DOT HS-803 650

ENFORCEMENT FREQUENCY, SANCTIONS AND COMPLIANCE LEVEL FOR PEDESTRIAN SAFETY

Karen B. DeBartolo
David F. Preusser
Richard D. Blomberg

Dunlap and Associates, Inc.
One Parkland Drive
Darien, Connecticut 06820

Contract No. DOT HS-5-01168
Contract Amt. $102, 927

April 1978
FINAL REPORT

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U.S. DEPARTMENT OF TRANSPORTATION
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16. Abstract

Parked vehicles can create a visual screen such that oncoming motorists and crossing pedestrians cannot see each other. One proposed safety countermeasure is parking bans for specific times at high risk locations. The purpose of this study was to investigate the effect of enforcement on motorist compliance with such time-phased parking bans. The study utilized the time-phased alternate side parking regulations in New York City. Enforcement varied from no increase above normally occurring enforcement to two additional enforcement visits per day. The results showed that increased enforcement can lead to improved motorist compliance. However, the timing of the additional visits within the period of prohibited parking is critical. The observed effects developed slowly and extinguished slowly. Recommendations are offered for employing and enforcing time-phased parking bans.

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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
	inches	*2.5	centimeters	cm
	feet	30	centimeters	cm
	yards	0.9	meters	m
	miles	1.6	kilometers	km
		AREA		
	square inches	6.5	square centimeters	cm^2
	square feet	0.09	square meters	m^2
	square yards	0.8	square meters	m^2
	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
	ounces	28	grams	g
	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
	teaspoons	5	milliliters	ml
	tablespoons	15	milliliters	ml
	fluid ounces	30	milliliters	ml
	cups	0.24	liters	l
	pints	0.47	liters	l
	quarts	0.95	liters	l
	gallons	3.8	liters	l
	cubic feet	0.03	cubic meters	m^3
	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

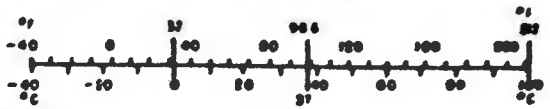

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

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Principal staff for the project consisted of Richard D. Blomberg, responsible officer, Karen B. DeBartolo, project director and David F. Preusser, Ph.D., technical consultant. At various times during the course of the project, additional staff performed significant project roles, including Adele R. Shaw, Robert Breedlove, Elizabeth King, Charles A. Gustansson and John J. Henschel. In addition, an outside consultant, Stanley L. Cohen, Ph.D., was employed in an advisory capacity during the design phase of the project.

The NHTSA Contract Technical Manager for the project was Mr. Ted Anderson, who skillfully guided the research effort for the majority of its term.

The project staff also wish to express their gratitude to the many individuals who assisted in the unique and demanding ways to arrange a study of this type in New York City. Foremost among these individuals is Mr. Nathan Yanofsky, Chief, Traffic Control Bureau, New York City Department of Traffic, who provided the support of his office, essential to arranging enforcement personnel for the project. Our appreciation extends to many members of the Department of Traffic who helped in various preparations for this study. In particular, we wish to thank the personnel of the 86th Street Manhattan Parking Enforcement Agents office, especially Ms. Barnice Arthur, the first Regional Commander who patiently assisted in planning the enforcement procedures, and later Ms. Beatrice Simon, who cooperated as Regional Commander of this PEA office.

A research study of this type relies largely on the individual efforts of those who collect data in the field, sometimes under difficult conditions. In this case, we are indebted to the very fine field staff, recruited with the assistance of the Department of Industrial and Management Engineering, Columbia University, most of whom demonstrated emotional and physical fortitude throughout the many cold winter weeks in the City.

Finally, we are grateful to the Parking Enforcement Agents (PEAs) who actually provided the experimental enforcement in the field. We especially wish to thank Agent Manigault, and her PEA squad, and Agents McNeil and Musco for their cooperation.

EXECUTIVE SUMMARY

Parked vehicles have been identified as a potential contributory factor in many urban pedestrian/vehicle accidents. They can create a visual screen such that oncoming motorists and crossing pedestrians cannot see each other. The problem appears particularly severe for child pedestrians in residential neighborhoods. One proposed countermeasure to deal with this problem is the banning of on-street parking at high risk locations during high risk times of day. However, to be effective, such a ban would have to be complied with by motorists. The purpose of the present study was to investigate the effect of enforcement on motorist compliance with a time-phased parking ban.

The study was conducted on residential streets of Manhattan, New York City, utilizing the existing alternate-side parking regulations. The intent of alternate-side is to clear one side of the street of parked vehicles for a three hour period on specified days so that street cleaning may be accomplished. As such, it is a time-phased parking ban in residential neighborhoods and possesses the essential features of the proposed pedestrian safety countermeasure. The first phase of the present study consisted of extensive observation of existing enforcement and existing motorist behavior with respect to the alternate side regulations. It was found that existing enforcement was relatively intense and concentrated in the beginning of the three-hour period. Motorist compliance was poor at the beginning of the period, improved rapidly, but suffered substantial deterioration during the last hour. In other words, this time-phased parking ban was most effective during the middle of the time period.

The second phase of this study attempted to improve observed motorist compliance through increased endorcement. The experimental design consisted of a control condition having no increased enforcement, an "Early only" condition where enforcement was increased only at the beginning of the period and an "Early-Late" condition where enforcement was increased both at the beginning and near the end of the period. A significant improvement in compliance was observed in the "Early-Late" condition during the last hour.

It was concluded that increased enforcement can lead to improved motorist compliance with a time-phased parking ban, but that the timing of the enforcement visits is critical. Equally important, the pattern of results clearly showed that improved compliance develops slowly (requires several weeks) and is persistent for at least several weeks. Recommendations, based on study results, are offered for employing time-phased parking bans, enforcing these bans and conducting research on the related compliance effects of sanction level (e.g., cost of parking ticket and effect of towing).

I. INTRODUCTION

This document is the final report under Contract No. DOT-HS-5-01168 between the U. S. Department of Transportation, National Highway Traffic Safety Administration and Dunlap and Associates, Inc. The project, entitled "Enforcement Frequency, Sanctions and Compliance Level for Pedestrian Safety" was sponsored under the program administered by the Office of Driver and Pedestrian Research of NHTSA. The contract effort yielded a two phased research program, conducted over the period 5 June 1975 - 31 May 1978.

The basic purpose of this project was to develop information which could be useful in formulating optional enforcement strategies to achieve desired levels of motorist compliance with certain model traffic regulations. A research program was designed to examine the effects of time-controled enforcement activity on motorist compliance with a time-phased, short duration parking regulation. The project involved, first, an extensive review of the literature and the preparation of an annotated bibliography, followed by a field research study conducted in two phases. The first phase resulted in an extensive examination of parking behavior, but without specific information on the effect of enforcement. The second phase resulted in specific enforcement-compliance information.

This study was originally designed to define the relationship between the level of enforcement and the level of compliance, as mediated by the motorist's perceived risk of detection, while holding sanction level constant. However, the research plan was subsequently modified when it was determined that direct measurement of the motorist's perception would not be possible. This was the result of denial of a request for a motorist survey by the Office of Management and Budget. Therefore, the research design was directed simply at measuring motorist compliance as a function of enforcement activity, with sanction level controled.

Much of the previous research into the effects of enforcement on motorist compliance had focused on various moving violations, particularly speeding, and had not addressed the problem of how to obtain compliance with a non-moving regulation, such as a parking restriction. Recently, studies have uncovered a potentially greater role for parking control in the context of traffic safety than had been previously recognized. In particular, the active pedestrian safety research program of NHTSA has been responsible for identifying the considerable impact that parked vehicles may have on the time drivers and pedestrians have to see each other. For example, a parked car was indicated as a predisposing factor in 35 percent of the non-intersection crashes involving a pedestrian in the comprehensive study by Snyder and Knoblauch (140).

While any regulation must receive a high degree of compliance for it to achieve its full traffic safety potential, parking

restrictions which reduce available space for on-street parking are often unpopular among residents in urban areas. In these areas, the demand for vehicle storage typically far exceeds the supply of available parking spaces. Consequently, voluntary compliance with parking restrictions in densely populated areas may be expected to be low. Enforcement or parking control represents the principal means by which a community can achieve an acceptable level of compliance with parking regulations. However, it was not known what level or intensity of enforcement is required to achieve a desired level of compliance. Thus, this was the principal information sought in the present study.

The study approach, methods and plans are discussed in Chapter II. The research findings generated during the first, or baseline, phase are presented in Chapter III. The results of phase two which examined the effects of changes in enforcement level appear in Chapter IV. The final chapter discusses the conclusions of the study and presents recommendations for pedestrian safety. The results of the literature review are summarized in Appendix A. Appendix B contains the annotated bibliography prepared as part of the literature review task.

II. STUDY APPROACH, METHODS AND PLAN

A. Background

Cars parked along a curb obstruct the driver's and the pedestrian's view of each other, particularly if the pedestrian is a child. In a study by Snyder and Knoblauch (140), vision obstruction caused by a parked car was identified as a "predisposing" factor in 21 percent of all pedestrian accidents studied. Furthermore, in the sample's 578 cases which identified any predisposing environmental factor, "parked cars" was by far the most frequent factor, being noted in 457 cases or 79 percent of all accidents "predisposed" by a factor in the environment.

Parked vehicles clearly represent a significant predisposing factor in pedestrian accidents. Although parallel parking is commonly related to several accident types, Snyder and Knoblauch found it to be an especially important predisposing factor in two major types of pedestrian accidents--dart-out first half and dart-out second half. These accident types account for 24 percent and 9 percent, respectively, of all pedestrian accidents. "Dart-outs," by definition in Snyder and Knoblauch's study, occur at non-intersection locations. They involve the sudden appearance of a pedestrian from the roadside. "First half" or "second half" in the terminology used, indicates at what point in crossing the street the pedestrian was actually struck by the vehicle.

The following data by Snyder and Knoblauch (140) summarize the above and highlight the significant role of on-street parked vehicles in predisposing pedestrian accidents:

- Almost 50 percent of all pedestrian accidents in urban areas occurred at non-intersection, i.e., mid-block, locations.
- Thirty percent of non-intersection crashes involved the predisposing factor of "environment-parked car."
- About 8 percent of all non-intersection crashes involved the specific pedestrian precipitating factor "pedestrian detection-parked car."
- About 9 percent of all non-intersection crashes involved the specific driver precipitating factor "driver detection-parked car."

Snyder and Knoblauch (140) developed many specific countermeasures to deal with the identified problems. Street parking redeployment was given the highest priority among these countermeasures on the basis of their judgment of countermeasure cost effectiveness.

Blomberg, Hale and Kearney (15), working largely with the Snyder and Knoblauch data, developed specific recommendations regarding parking regulations and pedestrian safety. They proposed a "Model On-Street Parking Ordinance" which would apply to new or redeveloped areas in an urban environment. The specific elements of this model ordinance were as follows:

- Prohibit on-street parking in new or redeveloped areas between sunrise and sunset (daylight hours account for most child pedestrian accidents).
- Allow the city traffic engineer to exempt an area from the no parking restriction if there would be no safety benefit or an undue hardship would result.

Thus, this proposal called for a time-phased ban on parking. It was designed for use in urban, residential neighborhoods and adopted the approach of simply prohibiting parked cars.

The effectiveness of any such ban on parking will necessarily be related to the extent to which motorists comply with it. Traditionally, enforcement has been the principal means by which a community can achieve an acceptable level of compliance with parking regulations. However, the relationship between enforcement and compliance was not known and thus was the focus of the current study. Enforcement strategies and required enforcement intensity as they relate to urban, residential, time-phased parking regulations were of particular interest. Sanction level (e.g., the dollar cost of a parking ticket) was not studied directly though it was a control variable.

B. Selection of a Test City

The first objective established for city selection was to find a single urban area that would 1) provide the required number of experimental sites, 2) permit enough distance between sites to minimize inter-site contaminations, and 3) support the planned data collection. The use of a single urban site offered several distinct advantages to this project. First, utilizing a single city ensured relative uniformity in the type of sanctions, sanction policies, enforcement practices and in the prevailing levels of enforcement and motorist compliance. A related advantage was that should any of the pre-existing conditions have changed during the field experiment, the impact of such environmental change would have been equally likely to occur at all experimental locations (i.e., at each city block site). Second, one city meant that the same group of officials, enforcement agencies and enforcement personnel were involved across all experimental sites. This ensured consistency in the application of enforcement policies at all sites. Third, the organization, administration and coordination of the field experiment was simplified by dealing with one city and a single group of agencies.

In addition to desiring one urban area large enough for the experiment, a number of other characteristics were sought during site selection. First, the cooperation of city officials and the essential support of parking enforcement agencies were deemed of utmost importance to successful completion of this project. Second, the city had to contain a sufficient number of areas where a parking regulation related to pedestrian safety could be found. The ideal kind of regulation was defined to be a no-parking, time-phased restriction where parking would be permitted on a block most of the time, but prohibited some of the time (regardless of the reason for the prohibition). Third, the demographic and socio-economic characteristics of the city, as well as the areas containing the desired parking regulation, had to be relatively homogeneous and "representative" (i.e., not at the extremes). Fourth, the traffic environment and the demand for available parking should be representative of most urban, densely-populated areas. Fifth, the chosen city was required to have specifiable enforcement policies and procedures and to have adequate mechanisms for accountability and follow-up on citations issued. A sixth criterion was that the site selected be in an eastern or northern location so as to minimize travel costs. Further, having a nearby experimental site would facilitate all aspects of setting-up and conducting the field experiment. A final selection criterion was brought into sharp focus during preliminary baseline data collected at several candidate sites. Specifically, this is the requirement that the site provide high levels of both traffic and violation activity in order to provide a sufficient quantity of observations to support statistical inference testing.

Of these many criteria for site selection, only the last requirement for high levels of activity posed any significant problem. An intensive investigation of possible sites was made throughout Fairfield County, Connecticut; and in New York, serious consideration was given to parts of Westchester County, the Town of Hempstead in Nassau County, and the boroughs of New York City, excluding Richmond. In addition, exploratory contacts were made with New Haven, Connecticut, Albany, New York and Baltimore, Maryland.

Each of these candidate sites could satisfy some of the requirements for this study, but only New York City, and especially Manhattan, was found to meet them all, and to satisfy them best. Thus, Manhattan and its alternate-side-of-the-street parking areas was believed to be ideally suited to accomplish the field experiment. The following few paragraphs describe the specific relevant characteristics of Manhattan and the rationale for its selection.

Manhattan encompasses a large number of residential city blocks, each having a high density of population, which represent a reservoir of many candidate, relatively homogeneous experimental locations. In addition to providing a rich source of candidate sites, Manhattan offered high volumes of traffic-related activity,

i.e., vehicular and pedestrian flows, numbers of drivers seeking parking, and particularly desirable, large numbers of parking violators. With regard to parking violation rates, it should be noted that the rates reported and actually observed in Manhattan, and other New York City boroughs, far exceed estimated rates at any of the other cities considered. The final principal reason for choosing Manhattan as the test city is its abundance of block locations with alternate-side parking regulations.

C. Selection of a Parking Regulation for Test

Several existing parking regulations in virtually every urban traffic jurisdiction involve a time-phased ban on parking. Parking on through streets is often banned in the downtown direction in the morning and in the opposite direction in the evening. Parking near schools is often prohibited during school hours, yet allowed during the evening and at night. Parking in commercial districts is often banned during rush hours, yet permitted during mid-day. Current time-phased bans are typically instituted to improve traffic flow, facilitate all types of loading and unloading of trucks, buses, etc., and facilitate street operations such as street cleaning. Few are designed for the express purpose of enhancing pedestrian safety.

