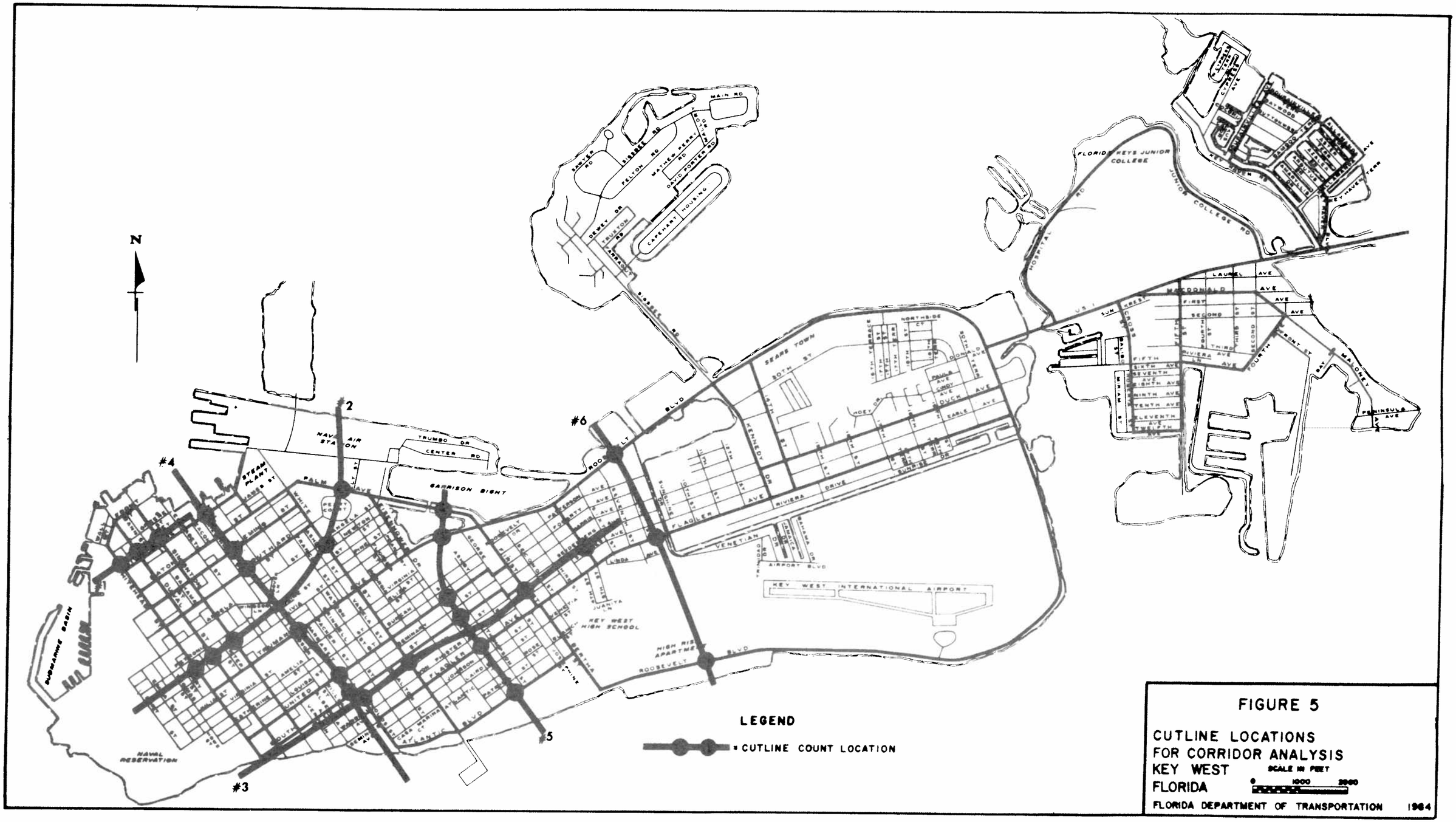

FIGURE 5

CUTLINE LOCATIONS
FOR CORRIDOR ANALYSIS
KEY WEST
FLORIDA

SCALE IN FEET
0 1000 2000

FLORIDA DEPARTMENT OF TRANSPORTATION 1984

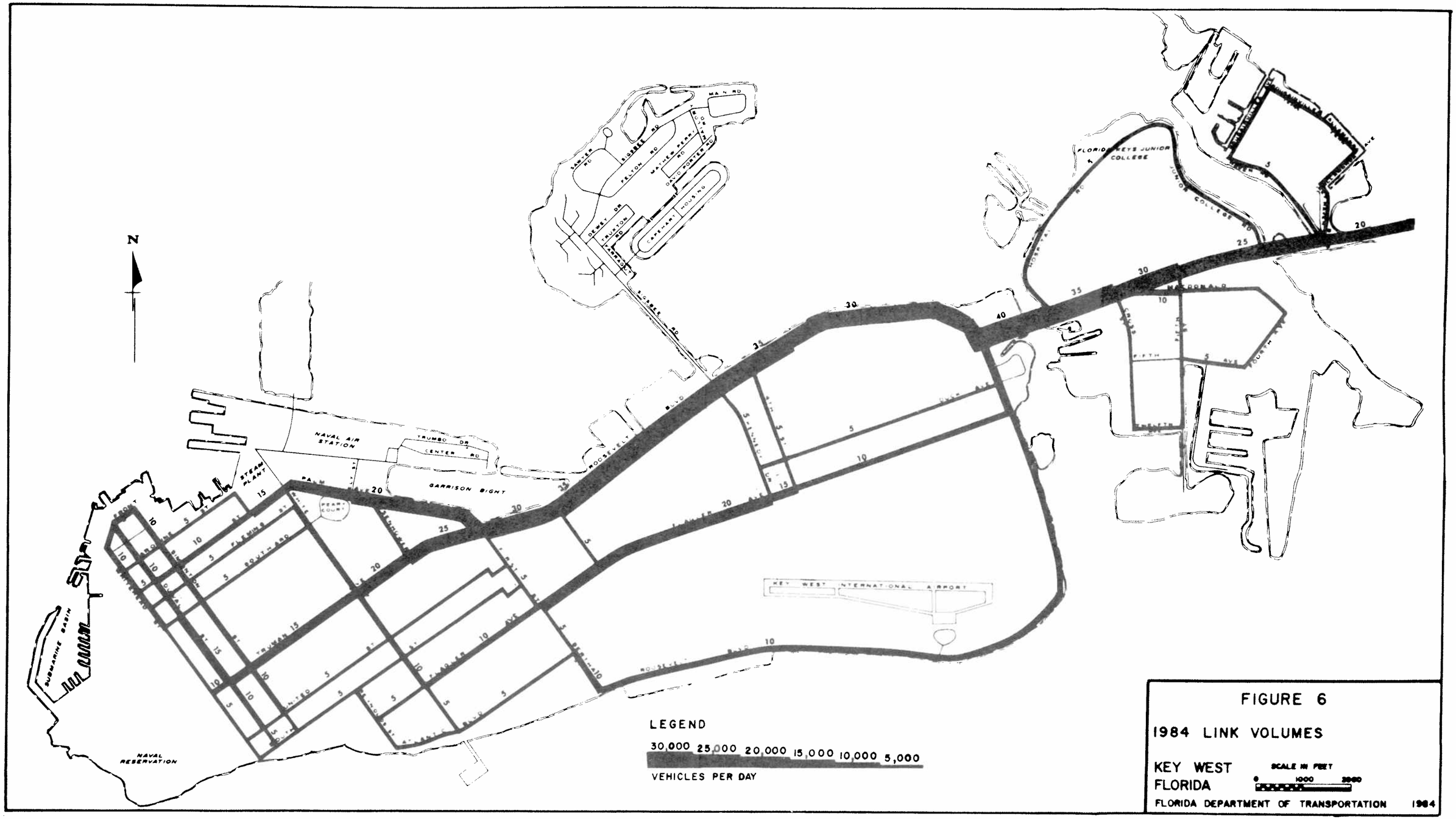

FIGURE 6

1984 LINK VOLUMES

KEY WEST
FLORIDA

SCALE IN FEET
0 1000 2000

FLORIDA DEPARTMENT OF TRANSPORTATION 1984

(2) 2-axle trucks

(3) 3-axle trucks

(4) 4-axle trucks

(5) 5-axle trucks

(6) busses

(7) recreational vehicles

(8) single and dual axle trailers

(9) motorcycles/bicycles

The primary purpose of this analysis was to determine the percentage of heavy trucks to the total traffic volume. Heavy trucks (categories 2-5) were found to be approximately 3 percent of all traffic over the 24 hour period.

An additional reason for this inventory was to determine the routes heavy trucks use to enter the downtown area. The split of Roosevelt Boulevard traffic was found to be approximately equal: of 891 heavy trucks, 437 traveled Palm Avenue and 454 trucks traveled Truman Avenue. Trucks accounted for approximately 3 percent of total traffic on each street.