The current project examined a variety of time-phased regulations for possible use as the test regulation. It was felt that an ideal test regulation would involve a time-phased ban on parking and would have the following characteristics:

- Apply in residential neighborhoods.
- Apply to at least one entire side of a street, not just a few parking spaces such as around a loading zone.
- Have current violation rates of sufficient magnitude to generate sample sizes large enough to detect the effects, if any, of changes in enforcement.
- Be currently operational and long-standing so as to avoid any unique problems associated with start-up and the concurrent need for public education.

In short, an ideal test regulation would be an existing situation in an urban area which approximated the elements of the "Model On-Street Parking Ordinance" and currently had significant violation activity.

Such an existing situation appeared to exist with respect to "alternate side of the street" parking in Manhattan, New York City. This regulation has been in effect for several years, in various forms it encompasses most of the residential areas of

Manhattan. The regulation is a time-phased ban on parking for one entire side of the street and preliminary observation of the streets showed that there was violation activity. The regulation exists to facilitate street sweeping operations. Its two major forms are "two-day" and "three-day." The two-day areas have parking bans on one side of the street, say, Monday and Thursday and the other side, Tuesday and Friday. Three day areas run on a Monday, Wednesday, Friday and Tuesday, Thursday, Saturday schedule. Only three-day areas were used in the current study. Figure 1 presents a map showing the three-day areas of Manhattan in which potential sites were sought.

The parking ban itself in the three-day areas is in effect for three hours on each day Monday through Saturday alternating between the two sides of the street. For half of the streets, the three hours are 8 a.m. to 11 a.m. (designated as a.m. sites) and for half the three hours are 11 a.m. to 2 p.m. (designated as p.m. sites). Three-day sites also vary with respect to sanction level. Those closer to the downtown section of Manhattan have a $25 fine for violating alternate side; those further north have a $15 fine. The first phase of data collection utilized both a.m. and p.m. sites and $25 and $15 sanction levels. The second phase utilized only p.m. sites but with both sanction levels.

D. Experimental Plan

The objective of this study was to quantify the effect of enforcement on motorist compliance with a time-phased parking regulation. The study was conducted in two phases. The first phase resulted in an extensive examination of parking behavior, but without specific information on the effect of enforcement. The second phase resulted in specific enforcement-compliance information.

As originally designed, the first phase was to have supplied information on the relationship between enforcement and compliance (i.e., observed violation rates) and on the relationship between enforcement and a motorist's perceived risk of detection (i.e., the subjective probability of getting a ticket). Perceived risk was to be measured through a motorist interview. An experimental design was developed to assess enforcement, compliance and perceived risk which included a motorist survey to be conducted via interview. The motorist survey was submitted to the Office of Management and Budget for approval and baseline data collection was begun. Unfortunately, approval of the survey was first delayed and then denied and the scheduled increase in enforcement never occurred. As such, the first phase of data collection became a baseline effort and a second phase was designed and implemented to examine the enforcement-compliance relationship only without regard to perceived risk.

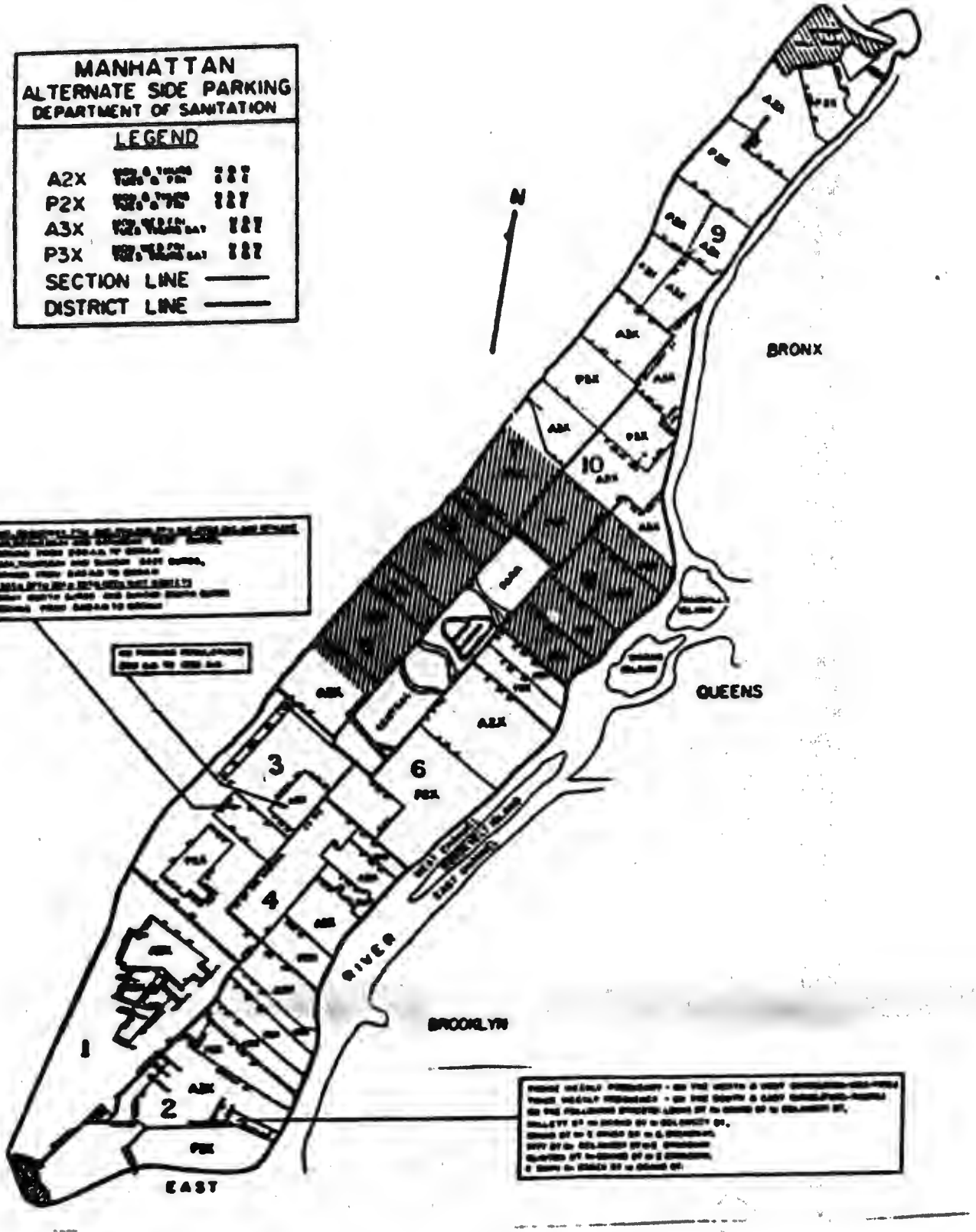

Figure 1. Hatched area shows 3-day alternate-side districts from which experimental sites (i.e., city blocks) were selected.

The first phase of data collection was conducted from November 1975 through March 1976. It involved observation of legal and illegal parking behavior, Monday through Saturday at 28 selected sites (i.e., city blocks) in Manhattan. Half of the sites were "a.m. alternate side" and thus observation was conducted from 8 a.m. to 11 a.m. Half of the sites were "p.m. alternate side" and were observed from 11 a.m. to 2 p.m. The sites were equally divided and counterbalanced between $15 fine areas and $25 fine areas. All sites were east-west Manhattan streets; none were north-south Manhattan avenues. All sites would best be described as "residential" without the presence of schools, police stations, fire houses or significant business, commercial or industrial operations. Observation was conducted for 6 to 24 days over a one to eight week period as specified in the original experimental design (Interim Report, September 1975). In all, there were 554 three-hour observation days or periods during which 29,411 legal and illegal parking events and 973 enforcement events (e.g., patrol car drove down the block with or without issuing any tickets) were observed. In general, one observer worked at each site for the full three hours. However, for 22 of the periods, a second observer was assigned to collect independently the same data as the first. This procedure was adopted to assess the reliability of the data collection process.

Second phase data collection was conducted from September 1976 to November 1976. It utilized six sites or blocks selected on the basis of first phase data. Each was a "p.m. alternate side" meaning that from 11 a.m. to 2 p.m., parking was prohibited on one side of the street Monday, Wednesday and Friday; the other side Tuesday, Thursday and Saturday. An overview of the experimental design is shown in Table 1. The primary independent variable in this design was enforcement level. The first two sites, designated as control, received no additional parking enforcement over what would normally occur. The next two sites, designated as "low", received one additional enforcement visit from a Parking Enforcement Agent. The visit was scheduled to begin early, at 11 a.m. or 11:20 a.m., and lasted 15 minutes whether or not there were sufficient violators to warrant 15 minutes of ticket writing. Visits occurred on <u>each</u> day, Monday through Friday, of the four week "Increased Enforcement" period shown in Table 1. The last two sites, designated as "high" (i.e., early and late visits) were scheduled to receive additional visits both at 11 a.m. (or 11:20 a.m.) and 1:20 p.m. (or 1:40 p.m.) each lasting for 15 minutes. Again, the visits occurred Monday through Friday on each day of the four week "Increased Enforcement" period. Half of the sites had the $15 sanction level and half had the $25 sanction level.

The field study was conducted over an eight week period at each site. During the first, or baseline, week, all sites, whether control or experimental, were simply observed on each day Monday through Friday. Monday through Friday observation was continued through the "Increased Enforcement" period (excluding holidays when alternate-side regulations are suspended). This four-week

Table 1. Outline of Experimental Design.

Enforcement	Time of Day	Day of Week	Sanction Level	Study Week: Baseline	Increased Enforcement 1	2	3	4	Pause	Post 1	Post 2
Control	11 a.m. to 2 p.m.	Mon. to Fri.	$15	Site #1	→	→	→	→	- - - -	→	
			$25	Site #2	→	→	→	→	- - - -	→	
Low[a]	11 a.m. to 2 p.m.	Mon. to Fri.	$15	Site #3	→	→	→	→	- - - -	→	
			$25	Site #4	→	→	→	→	- - - -	→	
High[b]	11 a.m. to 2 p.m.	Mon. to Fri.	$15	Site #5	→	→	→	→	- - - -	→	
			$25	Site #6	→	→	→	→	- - - -	→	

[a]Early additional enforcement visit scheduled during the first hour of the parking ban.

[b]Both an early (scheduled as defined above) and a late additional enforcement visit scheduled during the final hour of the parking ban.

period followed by a one week pause during which no observation and no increased enforcement occurred. The "Post" period, consisting of the seventh and eighth week at each site, involved observation on one Monday, one Tuesday, one Wednesday, etc., over the two week period for a total of five days of observation with no increase in enforcement. Data collection and manipulation of enforcement were conducted concurrently at all six sites. This ensured that extraneous variables such as weather, seasonal variation, holidays, etc., were all equally applicable at all sites.

It should be noted that the "Low" and "High" enforcement strategies were selected based on the findings from the first phase of data collection. In particular, it was found that the normally occurring enforcement of alternate side regulations was quite high. The 28 Phase I sites averaged nearly two enforcement visits per three hour day. Thus, to be perceived by motorists, any enforcement increase would have to be relatively intense and/or novel. Second, violation activity was both high and centered on the first and last hour of the three hour period. Thus, it appeared that enforcement should be centered early and late during the three hour period to have maximum effect on illegally parked vehicles. Simply, more targets of opportunity (illegally parked cars) could be found at these times.

E. Observation Plan and Data Collection Instrument

As discussed earlier, one observer was stationed at each block for each three-hour observation day during both the first and second data collection phases. The observer was instructed to remain as inconspicuous as possible and was not permitted to discuss the project with area residents. Essentially, his job was to record all enforcement actions and parking behaviors that occurred at his assigned block during each observation period. The following specific data items were recorded:

Vehicles parked at beginning of observation period

Legally parked

- license number and state
- vehicle type
- body style
- vehicle use and condition

Illegally parked

- license number and state
- vehicle type
- body style
- vehicle use and condition
- specific parking violation
- vehicle ticketed
- driver stayed with car

Vehicle movements during observation period

Parking legally

- license number and state
- vehicle type
- body style
- vehicle use and condition
- driver age (estimated)
- driver sex
- driver race
- number of passengers
- exact time
- ticketed
- driver stayed with car

Parking illegally

- license number and state
- vehicle type
- vehicle use and condition
- body style
- driver age (estimated)
- driver sex
- driver race
- number of passengers
- specific violation
- exact time
- vehicle ticketed
- driver stayed with car

Leaving parking

(carry forward data items already tabulated when vehicle arrived)

- driver age (estimated)
- driver sex
- driver race
- exact departure time

Enforcement during observation period

- time arrived on block
- time left block
- vehicle number (if on vehicle)
- citations issued (referenced back to the specific vehicle cited)
- unit, precinct or command designation (e.g., Parking Enforcement Bureau, Sanitation Police, regular precinct patrol, etc.)

Vehicles which were clearly stopping or standing but not parking were not tabulated. Observers were also responsible for recording any unusual occurrences which might have influenced parking behavior. An accident, for instance, or the presence of any emergency vehicles could influence motorist behavior. The actual data collection form is shown in Figure 2. The upper right hand corner of this form was used to add site related data such as location, block characteristics and when the observation was conducted. Forms and procedures were pretested prior to implementation.

F. Selection of Test Sites

Using parking maps provided by the Department of Traffic, coupled with Manhattan demographic data, an area comprising sixty contiguous census tracts was defined for initial site review (see hatched area of map in Figure 1). This area contained only three-day alternate side parking blocks (i.e., contained no two-day alternate side zones) and encompassed hundreds of potentially suitable test sites. The area represented a large number of residential neighborhoods, with commercial activity generally limited to the avenues, and was included entirely within the jurisdiction of a single parking enforcement office of the NYC Department of Traffic. Site selection criteria were specified which were designed to provide comparability among sites with respect to 1) traffic volume and mix, 2) parking volumes, including both supply and demand, 3) land usage, 4) resident population/income characteristics, and 5) traffic regulations and enforcement practices. Preliminary selection of sites was based on on-site observation of parking regulations and land use characteristics. Sites were rejected if any of the following types of characteristics were observed:

- Significant encroachment by other parking regulations (metered parking, no-parking zone, bus stop, etc.)
- Parking garage or several private driveways or garages
- School or day care center or playground or block designated as a playstreet
- Police precinct office or post office or other public offices
- On-street construction work or significant building construction on block

Preliminary screening yielded many sites potentially acceptable which were then examined for population/income comparability, distance from each other and length of block. A total of 28 city blocks were eventually selected, dispersed throughout the 200 blocks on Manhattan's west side, ranging in location from 73rd to 113th streets.

DUNLAP AND ASSOCIATES, INC., PARKING STUDY

Location_____ Date_____ Time Period_____

Site No._____ Observer_____ Page____ of____

DO NOT WRITE IN:

64 55 | 56 | 57 58 59 | 60 61 | 62 63 | 64 65 66 67 68

69 70 71 | 72 73 | 74 75 | 76 | 77 | 78 | 79 80

	ALL EVENTS		AUTHORITIES			ILLEGAL OR DOUBLE PARKERS													MISC.	
			Police Type	Police Action			State	Violations		TICKET?	Vehicle			Driver						
No.	Time In	Time Out	1=NY PD 2=PEA 3=Sanit. Police 4=Tow-Away 5= Sweeper	1= Driving 2= Walking	0=none (passed thru) 1-8=no. tickets written 9=9 or more tickets	License Plate No.	1=NY 2=NJ 3=CT 4=DPL 5=DC 6=VT 7=other state 8=other country 9=other	1=on illegal side 2= illegal on legal side	1=at hydrant 2= driveway 3= double parked 4=only on illegal side	1= yes 2= no	Type 1=subcompact (car/trk/wagon) 2=intermed. car 3=full car 4=full wagon 5=panel trk/van 6=p.u. truck 7=full truck 8=bus 9=other	Use 1= private 2= commercial 3= gov't	Cond. 1= new or al. most new 2= average 3= run-down	Age estimate	Sex 1= male 2= female	Race 1= White 2= Black 3= Span. 4= Oriental 5= Other		Thru Traffic Count 15 min. each hour on 1/2 hour)	Legal Parkers Count (each hour on 1/6 hour)
	1 2 3 4	5 6 7 8	9	10	11	12 13 14 15 16 17 18 19	20	21	22	23	24	25	26	27 28	29	30	31		
1																			
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16																			

Figure 2. Observation data collection form.

Since more than four months were required to complete data collection at all 28 first phase sites, conditions at each site were continually monitored. Conditions which were judged to affect the parking did occur at several blocks (e.g., a fire, construction work, "playstreet" designation) but selection of a replacement site was required in only one case, where a street was closed to all traffic in the afternoon for children's play. In the other cases, changes were temporary and were handled by re-scheduling data collection when conditions returned to "normal."

The second phase of data collection was based on the careful selection of only six of the 28 sites investigated in the initial set. Selection of the six sites involved determining the "best match" of sites using the previously described criteria along with the parking descriptive data newly acquired from Phase I. The six second phase sites, then, represented city blocks which shared similar demographic profiles, parking regulation mix, traffic conditions, residential land use and parking characteristics.

G. Enforcement Control Plan

During the course of this study, several enforcement control mechanisms were developed, tested, modified, and in some cases, discarded in the process of evolving an acceptable control plan. The enforcement plan that was ultimately employed was based on a close working arrangement with enforcement personnel and daily monitoring of enforcement visits. With the approval of Manhattan parking enforcement agency personnel, project staff worked directly with enforcement agents assigned to this program.

Two agents, selected by the Department of Traffic, were temporarily relieved from their regular duty tours and assigned to enforcing parking for this project. The agents and their immediate superior were first briefed by project staff as to the general objectives and approach of the study. The specific procedures that were to be followed by them were discussed in detail. They were made aware that their duty tours for part of each day would be both determined and monitored by project staff for the next several weeks.

Each agent was provided a detailed schedule indicating the specific 15-minute interval (during the first and/or third hour of the regulation) for an enforcement visit to a particular block. The agent was instructed to remain on the block for at least 15 minutes--longer if needed for ticketing--and to ticket all illegally parked cars. The project's enforcement visits were in addition to any enforcement already occurring at the sites from regular police or sanitation police. Although each block was visited for the required number of times each day, Monday through Friday, the precise time of the enforcement activity as well as the particular agent appearing on a given day were varied, so that neither would be predictable to drivers on the block. This activity was

monitored each day by the field observers.

H. Field Staff Selection and Training

Field staff were recruited with the assistance of a major university in Manhattan. Virtually the entire field staff employed by the project were either graduate students or senior class undergraduates. The few non-students employed were selected from applications sent by acquaintances of existing staff. During the course of two phases of data collection, more than 30 people were employed by the project. A large field staff was necessitated by both the limited availability of enrolled students and the fairly high attrition among staff. Attrition was often reported to be due to intolerance for outdoor work during a cold winter in New York City. In other cases, class schedules changed to less favorable times, one person moved from the area, several people got better or full-time jobs and one person was fired.

Personnel were screened initially by means of a written application form, completed by the applicant and mailed in well before the scheduled training session. Selected applicants were then interviewed by telephone, and if there was still mutual interest, were invited to participate in a paid training session lasting about two hours. Several training sessions (one session per trainee) were conducted before the start of data collection so that any one session could be limited to 5-6 trainees.

The training program included a general orientation to the objectives and approach of the study, a detailed account of how the alternate-side regulation works in Manhattan, and a general description of parking behavior at alternate side locations. Following this introduction, a set of detailed instructions for properly completing the field observation form was distributed to each trainee. The data collection form was then discussed in depth and the coding of each column in the form was explained. Practice in filling out the form was simulated in the classroom by means of chaulkboard illustrations of typical parking behaviors which the trainees would then have to code properly on their observation sheet. Each training session concluded with a review of a checklist of procedures for all field observers and a discussion of the importance of accuracy and neatness in providing acceptable raw data sheets. Staff were warned about the necessity of being at a site at the right time and remaining there the full three hours. They were also encouraged to notify the project supervisor (as soon as possible) if they would not be able to keep an assignment; only the project supervisor could transfer an assignment to another observer. The final phase of training was accomplished in the field after the trainee had experienced one or two actual work assignments and had received direct feedback concerning performance from project staff. Most new observers worked independently on a block with a more exper-

ienced observer so that two, hopefully identical, data sets would be collected during field training. This precaution assured usable data and also aided in providing information for trainee performance appraisal.

I. Data Management

The field assignments schedule was completed early in the week prior to the planned data collection. Work was distributed equitably across the entire active staff for the week and in accordance with their availability and work load preferences. Since field observers were required routinely to telephone their enforcement activity report, work assignments for the following week were accomplished during one of these calls for each individual.

Immediately following a field assignment, the observer was required to check the clarity and identifying information on the data sheets and to mail them to the Contractor in addressed, business reply envelopes provided. Data sheets were reviewed as they were received by project staff and any problems discovered were discussed with the field observer. The data set was then recorded and assembled for processing. Although few data sets were lost in the mails, or not accounted for, most took several days to arrive and some were very late. In the interest of not penalizing the observer for this, and in order to simplify record keeping, observers were mailed checks at the end of each work week for the assignments they worked that week. The typical workload was three or four assignments (9 or 12 hours) per observer per week.

Supervision of field staff occurred in three unobtrusive, unpredictable ways. Field staff were advised that the project supervisor would be spot checking assigned locations throughout data collection. Second, any particular field assignment could be given to two staff members (for developing a measure of observer reliability) who would each work independently of the other. Neither observer would know in advance of the appearance of the other, but they knew all field procedures would remain in effect regardless. The final means of "supervision" was operative at experimental sites since the parking enforcement agent would visit for one or two 15-minute intervals each day and would be quite evident to the observer, and vice versa. The field staff also knew that project staff were in close contact with parking enforcement personnel. Only one case of observer unreliability was discovered and the individual was subsequently terminated.

A project of this size, sustaining a high level of field activity over many weeks, and yielding a massive data base necessitates much record keeping and an adequate data management system. Some of the records and administrative aids that proved especially effective included:

- Frequent, personal contact with field staff
- Daily monitoring of enforcement activity including a written record of the report highlights and multiple backup arrangements for receiving the information when called in
- Enforcement activity schedule presented to agents on a form convenient for use in the field
- Single-sheeted field observation forms bound with a self-contained firm backing and rain shield, eliminating the need for clipboards
- Site schedule chart, easily updated, showing planned and actual enforcement and data collection activities at all sites throughout the program
- A (single sheet) checklist of procedures to be followed by field staff before, during and immediately following a field assignment
- A separate, detailed set of instructions explaining observations to be made and proper entries on data collection form
- Weekly schedule of data collection assignments showing, at a glance, the individuals assigned to all sites cumulative to date

Sites were assigned to observers on an informal rotation basis so that no one person would become readily identified with the block and in order to distribute the workload fairly. Some blocks were more difficult to work than others, e.g., greater parking/traffic activity levels, physically longer blocks, longer travel times to the site, etc. Observers were not assigned to a block where they were known or had a friend. Although this limitation occurred in two cases, it posed no problem since there were sufficient personnel to work around the constraint. An observer was generally not assigned to the same block two days in a row nor was he assigned the same site for the same day of the week for two weeks in a row, if it could possibly be avoided.

Field staff were instructed to record their observations in an inconspicuous manner, to move about the block and to avoid conversation with people they might meet. A letter of introduction, which identified the observer and his participation in a study being conducted with the cooperation of the NYC Department of Traffic, was given to each observer. The letter was needed only once.

Sets of data, mailed by field staff, arrived in batches each day at Dunlap's office. The completeness, general read-

ability, assignment identifying information and the adequacy of the coding were reviewed as each set was received. This process was particularly thorough for data collected by new observers. Any questions or problems regarding the data were discussed with the appropriate field observer and corrected when possible. The sets were logged in and filed according to block location.

All data were retained until completion of a phase of data collection when it was then keypunched and sorted into site batches. There were several iterative steps in the processing of the data decks to ensure the basic validity of the data. At the end of this verifying and correction process, all data were recorded on magnetic tape for easy handling, ready for cross tabulations and subsequent analysis.

J. Reliability of Data Collection Procedures

Early in the work effort, consideration had been given to utilizing two observers per block per day. The problem was that parking activity was extremely intense during the first and last half hours of the three hour interval. However, particularly during the middle hour, there were times when little parking activity occurred. Thus, the decision was made to utilize only one observer at the possible sacrifice of some early and late data. As discussed earlier, this decision and the reliability of the entire data collection process, was tested by assigning a second observer for 22 of the observation periods in Phase I. The two individuals worked independently on the same block at the same time. Product moment correlations were computed comparing the number of legal, illegal and double parked vehicles and the number of police visits recorded by the two observers.

The correlation was highest for legally parked vehicles ($r = .91$) followed by number of police visits ($r = .89$), number of illegals ($r = .84$) and number of double parkers ($r = .68$). The moderate correlation for double parkers is quite understandable since double parkers tend not to leave their vehicles for very much time, and it is often difficult to determine whether they were "stopping" (not tabulated), "standing" (also not tabulated) or actually parking. Otherwise, the correlations ranged from .84 to .91 which was considered relatively high given the constraints of the observation task.

III. DESCRIPTIVE RESULTS

The first phase of data collection involved 28 Manhattan streets, observed for a total of 554 three-hour alternate side periods. In all, 29,411 parking events and 973 enforcement visits were observed. Data were gathered on vehicles, drivers and police actions. The purpose of this section is to present a description of alternate side parking in Manhattan. Data will be shown relative to the vehicles and drivers and how and when they park. This will be followed by a description of normally occurring enforcement activity.

A. Parking Behavior of Vehicles

Throughout this study, parking events were classified as:

Illegal side - vehicle parked on side of street where no parking was allowed on that day

Legal side - vehicle legally parked on side of street where parking permitted for that day

Other illegal - vehicle parked illegally on legal side of street (e.g., fire hydrant, driveway, etc.)

Double park - vehicle parked in traveled lane

To be tabulated, a vehicle must have been "parked" at least in some sense of the word. Vehicles standing in traffic or stopping momentarily to load or unload passengers were not tabulated. However, vehicles which were technically "standing" (e.g., motor running, driver stayed with car, in a double parked position) were tabulated if the behavior was more than "momentary." Frequently, drivers will "stand" double parked waiting for the end of the three hour period. When the period ends (or more often shortly before) they move into parking spaces on the illegal side which have become legal spaces. It should be noted that it was possible for one vehicle to be tabulated more than once on the same day. The double parker above, for instance, could have been tabulated for double parking and for illegal side parking if he moved onto the illegal side before the end of the three hour period.

Across all 28 sites and all observation periods, there were 9,190 (31%) parkers on the illegal side; 10,340 (36%) legal; 9,387 (32%) double parked; 336 (1%) other illegal; and 158 for which parking information was not obtained. Table 2 shows the distribution of these parking events as a function of vehicle type. The table shows that there is little difference in the parking behavior of subcompacts, intermediates, full size cars and station wagons. All are found about equally often as legal, illegal and double parkers. The behavior of these vehicles, how-

Table 2. Parking Status by Vehicle Type.

Vehicle Type	Parking Status: Illegal Side	Legal	Other Illegal	Double Park	Total N	Total %
Subcompact	31%	35%	1%	33%	6,682	100%
Intermediate	34%	32%	1%	33%	5,381	100%
Full Size	34%	32%	1%	33%	8,746	100%
Station Wagon	34%	30%	2%	34%	2,480	100%
Panel/Van	33%	14%	2%	50%	2,186	100%
Truck	48%	8%	3%	40%	871	100%
Other	29%	45%	3%	22%	246	100%
Vehicle type not obtained	9%	83%	<1%	7%	2,661	100%
				TOTAL	29,253	

ever, is much different from van and truck behavior. Trucks were more often found on the illegal side (48%) or double parked (40%) than legal (8%). Panel trucks or vans were most often found as double parkers (50%), followed by illegal side (33%) and legal (14%). Vehicles listed under "type not obtained" were predominately legally parked and most can be presumed to be cars. The parking behavior of trucks is not unexpected as most vehicles of this type were probably in commercial service and making deliveries or service calls.

Table 3 shows vehicle parking status by vehicle use and condition as judged by the observers. Concerning vehicle use, it was found "private" vehicles appear about equally often as legal, illegal and double parkers. Commercial vehicles are most often found double parking (51%) and government vehicles are most often found on the illegal side (52%). Concerning vehicle condition, there is a clear relationship between condition and parking status. Vehicles double parked and illegally parked tend to be "newer" and legal vehicles tend to be "run down." This finding possibly reflects the fact that older vehicles are probably more often left on the street overnight and thus more likely to have one of the legal spaces.

Vehicle registration state by parking status is shown in Table 4. The data indicate that parking behavior does vary by vehicle registration. New York vehicles are more likely to double park (33%) than vehicles from Connecticut (27%) or some other state (24%). These findings support the notion that double parking during alternate side time periods is a local phenomenon and is practiced by many New York motorists. These motorists are likely aware that double parking is tacitly condoned during alternate side hours.

Table 5 shows parking status and duration of the parking event as a function of whether or not a ticket was issued. It may be seen in this table that 9,190 of the observed parking events were on the illegal side. Of these, 555 or 6% resulted in a parking ticket. Those vehicles receiving a ticket remained on the illegal side for an average of 125 minutes, whereas those vehicles which were not ticketed averaged only 36 minutes. Legal parkers averaged a full 174 minutes out of a maximum possible 181 minutes. These results, as expected, indicate that the longer a vehicle remains in an illegal space the greater is the risk of a ticket. Also, legal parkers do not readily move from their legal spaces. Double parkers averaged 91 minutes, and received very few tickets due to the accepted practice in New York of "allowing" double parking for the duration of the three-hour alternate side period.

Table 6, showing parking status by "time in," attempts to highlight the modal parking behavior on these blocks as implied in the previous table. First, though not shown in Table 6, legal parkers tended to be on the block at the beginning of the alternate side period and remain there for the full three hours. Approximately 99% of all legally parked vehicles observed were on the block, parked, when the observers arrived. The same was

Table 3. Parking Status by Vehicle Use and Condition.

	Parking Status					
Vehicle Use	Illegal Side	Legal	Other Illegal	Double Park	Total N	%
Private	34%	31%	1%	34%	22,415	100%
Commercial	39%	7%	3%	51%	2,482	100%
Government	52%	22%	1%	26%	198	100%
Other/Unknown	12%	78%	1%	9%	4,158	100%
Vehicle Condition						
New	39%	23%	1%	37%	2,950	100%
Average	33%	31%	1%	34%	21,504	100%
Run Down	30%	40%	1%	29%	2,026	100%
Other	11%	77%	<1%	11%	2,773	100%
			TOTAL		29,253	

Table 4. Parking Status by State of Registration.