Street Surface Rideability

The street surface rideability was checked visually as well as by riding the principal street system to determine the surface condition of the pavement. Most of the city streets in Key West are deficient and need resurfacing badly. Resurfacing alone can increase traffic capacity.

Traffic Accident Inventory

Traffic accident data was provided by the Key West Police Department. The accident data covered a period of one year from January 1983 to December 1983. The data was stratified into seven different accident categories: (1) Auto-Auto, (2) Auto-Truck, (3) Auto-Bicycle, (4) Auto-Pedestrian, (5) Truck-Truck, (6) Truck-Bicycle, and (7) Truck-Pedestrian. The data was further stratified by two location categories: (1) at an intersection and (2) those which occurred at mid-block. The purpose of this inventory was to determine how many accidents occurred at each location and to identify possible traffic geometry problems. This study revealed three locations that had fairly high accident rates: (1) the triangle (US-1 at SR-AIA), (2) Duval Street at Southard Street and (3) Duval Street at Green Street. The accident rates at these locations range from 2.0 to 2.2 accidents per million vehicles entering the intersection. While these rates are not extremely high

they do indicate problems. These intersections are addressed in the following recommendations.

Low Cost Immediate Action Plan

The purpose of the Immediate Action Plan is to respond to immediate needs with low-cost solutions. The Immediate Action Plan will be incorporated into the Cost Feasible Plan when it is developed. The Cost Feasible Plan will address a longer range forecast of need and include major improvements that will be formulated in the next planning phase.

Low-cost improvements with application to immediate problems consist of intersection improvements such as a signal timing adjustment, restriping, additions of turn lanes, minor widenings, and other transportation system management improvements. These project development activities can be programmed and constructed within a 5-year period. Construction projects involving minor widening of existing facilities, resurfacing of existing facilities, and intersection improvements on major facilities are also included in the Immediate Action Plan and are listed along with estimated costs in Table 3. The total cost of all improvements is $1,102,000.

The anticipated improvement in level of service at several critical intersections in Key West is shown in Table 4 for both 1985 and 1990. If these improvements are made, traffic movement would be improved substantially at each intersection.

Table 3

SHORT RANGE IMPROVEMENTS

Street/ Highway	Location	Responsible Agency	Estimated Cost (1984 $)	Recommended Improvements
(1) Whitehead Street	From South Street to Front Street	FDOT =	43,000	Resurface - complete with pavement marking
		City Key West =	63,000	
(2) Duval Street	From South Street to Front Street	Monroe Co. =	20,000	Resurface where needed - complete with pavement markings
		City Key West =	38,000	
(3) Duval Street	at Green Street	Monroe Co. =	20,000	Install a semi-actuated traffic signal because of accident rate (2.2 accidents per million)
(4) Simonton Street	From South Street to Front Street	City of Key West =	100,500	Resurface - complete with pavement markings
(5) Eaton Street	From Whitehead Street to White Street	Monroe Co. =	4,000	Make Eaton Street one-way westbound to help relieve the high volume demand approaching via Palm Avenue. Eaton Street is planned to be a major entrance into the Truman Annex area. At least one and possibly two multi-level parking facilities are planned inside this entrance. With good signing, traffic arriving via Palm Avenue could be directed to this parking area and thus relieve congestion downtown.
		City Key West =	1,000	
(6) Southard Street	From Whitehead Street to White Street.	City of Key West =	2,500	Remove the existing one-way designation and make two-way, to relieve the accident rate at Duval Street.

Table 3
(Continued)

SHORT RANGE IMPROVEMENTS

Street/ Highway	Location	Responsible Agency	Estimated Cost (1984 $)	Recommended Improvements
(7) Flagler Avenue	At 1st/Bertha Street	Monroe Co. =	500	Paint stripe center line through intersection on 1st and Bertha.
(8) Truman Avenue	At Duval Street	FDOT =	3,500	(a) Provide separate left turn storage lane on Duval Street (North approach) by eliminating parking approximately 200 feet on west side of Duval Street and by encroaching approximately 2 feet on the east sidewalk area.
		Monroe Co. =	2,000	
				(b) Provide separate right turn storage lane approximately 200 feet on Truman Avenue (East approach) by encroaching 4 feet on north sidewalk area.
				(c) Remove lead and lag phase on existing signal; no left turn arrow (North approach) is required, storage only.
(9) Truman Avenue	At White Street	FDOT =	1,000	(a) Provide a separate left turn storage lane on White Street (North approach) by removing parking left and right for approximately 200 feet.
		City of Key West =	1,000	

Table 3
(Continued)