State	Illegal Side	Legal	Other Illegal	Double Park	Total N	Total %
New York	31%	34%	1%	33%	23,016	100%
New Jersey	32%	35%	2%	31%	2,430	100%
Connecticut	29%	43%	1%	27%	538	100%
Other State	32%	43%	1%	24%	2,843	100%
Other	43%	27%	2%	28%	164	100%
Unknown	26%	43%	3%	27%	262	100%
			TOTAL		29,253	

Table 5. Parking Status, Duration of Parking Event and Ticketing.

Parking Status	Vehicle Ticketed N	%	Average Duration (mins.)	Vehicle not Ticketed N	%	Average Duration (mins.)	Other/Unknown N	%	Average Duration (mins.)
Illega.. side	555	91%	125	8,323	30%	36	312	46%	25
Legal	6	1%	145	10,333	37%	174	1	<1%	N.A.*
Other illegal	14	2%	130	318	1%	58	4	1%	N.A.
Double park	34	6%	107	8,987	32%	91	366	54%	107
Total	609	100%	127	27,961	100%	90	683	100%	69

*N.A. = insufficient data for calculation.

NOTE: Average duration calculations based on 29,055 events for which data were available, not the full sample. Maximum possible duration was 181 minutes.

Table 6. Parking Status and Event Distribution by Time In for Illegal and Double Parked Vehicles.

	Parking Status					
	Illegal Side			Double Parking		
Time In	N	%	Average Duration (mins.)	N	%	Average Duration (mins.)
Already there or, 1st 20 min.*	2,753	30%	67	5,022	54%	124
2nd 20 min.	237	3%	36	777	8%	83
3rd 20 min.	285	3%	38	682	7%	68
4th 20 min.	270	3%	37	700	8%	60
5th 20 min.	295	3%	46	631	7%	48
6th 20 min.	613	7%	51	578	6%	38
7th 20 min.	1,214	13%	42	503	5%	30
8th 20 min.	1,943	21%	27	259	3%	21
9th 20 min.	1,471	16%	10	130	1%	11
Total	9,081	100%	39	9,282	100%	54

*For a.m. sites, this is 8:00 - 8:20; for p.m. sites, this is 11:00 - 11:20.

true for only about one third of the illegal side parking events observed and about one half of the double parking events. The data presented in Table 6 are "Time In" for illegal and double parked vehicles. "Time in" is in 20 minute intervals across the three hour alternate side period. Concerning the illegals, it can be seen that only 30% were on the block already or came within the first 20 minutes. Few additional illegal parkers entered the block during the second through the fifth 20 minute periods (8:20 a.m. to 9:40 a.m. for a.m. sites; 11:20 a.m. to 12:40 p.m. for p.m. sites). This figure increased for the sixth, seventh and eighth 20 minutes decreasing slightly in the ninth 20 minute period. The pattern here is one in which the alternate side is violated early and late in the three hour period but not during the middle. Late violation is particularly interesting since it results from the local understanding or custom that once the street sweeper has past, alternate side violation is acceptable and generally is not ticketed.

Double parkers behave almost in reverse or opposite of the illegal parkers. Fully 54% of the double parked vehicles either were on the block already or entered within the first 20 minutes. As shown in Table 6, the number entering decreased steadily throughout the three hour period until the last 20 minutes when only 1% of the double parkers entered the block. Thus, common behavior is for a motorist to move his vehicle from the illegal side just prior to the three hour period. Often, this means double parking on the same block and generally he will not be ticketed during the period for double parking. Toward the end of the period, after the sweeper has passed, the motorist moves back to the illegal side and again he probably won't be ticketed. This pattern of behavior has developed in Manhattan over the years. It serves the purpose of clearing one side of the block for street sweeping while at the same time providing double parking as a place to go for the motorist.

B. Control Variables and Parking Behaviors

Of the 28 sties, half were morning or a.m. sites and half were afternoon or p.m. sites. At a.m. sites, alternate side parking regulations were in effect from 8 a.m. to 11 a.m.; at p.m. sites from 11 a.m. to 2 p.m. In addition, half of the sites were $15 fine locations and half were $25 fine locations. Blocks or sites for observation were selected such that a.m./p.m. and sanction level were counterbalanced across sites. As such, these two variables may be considered as between-site control variables. The only within-site control variable was day of week. Each site was observed on a Monday through Saturday schedule.

Table 7 shows the distribution of parking events for the three control variables. First, with respect to a.m./p.m., it can be seen that there is little difference in the two distributions. Differences are apparent, however, with respect to sanction level. The $25 locations had more legal parkers and fewer illegal and double parkers and fewer total parking events. Differences with respect to day of week are also apparent. For some reason, the percentage of motorists parking illegally is

Table 7. Parking Status by a.m./p.m., Sanction and Day of Week

	Parking Status				Total	
a.m./p.m.	Illegal Side	Legal	Other Illegal	Double Park	N	%
8 a.m.-11 a.m.	31%	36%	1%	32%	14,777	100%
11 a.m.-2 p.m.	32%	34%	1%	33%	14,464	100%
Sanction						
$15 Fine	32%	33%	1%	35%	15,445	100%
$25 Fine	31%	38%	1%	29%	13,796	100%
Day of Week						
Monday	28%	39%	1%	32%	3,689	100%
Tuesday	34%	32%	2%	33%	5,584	100%
Wednesday	30%	37%	1%	32%	5,109	100%
Thursday	33%	33%	2%	32%	4,867	100%
Friday	29%	38%	1%	32%	5,535	100%
Saturday	34%	34%	1%	31%	4,469	100%

highest on Tuesdays and Saturdays, lowest on Mondays and Fridays. Double parkers are relatively constant across the week and legal parking is the mirror image of illegal parking, being highest on Mondays and Fridays. Because of the very large sample sizes, the differences shown in all three distributions (a.m./p.m., sanction level and day of week) are statistically significant. However, the chi squared value for a.m./p.m. is only 13.7 ($p < .01$) whereas the value for sanction level is 146.7 ($p < .001$) and for day of week it is 195.1 ($p < .001$). Thus, it was concluded that only day of week and sanction level had to be included as control variables in the second phase effort.

C. Drivers

Observers were instructed to record the age, sex and race of each driver parking or leaving parking during the observation period. Obviously, any vehicle parked on the block when the observer arrived and still there at the end of the three hour interval did not produce an observable driver. This was particularly true for legally parked vehicles; only 10% of these vehicles had an observable driver. In contrast, drivers were observed for 69% of the illegally parked vehicles and 64% of the double parked vehicles.

Observed driver age by parking status is shown in Table 8. The results suggest that there is little difference between driver age as a function of parking status. The modal driver was described as being between 31 and 40 years of age with most drivers falling into the broader 26-50 age category. Statistically, the differences between legal parker age and illegal parker age were not significant ($\chi^2 = 8.42$, N.S., with 6 d.f.), though the legal-double comparison was significant ($\chi^2 = 18.43$, $p < .01$, with 6 d.f.). Nevertheless, differences are minimal and there is no evidence to suggest that any one age group is particularly prone to violation activity.

Table 9 shows parking status as a function of driver sex. The most interesting feature of this table is that at least 84% of the drivers in each category are male. For double parkers, the percentage is 87%. Statistically, the sex by parking status distribution is significant ($\chi^2 = 26.00$, $p < .001$, with 3 d.f.) with nearly all the difference coming from the increase in males in the double parking category. This result is not surprising since double parking is more common among commercial vehicles which may be presumed to have more male drivers. This table also shows parking status by observed driver race. Again, there is little difference by race across the parking status categories. The differences that do occur are between double parkers and the remaining categories with whites less likely to double park ($\chi^2 = 81.20$, $p < .001$, with 3 d.f.).

Table 8. Parking Status by Estimated Driver Age (Observation Data).

Driver Age	Parking Status			
	Illegal Side N=6,383	Legal N=984	Other Illegal N=227	Double Park N=6,048
20 or less	1%	1%	0%	2%
21-25	10%	11%	7%	11%
26-30	25%	21%	27%	26%
31-40	36%	38%	41%	37%
41-50	19%	20%	18%	17%
51-60	7%	8%	6%	6%
61 or more	2%	1%	1%	1%
TOTAL	100%	100%	100%	100%

Table 9. Parking Status by Observed Driver Sex and Driver Race.

	Parking Status			
Driver Sex	Illegal Side N=6,423	Legal N=983	Other Illegal N=228	Double Park N=6,072
Male	84%	84%	84%	87%
Female	16%	16%	16%	13%
TOTAL	100%	100%	100%	100%
Driver Race	Illegal Side N=6,357	Legal N=977	Other Illegal N=226	Double Park N=6,107
White	66%	67%	65%	59%
Black	19%	17%	14%	23%
Spanish	13%	14%	19%	16%
Other	2%	2%	3%	2%
TOTAL	100%	100%	100%	100%

D. Enforcement

Alternate side of the street parking regulations in New York are enforced by the New York Police Department (NYPD), the Sanitation Police and the Parking Enforcement Agents (PEAs) of the New York Department of Traffic. Observers were required to record any presence on the block of any of these Police or Parking Enforcement personnel. Data were collected as to which enforcement agency, when arrived, when left, number of tickets issued and whether the individuals were on foot or in a car. Across all 554 three-hour observation days, a total of 973 enforcement "visits" (i.e., separate police presence) were recorded and observers saw 569 tickets being written.

The majority of the visits (79%) were made by NYPD, followed by the PEAs (12%) and the Sanitation Police (8%). However, many of the NYPD visits probably had nothing to do with parking as the officers could have been responding to any police emergency or simply patrolling down the block. Overall, NYPD wrote an average of .52 tickets per visit as compared with .97 tickets per visit by the PEAs and .67 tickets per visit by the Sanitation Police. Number of tickets also varied as a function of whether the police presence was on foot or by car. Overall, 77% of the enforcement visits were by car and an average of .41 tickets per visit were written. The remaining visits were on foot (23%) with an average of 1.16 tickets per visit.

Timing of the enforcement visit was also a critical variable. As shown earlier in Table 6, violation activity tends to be concentrated early and late during the three hour period with few violators during the middle hour. However, by custom, vehicles are generally not ticketed after the street sweeper has passed even though they are parked on the illegal side. Thus, the best time to write tickets, and thus the best time for police to visit the block is early in the three hour period. Table 10 shows number of police visits, number of tickets written and average number of tickets per visit by time. Clearly, the most visits (46%), most tickets (71%) and highest average of tickets per visit (.91) occurred during the first hour of the three hour interval.

It should also be mentioned that these results indicate that parking enforcement in New York is relatively intense. On average, the observers recorded 1.76 enforcement visits for each three hour observation day.

E. Summary

First phase data collection was essentially a baseline effort which resulted in an elaborate description of alternate side parking behavior in Manhattan, New York City. Observers recorded 29,411 parking events and 973 enforcement visits. This section has presented some of the overall findings and has produced a description of who is parking, where and when. The results showed

Table 10. Observed Enforcement Activity.

Time In	Number of Visits		Number* of Tickets		Tickets/ Visit	
1st 20 min.	164		200		1.22	
2nd 20 min.	143	443	124	403	.87	.91
3rd 20 min.	136		79		.58	
4th 20 min.	117		36		.31	
5th 20 min.	117		66		.56	
6th 20 min.	106		29		.27	
7th 20 min.	98		18		.18	
8th 20 min.	59		17		.29	
9th 20 min.	33		0		.00	
TOTAL	973		569		.58	

*Does not include vehicles ticketed when the observer was not present (e.g., a hydrant violation ticketed prior to the alternate side time period).

that parking events were about equally divided between the legal side of the street, illegal side and double parking. Legal side vehicles tended to be there when the observer arrived and remain for the full three hour observation period. Double parkers (double parked on the legal side) came and left during the three hour period and averaged approximately 92 minutes as double parkers on the block. Illegal parkers tended to be on the block when the observer arrived but moved off the block or to double parking soon thereafter. Toward the close of the three hour interval, illegal parkers moved back such that often the illegal side was nearly full by the end of the three hour period. The observed illegal parking events which were ticketed averaged 125 minutes; those that were not ticketed averaged 36 minutes. Thus, the pattern here is one in which alternate side is violated both early and late in the period and typical movements off of and on to the illegal side are apparently designed to avoid ticketing yet ensure a parking space.

Enforcement presence is intense averaging 1.76 enforcement visits per block per day. While most of the visits are not specifically for the purpose of enforcing parking regulations, there is still more than one ticket written per block per day. Most tickets are written within the first hour.

The modal vehicle violating alternate side was a subcompact, intermediate or full size car in "average" condition and apparently for personal or "private" use. Commercial vehicles and/or trucks, while in the minority relative to all vehicles, were nevertheless much more often observed on the illegal side or double parked as opposed to legally parked. The modal illegal side driver was a middle aged white male. Few female drivers were observed regardless of parking status.

IV. RESULTS OF CHANGES IN ENFORCEMENT LEVEL

The second phase of data collection involved six of the original 28 streets. The six were all p.m. sites selected as being representative of first phase parking and enforcement patterns. As shown earlier in Table 1, half were $15 sanction sites and half were $25 sites counterbalanced across experimental conditions. The independent experimental variable in the second phase was enforcement level and was assigned as follows:

Control (2 sites) - No increase above normally occurring parking regulation enforcement

Low (2 sites) - One additional enforcement visit per day during the first half hour of the three hour period (i.e., one additional "early" visit only)

High (2 sites) - One additional enforcement visit per day during the first half hour plus one additional visit per day during the last half hour (i.e., two additional visits, one "early" plus one "late" during the three hour period)

The additional enforcement was provided by the Parking Enforcement Agents. Other enforcement agencies and PEAs not directly involved in the project did not know when or where the study was being conducted. This was necessary to ensure that the normally occurring enforcement would not change and thus the early and early-late conditions would be true increases in enforcement activity.

The study was conducted over an eight week period. The first week at all six sites was "Baseline" involving observation only. The next four weeks, referred to as "Program" involved observation at all sites and the specified increased enforcement at the "low" (early visit) and "high" (early-late visits) sites. During the sixth or "Pause" week there was no observation and no increase in enforcement. The last two weeks comprised the "Post" period during which observation only was conducted at all sites. Observers followed the same instructions, utilized the same procedures and completed essentially the same data collection forms in the second phase as were utilized in the first phase.

In all, there were 152 observation days during which 8,872 parking events were observed. Of these, 3,016 (34%) were illegal side events; 2,970 (33%) were double parking; 2,760 (31%) were legal parking; and the remainder (1%) were for other illegal events and parking status unknown. Observers also recorded 337 enforcement visits and saw 204 tickets being written. Descriptive analyses of these results were conducted in the same manner as the results reported in the previous section. The typical vehicle was, as before, a New York registered (81%), car (76%)

apparently for private use (81%) and did not get a ticket (98%). The typical driver was a white (66%), male (82%), approximately 31-40 years old (42%). Parking behaviors, vehicles and drivers appeared quite similar to the First Phase results.

The remainder of this section presents the results related to increased enforcement. First, actual enforcement as recorded by the observers is presented. This is followed by a discussion of parking behavior, changes in behavior related to enforcement and how these changes may have occurred. The section concludes with a discussion of "repeaters" as identified through matching vehicle license plates.

A. Enforcement

The primary independent variable in this study was enforcement level. From the first phase results, it was known that enforcement of alternate side regulations is intense. Observers recorded nearly two enforcement visits per block per three hour day and saw approximately one ticket per block per day being written. Much of this enforcement presence, however, was due to NYPD patrol cars that may or may not have been checking parking compliance. Even when they were checking parking, they typically stayed on the block for only a brief period of time, stopping only to write tickets. Thus, duration of police visits was one possible method for "increasing" enforcement. A second characteristic of normally occurring enforcement was that it was concentrated in the early portions of the three hour interval. Few visits (at least comparatively) and even fewer tickets occur in the last hour. This practice has arisen from local custom despite the fact that alternate side violation is heavy during the last hour.

Thus, it was felt that alternate side enforcement could be increased by extending the duration of enforcement visits and by manipulating the timing of the visits. The early-late or high enforcement condition called for two additional visits each lasting approximately 15 minutes, the early (only) or low enforcement condition called for one additional visit and the control condition called for no increase in enforcement. Actual enforcement achieved as recorded by the observers is shown in terms of frequency in Table 11 and by duration in Table 12.

Concerning frequency, the sites averaged roughly two visits per day concentrated in the first hour during the Baseline and Post periods. Unfortunately, this average was somewhat higher at the control blocks than at the experimental blocks despite the fact that all blocks were matched on enforcement level using first phase data. Tickets per day per block ranged from .5 at the two early-late sites to 2.1 at the two control sites. In terms of increased enforcement during the Program period, the control sites remained stable, the low (early only) sites remained stable and only the high (early-late) sites showed a sizeable increase in enforcement frequency. By design, there

Table 11. Average Number of Enforcement Visits per Day by Time of Visit.

No. Observation Days (Summed across both blocks)	Control (2 Blocks)			Low (Early Only) (2 Blocks)			High (Early & Late) (2 Blocks)		
	Base-line 10	Pro-gram 31	Post 10	Base-line 10	Pro-gram 30	Post 9	Base-line 10	Pro-gram 32	Post 10
Arrival Time of Enforcement Agent									
11:00-11:19	1.1*	.7	1.0	.5	.7	.7	.5	.9	.4
11:20-11:39	.2	.5	.4	.3	.6	.4	.3	.6	.3
11:40-11:59	-	.2	.2	.5	.2	.1	.2	.2	.1
12:00-12:19	.1	.2	.4	.2	.1	.1	.1	.1	.1
12:20-12:39	.3	.1	.4	.1	.1	.2	.1	.2	.2
12:40-12:59	.1	.2	-	.2	.1	.1	.1	.2	-
1:00-1:19	.3	.2	-	.2	.1	-	-	.1	-
1:20-1:39	.1	.1	-	-	-	.1	.1	.4	-
1:40-1:59	.1	.2	-	-	.1	-	-	.1	-
Total Average Visits/Day	2.5	2.5	2.4	2.0	2.0	1.8	1.4	2.9	1.1
Average Number of Tickets/Day	2.1	1.1	1.9	.7	1.4	.8	.5	2.0	.7

*Entry is average per block across two blocks.

Table 12. Duration of Enforcement Visits Across Experimental Conditions.

Duration of Enforcement Visit	Control (2 Blocks)			Low (Early Only) (2 Blocks)			High (Early & Late) (2 Blocks)		
	Base-line 10	Pro-gram 31	Post 10	Base-line 10	Pro-gram 30	Post 9	Base-line 10	Pro-gram 32	Post 10
1 min.	1.4*	1.3	.9	1.3	.9	1.2	1.2	1.0	.5
2-10 min.	1.1	.9	1.5	.5	.6	.4	.2	.6	.5
11 + min.	-	.2	-	.1	.5	.1	-	1.2	.1

*Entry is average number of Police and Enforcement Agent visits per block per day of the specified duration.

should also have been an increase at the early (only) sites though not as great as at the early-late sites. The increase was not achieved largely because of a coincident drop in NYPD enforcement at these sites. Simply, the study was coordinated through the Parking Enforcement Agents (PEAs). NYPD did not know when or where the study was taking place. PEA enforcement visits at the early (only) sites increased by 100% during the program period, but NYPD visits dropped by 33%. It is felt that this drop indicates that there is some upper limit to the number of enforcement visits which are possible under current enforcement practices. Many NYPD officers seeing a Parking Enforcement Agent on the block or seeing ticketed vehicles probably just drove by to the next block. If such an upper limit does exist, it is probably in the range of one to two visits per hour.

While the enforcement frequency data shows an increase only for the early-late sites, an examination of visit duration shows increases both for early (only) and early-late. As shown in Table 12, the early (only) sites averaged .5 visits of 11 or more minutes per block per day during the program period versus .1 visits during both the baseline and post period. The early-late sites averaged 1.2 of these long visits per block per day in the program period as compared to none in the baseline period and only .1 per day in the post period. Thus, data for enforcement visit duration shows an increase in enforcement presence at the early (only) sites and a large increase at the early-late sites.

In summary, litt[illegible] change in enforcement activity was observed at the control sites over the baseline, program and post periods. At the early (only) or low enforcement sites there was no change in the number of police visits but the visits did last longer. At the early-late or high enforcement sites there were changes both in the number of visits and in the length of the visits. Number increased from 1.4 per day in the baseline to 2.9 in the program period; long visits of 11 or more minutes increased from zero in baseline to 1.2 per day during the program period. Equally important, the increased enforcement at the early-late sites also brought with it a change in the character of the enforcement. As a matter of custom in New York, few tickets are written and few visits occur late in the three hour alternate side period, particularly after the street sweeper has passed. The "late" component of the early-late condition was a clear departure from this local custom.

B. Illegal Side Parking

The dependent variable in this study was number and behavior of vehicles parking on the illegal side of the street. Increased enforcement should have produced a reduction in the number of illegal parkers and/or some other changes in their behavior. Data for the number of parkers by week is shown in Table 13. The data suggest a downward trend in illegal side parking events particularly at the early-late or high enforcement sites. However, as shown by the statistics at the bottom of the table,

Table 13. Average Number of Illegally Parked Vehicles Per Day as a Function of Study Week.

Study Week	Control Sites (2 Blocks)	Low (Early Only) (2 Blocks)	High (Early&Late) (2 Blocks)
Baseline	17.0*	23.7	26.5
Program - 1	19.2	24.0	25.4
Program - 2	11.6	22.2	19.0
Program - 3	15.8	21.7	22.4
Program - 4	14.2	21.1	19.9
Post 1	13.8	22.5	18.8
Post 2	17.8	21.0	16.8

$\chi^2 = 5.92$, N.S., with 6 d.f.**

$\chi^2 = 8.46$, N.S., with 6 d.f.

*Entry is average number of illegal side parking events per block per day for the specified week.

**Statistics based on row frequencies, not average per day.

this trend is not statistically significant. Thus, at least with this overall measure, it cannot be shown that there was a significant decrease in the number of illegal side parking events.

Illegal side parking events were also examined on the basis of the duration of the events. It would have been possible, for instance, for the total number of events to remain stable but for the events to last for shorter periods of time in the increased enforcement conditions. Again, however, the results suggested a downward trend for event duration at the early-late sites but the results were not conclusive.

A third approach to analyzing illegal side parking behavior was to examine when the illegal side events occurred. Presumably, the increased enforcement described in the preceding paragraphs should have had its greatest effect at the early-late sites during the last hour of the three-hour alternate side interval. The "increase" in enforcement during the first hour at both the early (only) and early-late sites was minimal since the already existing enforcement was so intense. The "increase" in enforcement during the last hour at the early-late sites, however, should have represented a real change since it was a real increase and it was a departure from existing enforcement custom. Results as a function of time are shown in Table 14. They suggest an effect between enforcement and illegal side parking.

First, the data in Table 14 show a small general decrease in illegal side parking across the study periods. At the control sites, the decrease was from 17.0 (average illegal side parking events/block/day) during baseline to 15.4; 23.7 to 21.9 at early (only); and 26.5 to 17.0 at early-late. Some of this decrease is possibly due to observer presence in that regardless of how unobtrusive the observers attempted to be, some motorists must have been aware of their presence. Nevertheless, the decline at the early-late sites was greater. More importantly, the data in Table 14 show where, as a function of time, this decrease occurred. The data are based on number of vehicles on the street at specified times. For each specified time, the data entry was determined by adding the number of vehicles on the street from the last time plus the number entering illegal side parking since the last time minus the number that left. Thus, each data entry is actually the average number of vehicles on the street at that time. These data clearly show typical violation activity being high at 11 a.m., decreasing for the next two hours, and increasing during the last hour.

Control data are shown in the first three columns. Comparing the baseline week to the post weeks, it can be seen that the number of illegal side parkers decreased from 11 a.m. to noon; remained stable from noon to 1 p.m. and increased from 1 p.m. to 2 p.m. Roughly the same pattern of results across the baseline, program and post periods can be seen at the early (only) sites. For the early-late sites, the trend toward a decreasing number of illegal parkers during the program and post

Table 14. Average Number of Vehicles Parked on the Illegal Side by Time.

	Control (2 Blocks)			Low (Early Only) (2 Blocks)			High (Early & Late) (2 Blocks)			
No. Observation Days	Baseline 10	Program 31	Post 10	Baseline 10	Program 30	Post 9	Baseline 10	Program 32	Post 10	
Time										
11:00 a.m.	5.7*	3.5	4.1	5.9	4.3	4.4	3.9	3.9	3.3	
11:20 a.m.	2.0	1.1	1.2	3.4	1.4	2.3	1.4	1.8	1.2	
11:40 a.m.	1.7	1.0	1.0	2.7	1.2	2.0	1.4	1.5	1.1	
Noon	1.3	.9	1.0	2.3	1.3	2.1	1.5	1.6	1.0	
12:20 p.m.	1.0	.8	1.3	2.5	1.4	2.2	1.8	1.6	1.1	
12:40 p.m.	.8	1.0	1.3	2.5	1.9	2.4	2.0	1.8	1.0	
1:00 p.m.	.9	.9	.9	3.4	3.4	5.6	3.1	2.5	1.0	
1:20 p.m.	1.1	1.8	2.3	7.3	7.5	10.1	7.4	4.5	3.3	(p <.001)
1:40 p.m.	3.2	3.9	4.6	10.8	11.4	12.1	13.1	9.4	7.9	(p <.01)
2:00 p.m.	10.4	9.6	9.4	13.5	14.8	15.9	17.2	14.7	11.0	
Total Illegally Parked Vehicles (Average/Day)	17.0	15.0	15.4	23.7	22.2	21.9	26.5	21.7	17.0	

(p <) distribution compared to control site distribution was significant

*Entry is average number of vehicles on the illegal side on each of the two blocks at the specified time. Total is the total number of vehicles who parked on the illegal side regardless of time.

periods can be seen not only for the 11 a.m. to noon time period, but for the entire three hours. At 1:20 p.m., for instance, there was an average of 7.4 illegal side vehicles during baseline at the early-late sites as compared with 3.3 during the post period.

The chi square statistic was used to compare the baseline-program-post distributions for each specified time. Each distribution for the early (only) sites was compared to each distribution for the control sites and none was found to be statistically significant. Similarly, each distribution for the early-late sites was compared to each distribution for the control sites. The results showed no statistically significant difference for the times 11 a.m. through 1 p.m. However, the difference at 1:20 p.m. was significant ($\chi^2 = 14.41$, $p < .001$, with 2 d.f.) as was the difference for 1:40 p.m. ($\chi^2 = 13.40$, $p < .01$, with 2 d.f.). In both cases, the number of illegal side parkers decreased baseline to post at the early-late sites while there was an increase at the control sites. This result clearly suggests that the increased "late" enforcement at the early-late sites did reduce the number of illegal side parking events at least during the last hour of the three hour interval.

Several analyses were undertaken to determine whether this decrease in illegal side parking was specific to any particular vehicle or driver descriptor. It might have been, for instance, that young drivers discontinued their illegal side parking more than older drivers. In other words, increased enforcement may have had a differential impact on specific classes of vehicles or drivers. The following vehicle and driver descriptive variables were examined:

- state of registration (N.Y. vs. other)
- vehicle type
- driver age
- driver sex
- driver race

In all cases, there were no statistically significant differences when comparing across baseline, program week 1, week 2, week 3, week 4 and post periods for illegal parking events at the early-late sites for the 1:20 p.m. and 1:40 p.m. times. Thus, with respect to the above variables, it does not appear that increased enforcement had a differential effect.

It was mentioned earlier that the data collection form and procedures were virtually identical for the first and second phases of data collection. However, there was one small change which did provide some interesting results. During the second phase, observers were asked to record whether or not the driver stayed with his or her vehicle. Staying with the vehicle is a relatively common practice, particularly during the last hour. Across all sites and all periods, baseline through post, 8% of the drivers stayed with their vehicles for those vehicles on

the illegal side at 11 a.m. This increased to 23% at noon and 25% at 1 p.m. At 1:20 p.m. the figure was 26% and at 1:40 p.m. the figure was 23%. Staying with the vehicle allows the driver to save a spot on the illegal side (which will become legal at 2 p.m.) and gives the driver the opportunity of moving the vehicle should an enforcement officer visit the block.

The variable, "stayed with vehicle--yes, no" was examined both at 1:20 p.m. and 1:40 p.m. across the study weeks of the early-late sites. The comparison across weeks for 1:20 p.m. showed no significant difference (χ^2 = 10.69, N.S., with 5 d.f.) though the trend was toward increased staying with the car during the program (increased enforcement) period. The same comparison for 1:40 p.m. at the early-late sites was significant (χ^2 = 29.59, p <.001, with 5 d.f.). During the baseline period, 20% of the illegal side vehicles had a driver staying with the car at 1:40 p.m. Across the four program weeks, the figures were 37%, 47%, 42% and 36%, respectively. During the post period the figure dropped to 14% (the control sites did not show a significant change at 1:40 p.m.). Thus, one effect of the increased late enforcement at the early-late or high enforcement sites appears to have been an increased percentage of drivers staying with their vehicles during the program or increased enforcement period. Since the stay-in-vehicle driver reduces his risk of receiving a ticket, this effect suggests that drivers may have perceived a greater risk at high (early-late) enforcement sites, program versus baseline.

C. Repeaters--Prior Vehicle Presence

The license plate number for each observed parking or parked vehicle was recorded by the observers. Plate numbers, on a site by site basis, were tabulated and checked for any duplicates. Not surprisingly, the results showed that several vehicles were on the same block once a week or more. Table 15 shows the distribution of the number of times each vehicle was observed on a given block. For control and early (only) sites, 68% of the observed vehicles appeared only once, and for early-late sites 71% appeared only once. Approximately 8% of the observed vehicles appeared six or more times at all sites. The distribution of the number of parking events for specific vehicles did not differ significantly between the control sites and the early (only) sites nor between the control sites and the early-late sites. In other words, the number of "repeaters" and the amount of "repeating" was roughly comparable between the three experimental conditions. On average, each vehicle was observed approximately two times with the modal vehicle being observed only once and several vehicles being observed ten, twenty even thirty times across the three study periods.

It was hypothesized that any continued increased enforcement would have its greatest effect on drivers most familiar with the block. Thus, repeaters should be most likely to discontinue

Table 15. Distribution of the Number of Times Each Observed Vehicle Parked on a Given Block.

Treatment Condition	Control Sites (2 Blocks) N	%	Low (Early Only) (2 Blocks) N	%	High (Early&Late) (2 Blocks) N	%
Total Number of Parking Events for a Given Vehicle						
1	820*	68%	969	68%	964	71%
2	151	13%	213	15%	166	12%
3-5	130	11%	142	10%	123	9%
6-10	55	5%	56	4%	51	4%
11+	45	4%	44	3%	52	4%
	χ^2 = 4.61, N.S., with 4 d.f.					
	χ^2 = 3.80, N.S., with 4 d.f.					
Total Vehicles	1,201	100%	1,424	100%	1,356	100%
Total Parking Events	2,548		2,804		2,805**	
Events/Vehicle	2.12		1.97		2.07	

*Entry is number of vehicles with one parking event, two events, etc.