SHORT RANGE IMPROVEMENTS

Street/ Highway	Location	Responsible Agency	Estimated Cost (1984 $)	Recommended Improvements
				(b) Existing signal ok; no left turn arrow (North approach) required, storage only.
(10) Truman Avenue/ Roosevelt Blvd.	At Eisenhower Drive	FDOT = City of Key West =	6,500 2,500	(a) Provide a separate right turn storage lane (approximately 150 feet) on Roosevelt Blvd.(East approach) by encroaching approximately 5 feet on sidewalk area.
				(b) Utilize inside lane for exclusive left turn storage on Roosevelt Boulevard (East approach).
				(c) Provide a separate left turn storage lane on Eisenhower Drive (North approach) by removing parking on west side of Eisenhower Drive and encroaching on dirt R/W on east side of Eisenhower Drive.
				(d) Existing signal ok; no left turn arrow (North approach) required, storage only.
(11) North Roosevelt Blvd.	At Palm Avenue	FDOT = Monroe Co. =	44,500 11,000	(a) Provide a larger right turn storage (12 feet wide by 300 feet long) on N. Roosevelt Blvd. (East approach) by encroaching approximately 4 feet on dirt sidewalk area. Relocation of palm trees will be required.
				(b) Provide a double left turn storage on Palm Avenue (North approach) by encroaching

Table 3
(Continued)

SHORT RANGE IMPROVEMENTS

Street/ Highway	Location	Responsible Agency	Estimated Cost (1984 $)	Recommended Improvements
				approximately 8 feet on sidewalk and parking area on west side of Palm Ave. This will allow for through and right turn movements on Palm Avenue (North approach).
				(c) Install a fully actuated three phase traffic control signal, but phase signal for no left turn arrow on South approach.
(12)North Roosevelt Blvd.	At Kennedy Drive/ Sigsbee Road	FDOT = City of Key West =	25,500 4,000	(a) Provide a separate right turn storage lane (10 feet wide by 200 feet long) on North Roosevelt Blvd. (East approach) encroaching approximately 10 feet on dirt sidewalk area.
				(b) Update the existing fully-actuated traffic signal to conform with the current "Manual on Uniform Traffic Control Devices".
(13)North Roosevelt Blvd.	At 5th Street (MacMillan Dr.)	FDOT = City of Key West =	7,500 500	(a) Sign the movements well in advance of the intersection, warning that the inside traffic lane (East approach) must stop for signal.
				(b) Lengthen the lane separation curb to the east and install pavement markings of reflectorized thermoplastic material well in advance of curbing.
				(c) Install high intensity street lighting along US-1 by utilizing existing poles.

Table 3
(Continued)

SHORT RANGE IMPROVEMENTS

Street/ Highway	Location	Responsible Agency	Estimated Cost (1984 $)		Recommended Improvements
(14) SR 5 (US-1)	At N. Roosevelt Blvd. and SR A1A	FDOT =	700,000	(a)	This project is presently in the FDOT work program for reconstruction (FY 85-86). The plans call for (1) improvements to the continuous right turn lane onto N. Roosevelt, (2) reconstruction of the intersection at N. Roosevelt/SR A1A and installation of a fully actuated three- phase traffic control signal (3) double left turn storage lanes (East approach) South onto SR-A1A (4) double left turn storage lanes from N. Roosevelt Blvd. (North approach) onto US-1.

Table 4

SUMMARY OF LEVEL OF SERVICE AND PERCENT SATURATION OF IMPROVEMENTS DURING PEAK HOUR
(2.2% growth rate per year)

Location	Without Improvements					With Improvements			
	1985		1990			1985		1990	
	LOS	%SAT	LOS	%SAT		LOS	%SAT	LOS	%SAT
Truman Avenue @ Duval Street	"C"	75%	"D"	86%		"A"	51%	"B"	58%
Truman Avenue @ White Street	"C"	70%	"D"	80%		"B"	61%	"C"	71%
Truman Avenue @ Eisenhower Drive	"C"	67%	"C"	77%		"B"	60%	"C"	68%
North Roosevelt @ Palm Avenue	"E"	90%	"E"	102%		"C"	71%	"D"	81%
North Roosevelt @ Kennedy Drive/ Sigsbee Road	"D"	78%	"E"	90%		"B"	64%	"C"	74%
S. R. 5 (US-1) @ North Roosevelt/ S. R. A-1-A	"E"	102%	"E"	116%		"A"	53%	"B"	60%

LEGEND:

LOS - Level-of-Service

% SAT - % satuartion, defined as the sum of critical movements at an intersection divided by the capacity of those critical movements.