**On this and succeeding tables, license plate unknown (9%) has been excluded.

illegal side parking. The results are shown in Table 16. Control, early (only) and early-late sites are compared separately for the baseline, program and post periods. In no case are the results statistically significant. Nevertheless, results for the post period are in the predicted direction. For control sites, 42% of the illegally parked vehicles had been on the block six or more times previously. This compares with only 31% for the early-late sites.

A similar, though still not statistically significant pattern of results may be seen in Table 17. Here, only prior illegal side events are considered since any increased enforcement should have been most apparent to drivers parking on the illegal side. As shown in the table, 23% of the illegal side vehicles at the control sites had been parked on the illegal side six or more times in the past. This compares with only 16% at the early-late sites. Thus, the result is in the predicted direction though not statistically significant and no definitive conclusions may be drawn.

In summary, the primary increase in enforcement that was achieved by this study occurred at the early-late sites during the last hour of the three hour alternate side period. This increase produced a decrease in the number of illegal side parking events as measured at 1:20 p.m. and 1:40 p.m. and as compared to the control sites. This statistically significant decrease was most pronounced during the post period. Increased enforcement also led to an increase in the number of drivers who stayed with their illegal side vehicles. While this latter result does not suggest as strong a pedestrian safety benefit as the absolute decrease in the number of illegal parkers, it clearly shows that drivers were aware of the increased enforcement presence. It was possible, through vehicle license plates, to determine which vehicles were new to the block and which had been there before. These results, while inconclusive, suggested that drivers familiar with the block were less likely to violate alternate side following increased enforcement than drivers not familiar with the block.

Table 16. Prior History of Illegally Parked Vehicles (All Prior Events).

		Baseline			Program			Post		
		C	Low	High	C	Low	High	C	Low	High
N (total illegal events)		170	238	265	465	669	695	154	188	172
Distribution of Prior Events (all types)										
0	N	93	153	165	216	307	318	56	74	75
	%	55%	64%	62%	46%	46%	46%	36%	39%	44%
1	N	27	29	34	47	72	69	17	14	16
	%	16%	12%	13%	10%	11%	10%	11%	7%	9%
2	N	17	27	30	33	45	39	3	8	6
	%	10%	11%	11%	7%	7%	6%	2%	4%	3%
3-5	N	26	25	29	56	91	78	14	17	21
	%	15%	11%	11%	12%	14%	11%	9%	9%	12%
6+	N	7	4	7	113	154	191	64	75	54
	%	4%	2%	3%	24%	23%	27%	42%	40%	31%
		χ^2=6.67, N.S.			χ^2=0.89, N.S.			χ^2=2.86, N.S.		
		χ^2=4.10, N.S.			χ^2=2.27, N.S.			χ^2=5.06, N.S.		

Table 17. Prior History of Illegally Parked Vehicles (Prior Illegal Events).

		Baseline			Program			Post		
		C	Low	High	C	Low	High	C	Low	High
N (total illegal events)		170	238	265	465	669	695	154	188	172
Distribution of Prior Events (all types)										
0	N	117	179	192	270	366	378	77	86	90
	%	69%	75%	72%	58%	55%	54%	50%	46%	52%
1	N	27	40	42	62	82	76	11	21	16
	%	16%	17%	16%	13%	12%	11%	7%	11%	9%
2	N	12	13	17	35	64	55	8	12	12
	%	7%	5%	6%	8%	10%	8%	5%	6%	7%
3-5	N	14	6	14	57	100	98	23	22	26
	%	8%	3%	5%	12%	15%	14%	15%	12%	15%
6+	N	-	-	-	41	57	88	35	47	28
	%	0%	0%	0%	9%	9%	13%	23%	25%	16%
		χ^2=7.63, N.S. (d.f. = 3)			χ^2= 3.57, N.S.			χ^2= 2.85, N.S.		
		χ^2=1.66, N.S.			χ^2=6.49, N.S.			χ^2=2.71, N.S.		

V. CONCLUSIONS AND RECOMMENDATIONS

The basic research question addressed in this project was the relationship, if any, between enforcement and motorist compliance with a parking regulation. The study demonstrated that a positive relationship exists between the level and timing of enforcement and the degree and type of compliance. The experimental design called for a control condition with no increase in enforcement, an early only or "low" condition with increased enforcement only during the first hour and an early-late or "high" condition with increased enforcement during both the first and last hour. However, it appeared that the additional enforcement visits by the Parking Enforcement Agents actually deterred visits by other agencies. This problem was most severe during the first hour when visits from other agencies were most numerous. Thus, the early only condition showed only a marginal increase in the number of visits, though there was an increase in the duration of the visits. The early-late condition produced an increase in the duration of the visits and an increase in the number of visits, particularly during the last hour.

Significant primary and secondary effects of increased enforcement were shown at the high (early-late) enforcement sites only, although data at the early sites suggested the same direction of effects. The primary effect demonstrated at the early-late sites was a significant reduction in the number of illegal parking events occurring in the final hour of the parking ban. This effect was most pronounced in the post period, suggesting that once developed, the effect of enforcement on parking compliance is persistant, at least for several weeks.

Stated more generally, the primary effect indicates that increased enforcement can improve compliance with a time-phased parking regulation. However, although this finding is generalisable, it is subject to the following qualifications:

- Only a short duration, time-phased parking regulation was studied
- The setting was urban and residential, with demand exceeding supply for parking
- Sanction levels must be similar to those studied (e.g., $15 - $25 fine--no routine towing)
- Enforcement visits must be time-controlled (i.e., both incidence and duration of visit must be specified)
- Parking behavior and enforcement patterns must be ingrained--parkers must have a firm expectation of existing enforcement strategies and parking availability and cost

Increased enforcement also led to an increase in the number of drivers who stayed with their vehicles on the illegal side. While this result does not suggest a strong pedestrian safety benefit, it clearly shows that drivers were aware of the increased enforcement presence. It was possible, through vehicle license plates, to determine which vehicles were new to the block and which had been there before. These results, while inconclusive, suggested that drivers familiar with the block were less likely to violate alternate side following increased enforcement than drivers not familiar with the block. This secondary effect taken together with the primary effect, discussed earlier, suggests that the likely effect of parking enforcement 1) develops slowly, 2) extinguishes slowly, and 3) depends on the timing of the enforcement visits (relative to violation activity).

Another conclusion supported by this research is that the observed enforcement effects can apparently be achieved without significant manpower increases. This study showed that the effectiveness of enforcement (vis-a-vis compliance) could be increased by deploying existing personnel so that they are visible to the greatest number of violators. This measure can be implemented (and was in this study) by controlling the time and the duration of the enforcement visits to coincide with peak occurrence of violations. However, since alternate side violations are concentrated during the first and third hours of the regulation over the entire borough, there would be far too many block locations to attempt to visit all in the same periods. Alternatively, existing personnel could be deployed to selected blocks during the target hours with the specific locations differing each day*. This would insure that enforcement on a particular block could not be predicted by residents. Moreover, since the effects appear to be persistent, an increased level could likely be maintained on virtually all blocks by rotating personnel according to a defined plan.

The final conclusion has direct bearing on the pedestrian safety environment. This research suggests that time-phased parking bans do have potential impact on dart-out pedestrian accidents. Even in an urban setting where the demands for parking greatly exceed the supply of legal parking, compliance was improved through increased levels of enforcement. Previous research suggested that the removal of on-street parking may be an effective countermeasure against dart-outs, and this study indicates that improved compliance with on-street parking bans can be achieved with time-controlled enforcement.

Several recommendations are offered based on the findings and conclusions of this study. Each is first indicated and then

*Currently duty tours are scheduled on a fixed territory basis to enforce all types of parking regulations; starting points in the territory are varied so that the arrival time of a PEA to a particular block would also vary.

discussed in this closing section.

First, and foremost, this study has demonstrated that positive changes in motorist compliance with a time-phased parking ban can be achieved through manipulation of enforcement. Moreover, it would appear that enforcement strategies can be developed which produce significant compliance improvements without greatly increasing personnel costs. Therefore, time-phased parking bans appear to be an operationally viable countermeasure approach. However, the ultimate benefit to pedestrian safety of removing on-street parking has yet to be demonstrated. It is currently being intensively researched on another NHTSA contract. If this research proves the merit of parking removal, it would be beneficial to examine in more detail the specific elements, including enforcement and sanction levels, to be recommended as part of a total countermeasures package.

Second, if parking removal is to be examined further as a pedestrian countermeasure, short term bans, such as the one studied by this project, should be given specific consideration. They might be used, for example, in the areas and at times of high dart-out incidence. Any consideration of short term bans would be best conducted in addition to and in conjunction with further examination of the model regulation removing parking in new or redeveloped areas (Blomberg, Hale and Kearney, 15).

Third, the in-depth examination of parking behaviors which resulted from Phase I or baseline data collection suggests that if a short term ban is employed, the duration of the ban should exceed the "target" time for removal of parking. The specific recommendation is that the ban should be extended for at least one hour before and after the time of interest in order to maximize compliance during the critical period without changes in enforcement.

Fourth, adjusting the timing of enforcement visits can reduce the need for extending the duration of the ban. Since violations tend to be greatest during the hours involving changing to or away from the short term ban, a community has the choice of designing those hours to fall in a non-critical period or to time enforcement activity for those hours just after the ban takes effect or just before it expires.

Finally, the relationship between the type and severity of sanction on parking compliance should be investigated. Sanction level was a control variable in this study and as such, was explicitly excluded from the scope of the experiment. Nonetheless, parking behaviors observed in Manhattan and anecdotal evidence from the media and elsewhere suggest that sanction level, especially of such high severity as routine towing, may have significant effects on a driver's decision to violate parking regulations.

APPENDIX A

REVIEW OF THE LITERATURE AND LIST OF REFERENCES

A survey of the open literature was conducted in the Fall of 1975. The primary objective of the search, at that time, was to identify studies which had dealt with relationships among law enforcement, driver compliance behavior and driver perception of risk, within the context of parking regulations. Beginning with a computerized search of the NHTSA literature file, an extensive review of the literature, encompassing a broad range of topics, was conducted. In general, previous research did not address the specific concerns of this study and offered few findings of direct relevance.

There is no coherent body of knowledge which exists regarding the effects of enforcement on parking compliance behavior but there is a considerable amount of related information. The following summary discusses possible applications of findings conducted in other research contexts to the parking enforcement concerns of this study.

A. Parking Regulation and Violation

The purpose of parking restrictions and regulations traditionally has been to facilitate the safe movement of traffic on the roadway and to ensure the equitable use of curb space. Traffic concerns underlying parking control have generally emphasized vehicular traffic although, more recently, evidence has been accumulating on the significant pedestrian hazard represented by on-street parked vehicles (15).

Parking is typically defined as "the standing of a vehicle, whether occupied or not, otherwise than temporarily for the purpose of and while actually engaged in loading or unloading property or passengers" (see the Model Traffic Ordinance, Uniform Vehicle Code). Most simply, parking is vehicle storage, and as such, it is usually afforded a relatively low priority in traffic law enforcement. The Traffic Institute of Northwestern University makes it clear that while parking is a necessity, it must be regulated to ensure that in the use of road space the safe, orderly movement of vehicles takes precedence over their storage.

Parking regulation as an enforcement task is not emphasized in the law enforcement literature nor has it been a focal point for much basic research. Parking enforcement appears in an illustrative role in the literature having to do with deterrence in general, and in the deterrent effects of punishment. It is the prime example of the "opposite end of the spectrum" from the most serious, violent crimes against society.

Only two experiments directly involving parking behavior were identified and reviewed. The 1943 Moore and Callahan (91) studied public reactions to changes in parking regulations proved to be of no value to this study. According to Andenaes (3) Moore and Callahan's "well known study...(is) more remarkable for its methods and its theoretical basis than for its results." The other study was conducted in the 1950's at a mid-western university by

Chambliss (28). This study involved a specialized group (faculty and students) of parking violators, but as Chambliss pointed out, "...at least in this limited area, an increase in the severity and certainty of punishment does act as a deterrent to further violation." It is interesting to note that the impact on the attitudes and behavior of parking violators was reported to be greatest in the group of repeat violators. There was little measured effect on "seldom" violators but those who reported "frequent" or "occasional" violations also reported the most drastic change in parking behavior.

Chambliss' study is mentioned here principally because it is one of a few intensive investigations of parking behavior. However, it was conducted more as a study of "deterrence" and did not try to examine the separate effects of a comprehensive program of public education, increased enforcement and greatly intensified severity of sanction. Other investigations in the general field of punishment and deterrence have information to offer concerning the parking violator, even though they may not have emphasized this specific type of offender in their study. Each of the following highlights a relevant general concensus among researchers, e.g., Andenaes (2,3), Chambliss (28,29), Cramton (39), Ross (123) and Zimring & Hawkins (160).

- The deterrent influence of punishment and the nature of deterrent effects differ according to the type of offense. Two basic kinds of offenses may be regarded: 1) expressive acts, such as murder, contain more emotional aspects and are more resistant to deterrence by punishment than are 2) instrumental acts, such as illegal parking, based on more rational thought, are more likely to be influenced by punishment.

- Illegal parking has been termed by Ross and others as a "folk crime." This means that the population that engages in illegal parking is virtually a replication of the entire adult community.

- Ross also suggests, as reported by Cramton (39), that "as traffic offenses become more serious (along a spectrum from parking to moving violations to reckless driving to drunk driving to negligent homicide), the group of offenders becomes more and more similar in its occupational and status characteristics to the criminal population engaged in offenses against persons and property."

- Andenaes (2) agrees with Ross and extends an application of this phenomenon to enforcement. He believes that as "enforcement of a law becomes more effective and penalties for its violation become stricter, the class of lawbreakers becomes more abnormal."

- Cramton (39) describes parking as a rational activity in the following way. "The choice of a particular park-

ing space is controlled largely by considerations of convenience. Free parking near the driver's destination is preferred, but different combinations of paid parking or remote location are available if the cost or inconvenience of nearby parking increases. The parking fine tends to be viewed as a cost of doing business roughly equivalent to a commercial parking fee."

B. Perceived Risk of Detection

There is a widely-held belief that the perception of risk of being detected is the deterrent and not the actual risk of being detected as a violator. Andenaes (3) states this clearly and emphatically: "The decisive factor in creating the deterrent effect is, of course, not the objective risk of detection but the risk as it is calculated by the potential criminal" or violator. Cramton (39) in his discussion of unwanted parking behavior does not make a distinction between "objective" and "perceived" risk but a relationship between the two is implied in the following:

> "If the fine is sufficiently low, or a low apprehension rate effectively reduces the per-unit parking cost, many persons will violate the law rather than use alternatives; there is no intense motivation to engage in the prohibited behavior...; other choices generally exist and will be preferred if violation is more costly or inconvenient."

Cramton (39) states later in his report that the "...effectiveness of a legal sanction depends, first, and more importantly, upon the perceived risk of apprehension and conviction, and second, upon the severity of the penalty." In the case of parking offenses, both apprehension rates and penalties are frequently low. Although Andenaes (3) warns that the evidence suggests that "...the lack of enforcement of ... laws designed to regulate behavior in morally neutral fields may lead to mass infringements," he also suggests that parking violation behavior may be an exceptional case. He believes that often the parking violator "...accepts the penalty as a reasonable price for carrying out the action."

No data were uncovered concerning how the driver's perceived risk of detection is created nor how his perceived risk influences his parking behavior. According to Fennessy (51) (and also appearing throughout the enforcement literature) the primary objective of traffic law enforcement is to create deterrence to potential violators through development of appropriate negative or avoidance actions on the part of drivers. Enforcement is frequently presented as the tool by which driver perceptions of risk are created but the relationship between the two is little understood. Milward (90) adds that drivers act on the basis of "their (own) estimates of the risk of being detected and apprehended..." and their own "...estimates of the certainty and degree of penalty which will be assessed upon being apprehended." He further states that "enforcement creates these perceptions" by observational effect and via reputation.

C. Effects of Enforcement

There is a large body of literature on enforcement--its effects and effectiveness--Council (36), Gunnarsson (57), Michaels (89), Joscelyn (75), Shumate (132), Smith (139) and Syvanen (144). Although the research has concentrated on assessing the effects of enforcement on moving violations, and especially with regard to speeding behavior, some findings are relevant in a general sense, to a parking enforcement study. However, their usefulness is essentially limited to identifying measures for which enforcement yielded a significant impact, and to findings regarding the magnitude and duration of impact of enforcement. Typically, the particular enforcement practices and techniques, and the experimental plans employed are not germane to the enforcement of parking regulations.

In addition to a sizable body of research, several excellent reviews of the general literature regarding the effects of enforcement exist. The interested reader is referred to 1) Cooper's (33) 1974 study entitled, "Effectiveness of Traffic Law Enforcement," 2) Joscelyn's (74) 1971 study of the effects of law enforcement on traffic flow behavior, 3) A. D. Little's (1) 1970 up-dated edition of "The State of the Art of Traffic Safety" and 4) Fennessy & Joksch's (51) 1968 evaluation of the police traffic services literature. It would serve no constructive purpose to reiterate, here, such research abstracts and reviews; rather, it would be more useful to synthesize that which is generally believed about enforcement and may have applicability to the enforcement of parking regulations.

- The objective of traffic law enforcement is to obtain compliance with safe driving practices by a majority of drivers.

- Enforcement activity strives to create a feeling of surveillance that will encourage most drivers to comply.

- Enforcement agents have certain punitive, persuasive and preventive methods that are designed to modify driver behavior in desired directions.

- Enforcement activities are directed principally at violators of traffic law. Increases in enforcement can increase the violation detection rate which probably, in turn, increases the number of citations issued. This may or may not lead to a reduction in the actual rate of violations, but even if it does, what effect a lower rate of violation will have on the accident rate is not known.

- In the case of speeding behavior, studies generally have shown significant responses to increased levels of enforcement. Typically, the average speed, the number of speed violators as well as the variance of the speed

distribution will be reduced in the vicinity of the enforcement presence.

- The duration of effects of enforcement presence are usually short-lived. Cooper (33) found enforcement increased compliance during police presence, but found no evidence of any "learning" behavior and observed that driver behavior tends to return, "instinctively," to original characteristics following cessation of enforcement. Fennessy (51) reports evidence that effects extending beyond the enforcement presence be observed with hidden enforcement techniques such as unmarked patrol cars.

- There is general agreement that the effectiveness of enforcement is not uniform over all types of violations. Cooper (33) suggests that violations which may be regarded as low severity with respect to safety risk are most affected by enforcement activity.

- The relationship between enforcement and traffic accidents is still undefined but the belief prevails that enforcement promotes traffic safety behavior, and thereby reduces accidents.

- Observational effects of enforcement are dependent upon 1) the strength of the enforcement symbol, and 2) the frequency with which drivers view the symbol.

- The reputation of effective enforcement is created by a steady, active enforcement program over a long period of time. According to Milward (90), via this reputation effect, drivers develop the feeling that their risk of being apprehended is high and "if the estimate of risk is high, drivers do not take the chance of being caught frequently."

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APPENDIX B

ANNOTATED BIBLIOGRAPHY

NOTE: Each bibliographic entry describes the contents of one of the asterisked items in the List of References, contained in Appendix A. The same reference numbers are used in both appendices to facilitate access to the report descriptions from the List of References.

1. A. D. Little, Inc. The state of the art of traffic safety. New York: Praeger Publishing, 1970.

A brief history concerning the state of the art of traffic safety cited several traffic studies which suggested the concept of increasing patrol activity as an enforcement tool. The concept that increased police enforcement will decrease traffic accidents has not been verified and has been difficult to study due to natural variations in accident rates. However, evidence is accumulating in support of increased police activity as an effective enforcement tool. Study results of this nature have tended to be inconclusive due to the numerous attempts to relate patrol activity intensity to a variety of different measures of driver behavior. More recent studies have attempted to identify the specific manner in which enforcement activity should be carried out and how enforcement resources could be best utilized. Since few attempts have been made to determine the effect of different levels of enforcement on accident rates, the study recommended that further research be directed to that area. The only specific conclusion stated in this report's chapter on "enforcement" was that enforcement action should create within the driver the illusion that he is under surveillance. This is thought to encourage the vast majority of drivers to follow a pragmatically accepted body of rules. The traffic safety review cites a 1965 International Association of Chiefs of Police Conference in which a strong feeling of patrol intensification for traffic supervision was revealed. Theoretical solutions to the problem are difficult to offer. Although greater and intensive patrol activity seems to produce greater driver compliance, this benefit should be assessed against the costs of increased enforcement.

3. Andenaes, Johannes. The general preventive effects of punishment. University of Pennsylvania Law Review, 1966, 114(7), 949-983.

The article focuses on the concept of general prevention while discussing the deterrent effects of punishment. A distinction is made between special or individual prevention and general prevention which contrasts effects on the person being punished versus effects on members of society in general. The latter type of prevention, and subject of the article, is described as the set of restraining influences emanating from the criminal law and the legal machinery. Further, while the effects of special prevention depend upon how the law is implemented in each individual case, general prevention occurs as a result of the interplay between the provisions of the law and its enforcement in specific cases.

The article deplores the neglect of research, to date, in investigating the effects of general prevention, and explains five erroneous inferences about general prevention which have persisted. Building upon these observations, the article then considers in some detail each of several "principles" of general prevention. First, it is pointed out that the deterrent effects of punishment depend upon the specific type of offense. In general, the more rational and normally motivated a particular violation may appear, the greater the importance of criminal sanctions (as opposed to moral restraints). Second, there are significant differences among people in their receptiveness to the general preventive effects of the penal system. Third, there are differences among societies. In general, the larger, more developed, urbanized societies rely more and more on legal control rather than informal social pressure. Fourth, conflicts between group norms and the law will influence the effects of sanctions. Finally, the degree of compliance with laws found among law enforcement agencies influences the effectiveness of laws.

The article then explores factors affecting each of three conditions which deter individuals from committing a punishable act: 1) moral inhibitions, 2) fear of peer censure and 3) fear of punishment. In the case of "fear of punishment", Andenaes strongly asserts that the deterrent effect is created not by increasing the risk of detection but by increasing the perceived risk of detection in the mind of the potential lawbreaker.

Concepts discussed in this article have wide applicability to a range of studies involving deterrence, sanction level, law enforcement, etc. In addition, the severity of penalties and the risk of detection, apprehension and conviction are discussed in some depth, ending with consideration of some ethical problems involved.

5. Andenaes, Johannes. Deterrence and specific offenses. University of Chicago Law Review, 1971, 38, 537-553.

The author contends that past debate concerning general evidence of deterrence resulting from punishment is no longer warranted. His argument is that it is not a question of whether or not punishment has deterrent effects but rather under what conditions and to what extent deterrence is effected. Two degrees of deterrence are distinguished: general deterrence (threat of punishment) and special deterrence (imposition of punishment). The author employs these concepts to discuss differences between his and Chambliss's views. Chambliss had been critical of the utility of these concepts since he felt they were so difficult to control in empirical research. Andenaes, however, felt that

Chambliss had actually proved the utility of these concepts by ignoring them in his research, and according to Andenaes, reaching mistaken conclusions because of it. Although Andenaes criticized Chambliss' use of the concepts of "expressive" versus "instrumental" acts as having little application in analytic method, he did concur that deterrent effects differed according to the type of offense. This article discussed the general deterrent effect of punishment in relation to three specific offenses--infanticide, criminal abortion and drunken driving--in addition to six offenses previously considered by the author in another article.

8. Baker, J. S. Effect of enforcement on vehicle speeds. Highway Research Board Bulletin 91, January 1954, 33-38.

This article summarized information on the effects of enforcement but it was written more than twenty years ago. The following key points were discussed.

- Police activity on highways works in the following ways: 1) visible presence is immediate deterrent, 2) belief on part of drivers that speeds are enforced (no visible police) and 3) general belief that community enforces its laws, including speed laws, stimulates compliance.

- How much enforcement necessary to produce the belief necessary to get compliance?

- Small sample pilot studies suggest: 1) standing patrol car appears to cause some slowing before and after overtaking in the same direction; no effect on traffic in opposite direction, 2) effect moving police vehicle limited to 1,000 feet or less ahead and only a few hundred feet behind and 3) Chicago study: somewhat more than doubling arrests for hazardous traffic violations (because of greater enforcement) resulted in slightly less than halving the excess speed per vehicle, night speeds responded more to additional enforcement than day speeds (were higher to begin with).

18. Calabresi, G. Optimal deterrence and accidents. Yale Law Journal, 1975, 84(4), 656-671.

A theoretical article dealing with legal liability factors and their effect on deterrence. The author discusses various methods of assigning liability in auto accidents and how they affect the goal of optimal deterrence. The article

addresses the following issues and considers how each relates to the goal of minimizing accident and accident prevention costs:

- the fault system and its no-fault assumption
- negligence
- contributory negligence
- assumption of risk
- the strict liability approach
- the role of collective deterrence

An interesting exploration of the effects of alternative assignments of liability, but this article is not directly relevant to the considerations in this project.

28. Chambliss, W. J. The deterrent influence of punishment. Crime and Delinquency, 1966, 12, 70-75.

A strong argument was presented for ending the dispute over the deterrent effects of punishment. Chambliss criticized the tendency for discussions concerning the deterrent effects of punishment to turn into debates over the morality of capital punishment. The article focused on a study of parking violations on a college campus, which suggested the inference that "punishment does deter." However, Chambliss quickly pointed out that this study supported the opposite conclusion from previous studies of murder which suggested that "punishment does not deter." The general conclusion drawn, therefore, was that the apparent conflict was due to dealing with specialized groups of offenders in both instances. A related recommendation was that research be directed away from attempting to generate all-encompassing answers. Instead, it should focus on examining those circumstances under which particular types of punishment do in fact act as a deterrent and those circumstances under which particular types of punishment have little or no effect.

29. Chambliss, W. J. Types of deviance and the effectiveness of legal sanctions. Wisconsin Law Review, Summer 1967, 703-719.

A hierarchical typology was developed for classifying alternative forms of deviate commitment to criminal behavior--instrumental and expressive. A criminal action is instrumental if it is performed to attain some goal and not because it may be pleasurable in and of itself. An action is expressive if it is performed because it is pleasurable, in and of itself, and not because it is a route to some other goal. Deviant behavior types were identified by their de-

gree of commitment to crime. A personality whose commitment to crime is high may have been influenced by 1) a perception of some sort of external group pressure, 2) a criminal self perception or 3) a lifestyle patterned around criminal actions. Personalities with low commitment may be described as the opposite of the high commitment personality. When a high commitment to crime motivates an expressive criminal action, deterrence through threat of punishment is least effective. Deterrence would be maximally effective when the individual's commitment to crime is low and the action is instrumental. Empirical data and typological examples which supported this contention were offered for specific legal problem areas: capital punishment, drug addition, parking regulations, white collar crime and thievery. Illegal parking behavior was described as instrumental and effectively controlled when the perceived risk of detection and the knowledge of the severity of the penalty and its consequences were at a maximum. However, no empirical data was presented which offered any evidence of how the driver's perceived risk of detection is created, nor the manner in which his perceived risk influences his parking behavior. The conclusion is that current legal practices negligably deter those persons whose criminal actions are principally expressive. The system also fails to properly impose sanctions on instrumental type offenders due to the fact that current statutes fail to take into account the instrumental or expressive character of criminal acts when levying sanctions. It is proposed that future law makers take empirical data into account when translating social policies into law.

31. Claster, Daniel S. Comparison of risk perception between delinquents and non-delinquents. Journal of Criminal Law, Criminology and Police Science, 1967, 58, 80.

This article reports the results of a survey conducted to measure possible differences in perception of risk between two groups--delinquents and non-delinquents. The study found a significant difference in the self perception of the two groups, with the offender having a distorted view of himself in terms of his relation to the real world. Delinquents believed enforcement action taken against others, and even, themselves as having no deterrent effect because they delude themselves into thinking they will not be caught (again). Even when the delinquent is apprehended for an offense, he typically denies the facts of arrest and dwells on times when he may have escaped detection.

33. Cooper, P. J. Effectiveness of traffic law enforcement. Canada, Ministry of Transport, Road and Motor Vehicle Traffic Safety Board, 1974.

This study investigated the effects of varying levels of police enforcement on driver behavior and safety at urban intersections. It attempted to define both the relationship between enforcement and driver behavior, and then, the relationship between driver behavior and accidents. Although this study yielded many significant findings, and represented one of the best studies of its kind to that time, it did not determine the actual relationship between enforcement and accidents.

Despite this limitation, increased police enforcement was shown to have a significant effect on driver behavior at one half of the intersections studied. Driver behavior at these intersections exhibited changes of an immediate and short-lived reaction to obvious police presence. While the data did not support a direct link of these behavioral changes to probable accident reductions, it appeared that the types of driving behavior most likely to lead to conflicts and accidents were affected less by enforcement than were the more innocuous types of violations.

Finally, the results suggest that short term benefits can be achieved from increases in enforcement level, the law of diminishing returns may well be operative in that the most significant effects are likely to result from initial increases at low surveillance levels with further increases producing little additional benefit.

36. Council, F. M. A study of the immediate effects of enforcement on vehicular speeds. University of North Carolina, Highway Safety Research Center, 1970.

This study examined the effects on vehicular speeds of two types of enforcement symbols in or adjacent to the traffic stream on rural roadways. The enforcement units of the North Carolina Highway Patrol were: 1) a single stationary patrol vehicle parked adjacent to the roadway and visible to oncoming traffic; and 2) a single patrol vehicle moving with the stream of traffic. The effect of the two symbols was measured by changes in traffic of mean speeds, speed variances, the percentage of vehicles traveling at speeds above the posted speed limit and the percentage of vehicles traveling at speeds above the posted speed limit plus a 5 mph tolerance. Data were collected approximately 1-3/4 miles upstream from the patrol unit and 1-3/4 miles downstream from the unit. Analysis of changes in the above stated measures resulted in the following conclusions.

- There were reductions in mean speed, variance and in the percentage of vehicles traveling above the posted speed limit and the speed limit plus tolerance when the stationary unit was employed on all test tracks under all test conditions.

- There was no significant change or a significant increase in the corresponding measurements between the upstream and downstream points when the moving patrol unit was introduced into the traffic stream.

40. Cramton, R. C. Driver behavior and legal sanctions: A study of deterrence. Michigan Law Review, 1969, 67(421), 421-454.

This article summarizes the "state-of-the-art" or concensus of opinion regarding 1) the deterrent effects of legal sanctions, 2) the effects of legal sanctions in controlling driver behavior and 3) the methods available for developing needed new knowledge.