APPENDIX A

PEAK-HOUR FACTOR

FDOT obtained 24-hour and peak period (i.e., 8-hour) data on 15 minute increments for recently inventoried locations. Based on these analyses, it was determined that the peak-hour factor typically ranged about 0.90. This is typical of urban areas such as Key West area.

The following table presents a data summary for each location for which 15-minutes summary information was available. A peak-hour factor represents a ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour. Fifteen-minute intervals are used to determine the peak flow during the peak-hour. Peak-hour factors were calculated using the basic formula below.

$$PHF = \frac{\text{Peak-hour volume}}{4\ (\text{Peak 15-min. Volume})}$$

It is obvious, therefore, that the peak-hour factor cannot exceed 1.0.

PEAK HOUR FACTOR CALCULATIONS

(Continued)

Location	Computation	Peak Hour Factor
1. (EB) on US-1 S. of MacMillan (control)	$\frac{1421}{(363)(4)} =$	.97
2. (WB) on US-1 S. of MacMillan (control)	$\frac{1343}{(348)(4)} =$	.96
3. (EB) on SR-A1A E. of US 1 Junction	$\frac{534}{(149)(4)} =$	.90
4. (WB) on SR-A1A E. of US-1 Junction	$\frac{672}{(202)(4)} =$	.83
5. (EB) on US-1 W. of Palm Avenue	$\frac{977}{(274)(4)} =$	.89
6. (WB) on US-1 W. of Palm Avenue	$\frac{834}{(233)(4)} =$	.89

PEAK HOUR FACTOR CALCULATIONS

(Continued)

Location	Computation	Peak Hour Factor
7. (EB) on US-1 E. of Jct. SR-A1A	$\frac{1409}{(396)(4)} =$	.89
8. (WB) on US-1 E. of Jct. SR-A1A	$\frac{1746}{(488)(4)} =$	.89
9. (WB) on US-1 E. of Palm	$\frac{1302}{(358)(4)} =$	.91
	Average =	.90

APPENDIX B

CRITICAL MOVEMENT ANALYSIS

FDOT performed intersection analyses for a number of intersections in the Key West study area. The McTrans Critical Movement Analysis (CMA) Program, developed by the Transportation Research Center, University of Florida was used in these calculations. The computational methodology for this version was based on the "Interim Materials on Highway Capacity" contained in Transportation Research Board Circulation 212.

The following table summarizes the worksheet/calculations used to derive the intersection level-of-service.

SUMMARY OF CRITICAL MOVEMENT ANALYSIS

Location	Level-of-Service	Percent[1] Saturation	S=Signalized U=Unsignalized
US-1 @ Key Haven Rd.	A	29%	U
US-1 @ E. College Rd.	A	28%	U
US-1 @ MacDonald Ave.	A	54%	S
US-1 @ Cross St.	A	40%	S

SUMMARY OF CRITICAL MOVEMENT ANALYSIS (con't)

Location	Level-of-Service	Percent[1] Saturation	S=Signalized U=Unsignalized
US-1 @ W. College Rd.	A	40%	U
US-1 @ SR A1A	E	102%	U
US-1 @ SEARS Ent.	A	35%	U
US-1 @ 14th St.	A	34%	U
US-1 @ Kenndey Dr.	D	79%	S
US-1 @ MacMillan Dr.	A	29%	S
US-1 @ Palm Ave.	E	90%	S
Truman Ave. @ Eisenhower	C	75%	S
Truman Ave. @ White St.	C	69%	S
Truman Ave. @ Duval St.	C	75%	S
SR-A1A @ Duck Ave.	A	15%	U
SR-A1A @ Flagler Ave.	A	13%	U
SR-A1A @ Airport Ent.	A	8%	U
Atlantic Blvd. @ Bertha St.	A	16%	U
Atlantic Blvd. @ White St.	A	12%	U
Flagler Ave. @ 14th St.	A	13%	U
Flagler Ave. @ Kennedy Blvd.	A	16%	S
Flagler Ave. @ MacMillan Dr.	A	17%	S
Flagler Ave. @ First St.	A	36%	S
Palm Ave. @ Eisenhower Dr.	A	32%	U
Palm Ave. @ Ely St.	A	29%	S

SUMMARY OF CRITICAL MOVEMENT ANALYSIS (con't)

Location	Level-of-Service	Percent[1] Saturation	S=Signalized U=Unsignalized
White St. @ Flemming St.	A	36%	U
White St. @ United St.	A	36%	S
Duval St. @ South St.	A	8%	S
Duval St. @ Front St.	A	20%	S
Whitehead St. @ Southard St.	A	27%	S

[1] %Saturation = the sum of critical movements at an intersection divided by the capacity of those critical movements.