Excluding the effects of capital punishment, little research has been directed at identifying the effectiveness of legal sanctions in achieving their goals. The distinction between general deterrence (overall influence on general population) and special deterrence (effect of punishment on the particular person who experiences it) was introduced followed by an in-depth discussion and concentration on general deterrence alone. The one conclusion drawn regarding the two forms of deterrence states: "...the general deterrent effect on the punished individual in the future is likely to be different than it is with the remainder of the population..." Although there is little doubt that punishment can modify human behavior, the types of behavior and the specific circumstances influencing the effects are not well defined.

Legal scholars have, however, summarized factors influencing the effects of legal sanctions on the behavior of the population. First, the existence of a law exercises a moral and educative influence on many people. Second, persons not influenced by moral suasion may be deterred by the fear of consequences of disobeying the law. In this context, Cramton as does many others, emphasizes that it is the individual's perception of risk, rather than the objective risk of apprehension that actually deters. Third, it is believed that if fear and moral influence are instilled at an early age, unconscious inhibitions are often created which can make lawful and desired behavior habitual behavior.

There are many other factors affecting deterrence which include those relating to the nature of the violation or to the

timing of rewards and penalties. For example, legal sanctions have proved to be very effective in the enforcement of parking regulations. Cramton characterizes parking as a rational activity, controlled largely by considerations of convenience and cost. As such, it is generally believed that increases in either apprehension rate or level of fines will produce measurable reductions in the incidence of illegal parking.

42. Dart, O. K., Jr., & Hunter, W. W. Evaluation of the halo effect in speed detection and enforcement. Highway Safety Research Center, University of North Carolina, 1976.

Report of an experiment involving four enforcement treatment conditions plus one control treatment. The test was conducted to determine if specific treatments on a two-lane rural roadway could extend the halo effect. This study was conducted simultaneously with a study to evaluate a visual speed indicator (VSI). By combining use of the VSI device with and without the presence of police enforcement, five-treatment experimental designs were employed.

Speed characteristics obtained for each treatment and replication were analyzed, and the following primary results and conclusions were noted:

- All enforcement treatments caused substantial reductions in all measures of speed, while the VSI treatment produced only a minor reduction.
- There were no significant differences among the three enforcement techniques and between the activated VSI sign and the control condition.
- The use of a speed enforcement scene, a speed-check zone, or a parked patrol vehicle produces significant reductions in speeds in the vicinity of the enforcement unit.
- All three enforcement techniques reduced the number of drivers exceeding the speed limit (55 mph), increased the number driving below the minimum speed (45 mph) and reduced the variability of speeds at the enforcement location.
- The VSI sign had no significant effect on vehicle speed and was no substitute for actual enforcement activity.
- The halo effect began to disappear at 1,000 feet past the enforcement treatment and was completely gone at a point 2 miles downstream.

49. Epperson, W. V., & Harano, R. M. An evaluation of some additional factors influencing the effectiveness of warning letters. Sacramento, Calif., Department of Motor Vehicles, 1974.

The primary objectives of the study were to determine the effectiveness of two types of warning letters and an informational pamphlet in reducing the subsequent collision and conviction records of pre-negligent drivers. An additional study objective was to determine the effectiveness of a follow-up reinforcement letter sent to collision and conviction free drivers. The results six months subsequent to treatment showed no significant treatment effects on convictions, but a positive pamphlet effect on collisions. The follow-up reinforcement analysis for collision and conviction free drivers showed no significant treatment effects on collisions. On convictions, however, there was a main effect attributable to type of warning letter as well as an interaction between type of warning letter, pamphlet condition, and follow-up reinforcement.

54. Galioto, A. J. Effect of curb parking on intersection capacity. The Port of New York Authority.

To increase the traffic capacity through signalized intersections, many traffic engineers have resorted to complete prohibition of parking on heavily traveled arteries. As a consequence, appropriate regulations have been adopted under which parking can be restricted for various reasons.

This study attempted to show, through quantitative evaluation, the effects on intersection capacity, of varying lengths of clear distance adjacent to an intersection. By controlling conditions at the study intersection, factors influencing capacity, such as pedestrian and parking maneuvers, are kept to a minimum in order to more accurately establish the relationship between clear distance and intersection capacity.

The results as they pertain to the specific intersection involved are that maximum volumes of traffic can be moved through an intersection without complete prohibition of parking, and that on the approach the clear distance adjacent to the intersection required for maximum volumes is related to the percentage of turning movements.

55. Gardiner, J. A. Traffic and the police: Variations in law enforcement policy. Cambridge, Mass.: Harvard University Press, 1969.

Report of a survey of 500 responding cities (populations ≥ 25,000) which examined traffic law enforcement practices and variations nationwide. Comparisons are made, using the case study approach, of traffic law enforcement in several Massachusetts communities with the national results. The author found that high enforcement activity (indicated by the volume of ticketing) was associated with the existence of a specialized traffic law enforcement group within the police department. Conversely, low ticketing was associated with the attitude that traffic law enforcement is of relatively low importance.

57. Gunnarsson, S. O. Investigation into the effects of intensified police surveillance on driver behavior. Chalmers Tekniska Hogskola, Institutionen for Stadsbyggnad Meddelande, 1972.

Results of an investigation into the effects of intensified police surveillance on driver behavior at signalized intersections indicate a change to more defensive driving. During periods of police supervision average speeds dropped 35 meters before the stop line for stopping drivers, who are directly affected by the signal change from green-amber to red, and for drivers who must stop because the signal shows red. Traffic signal violations dropped from 23% to 9.2% of the number of vehicles which were 40-100 meters from the stop line when the signals changed to green-amber. Periodic visible police supervision evenly distributed over different supervisable behavior patterns, traffic signal coordination, trials of optically programmed signals, which provide road user with only the relevant information and changing signals from the present green-amber phase to amber only are recommended.

60. Hall, W. K., & O'Day, J. Causal chain approaches to the evaluation of highway safety countermeasures. Paper presented at the 37th Annual ORSA Spring meeting, April 20-22, 1970, Washington, D.C.

Remarks address the development of a systematic procedure for the evaluation of highway safety countermeasures. This task has been difficult to accomplish because of tremendous complexity of the traffic accident and injury occurrence process which confound the measurement of the causal factors underlying these phenomena. Current approaches depend on

evaluation during project planning, project implementation, and later during project implementation: 1) expert judgment (most commonly used) but contains built-in bias, and 2) use of historical data--controversial--but useful in suggesting research hypotheses. Proposed "causal chain" approach involves: 1) systematically considering the etiology of the occurrence process and considering how a countermeasure program influences etiology, and 2) modeling the occurrence process as a finite sequence of time-dependent events makes the process more easily analyzed and can isolate potentially confounding factors at each element.

74. Joscelyn, K. B., Goldenbaum, D. M., & Bryan T. A study of the effects of law enforcement on traffic flow behavior. Bloomington, Indiana: Indiana University, Institute for Research in Public Safety, 1971.

Results of a study on the reactions of traffic flow to police vehicle stimuli are presented: both moving and stationary state police vehicles were used in an investigation to determine their effects on a variety of traffic flow measures. Six stationary enforcement vehicle configurations, representing various intensities of police activity, were included. A special computer-sensor system was used to collect and to store traffic flow data. Both mean speed and percentage of speed violators were affected by the enforcement vehicles. In terms of absolute reductions in these measures, the immediate effects were more pronounced for the more-threatening than for the less-threatening, stationary vehicle configurations. Principal findings were: 1) presence of stationary police car decreased significantly both speed of traffic flow and proportion of speed violators, 2) amount of decrease varied with traffic density; varied in proportion of "perceived severity" of symbol. But effect of the more severe symbols tended to taper off more quickly than the effect of less severe symbols, and 3) moving police car had somewhat less of an effect and tended to be of shorter duration.

75. Joscelyn, K. B., & Jones, R. K. A systems analysis of the traffic law system. Bloomington, Indiana: Indiana University, Institute for Research in Public Safety, 1972.

Systems analysis concepts were applied to define more precisely the objectives of the traffic law system and to identify alternatives and modifications that would allow the system to manage risk more effectively. The study focused on the operation of the system on man in his role as a driver. The authors discussed three important factors influencing compliance: 1) efficiency of law as a deterrent, 2) the

educational aspects of the law and 3) public opinion or the amount of respect for laws. In addition, the power to impose negative sanctions greatly enhances the effectiveness of laws especially in cases where the violator is insensitive to moral suasion or to the nature of the law. In such cases, according to the authors, the would be violator must be deterred by the fear of consequences. Most potential violators make a rational choice not to engage in contemplated conduct because the risks of apprehension are too great or the punishment is too severe, or both. However, it is emphasized that it is the individual's perception of these risk factors, rather than the objective circumstance itself, that actually deters.

83. Levis, A. H. Urban street cleaning. Final Report, February 1975, Polytechnic Institute of Brooklyn, Department of Electrical Engineering and Electrophysics, Grant No. R800938, U. S. Environmental Protection Agency, Office of Research and Development, National Environmental Research Center, Cincinnati, Ohio. PB 239-327.

This report presents the results of the analysis of mechanized street cleaning in urban areas. It describes a data bank that contains detailed information on a blockside basis for a 300 block area. On the basis of these data, the strong interrelationship between sweeper routes and no-parking regulations is established. It is then shown that the effectiveness of street cleaning by mechanical brooms is limited by the presence of illegally parked cars along curbs. Analytical models that assess the degradation of performance are developed for both metered and non-metered zones, and for any distribution of illegally parked cars. A model that relates enforcement to expected level of compliance is developed and validated with actual data. Optimal feedback policies that tend to minimize the cost of manpower while maximizing the level of compliance are derived.

86. McGuire, J. P. Field research planning for driver's license law enforcement. Final Report, March 1972-February 1973, GTE-Sylvania, Inc.

Research activities and results of the second phase of a contract to design a controlled field experiment aimed at increasing compliance with driver licensing laws are discussed. The enforcement technique employed to discourage driving by individuals whose driver's license has been suspended and to assist in the enforcement of other driver licensing laws is to require all drivers to display while operating a vehicle a special tag, indicating that they have a valid driver's license. The report describes the research

leading to a companion handbook describing the necessary legislation, management organization, public information program, evaluation procedures, display tag design and a schedule for conduct of the experiment. Cost estimates for the experiment and some estimates of the extent of driving under suspension are included in this volume.

87. May, A. D. Parking control: Experience and problems in London. Department of Planning and Transportation, Greater London Council, May 1975.

The objectives of parking policy include: 1) to maintain traffic flow, 2) to reduce accidents, and 3) to expedite traffic flow. The level of parking regulation depends on the extent of problems to be solved and the degree to which vehicle owners can use public transport. Criteria for effective parking control are discussed: 1) effective to meet identified restraint needs, 2) flexible, 3) selective, 4) fair, 5) simple and inexpensive to administer, and 6) easy to understand and comply with. Both on-street and off-street parking changes were studied. Principal results achieved were: 1) 60% reduction in on-street parking but counterbalanced by growth in off-street parking, 2) increase in private parking lots (doubled), and 3) greater traffic flows.

88. Mayer, P. A., & Rankin, W. W. One-way streets and parking. In Traffic control and roadway elements--their relationship to highway safety/revised. Highway Users Federation for Safety and Mobility, 1970.

One-way streets are reported as reducing certain accidents 10-50% but gaps in knowledge do not allow generalized conclusion to all situations. Two specific findings are discussed: 1) accident severity generally decreases, and 2) reduction in total accidents after just one year of operation; mid-block reduced more than intersection accidents. On-street parking and its effects on the accident environment are also examined. The following generalizations are suggested: 1) parking-related accidents are typically low injury and low property damage but high frequency, 2) largely an urban problem on streets less than 40' wide, 3) angle parking is more hazardous than parallel parking, and 4) research is needed into the layouts, traffic volumes, speeds and turnover rates in on-street parking.

89. Michaels, R. M. The effects of enforcement on traffic behavior. Public Roads, 1960, 31(5), 109-124.

This study examined the effects of differing levels of enforcement on three traffic variables: accidents, speed and volume. Three hypotheses were tested, stating that as the level of enforcement was increased 1) accident frequency would decrease, 2) traffic would divert to alternate routes and 3) the mean and variance of the speed distributions would decrease. The level of enforcement was measured as the average number of patrol units a driver would pass per mile of travel or the probable frequency of encountering a patrol. Measurements were made upon four test and three control routes in different parts of the State of Wisconsin. Results indicated that the first two hypotheses were not supported. Analysis of the speed distributions showed that the mean speed decreased for both the experimental and the control groups. However, the speed variancer did decrease for three of the four test routes while not for their controls. Only the observed decrease in variance of speed was statistically significant. This study suggests that motorist speed behavior is related to the imposed level of enforcement but that the effects of various enforcement levels are quite subtle and may influence overall traffic behavior in a very indirect fashion.

90. Milward, H. E. A. Legislation and enforcement as it relates to the prevention of motor vehicle traffic collisions. Paper presented to the 3rd Annual Conference, Canada Safety Council, Saskatoon, Saskatchewan, June 9, 1971. Ottawa, Canada: Canada Safety Council.

A general discussion of the nature and purposes of traffic law enforcement and factors affecting violation/compliance behaviors. The paper strives to outline the rationale and scope of traffic law and the purpose of traffic law enforcement. It attempts to develop a basic understanding of what traffic laws are, why people violate them and how enforcement affects drivers. In this regard, the paper strongly states the following beliefs:

- Traffic law enforcement activity seeks to obtain maximum compliance with safe driving specifications by a majority of drivers.
- Violations should be thought of as increasing the chance of a driver having a collision rather than as the cause of a collision.
- People violate traffic laws for extremely complex reasons, some of which are stable factors influencing behavior, others are temporary or variable factors.

- Motives, either positive or negative, cause human behavior.

- Enforcement deals primarily with negative motivation, seeking to cause people to avoid certain types of behavior.

- Transient traffic is more responsive to direct or observational effect than to the reputation for enforcement action.

- "The application of maximum enforcement effort at the time and places where violations are most plentiful makes the most effective use of available enforcement units."

- "Most drivers view enforcement in terms of their estimates of the risk of being detected and apprehended, their estimates of the certainty and degree of penalty which will be assessed upon being apprehended."

- Enforcement creates these perceptions by:

  - Observational effect: 1) the strength of the enforcement symbol, 2) the frequency with which the driver views the symbol.

  - Reputation: created by a steady, active enforcement program over a long period of time; drivers develop the feeling that their risk of being apprehended is high; "if the estimate of risk is high, drivers do not take the chance of being caught frequently."

The paper does not give any evidence nor does it document research which might substantiate the statements made. However, the claims are in general agreement with the body of knowledge surrounding traffic law enforcement.

108. Northwestern University, Traffic Institute. Parking offenses. Evanston, Ill., 1973.

A descriptive document aimed at police educational needs in traffic law enforcement. Types of parking offenses discussed: 1) time limitation (overtime, all night, parking meters), 2) places (signed and unsigned), 3) manner (angle, distance from curb, blocking drive), and 4) purpose (various). Enforcement procedures applied to parking regulations were described including: 1) spot checks (timing), 2) tolerance (judgmental allowance), 3) uniformity, and 4) cover poor compliance areas more often to secure desired level of compliance.

109. Organization for Economic Co-Operation and Development. Research on traffic law enforcement: Effects of the enforcement of legislation on road user behavior and traffic accidents. Paris, France, 1974.

Enforcement is a crucial factor in many road safety measures. The philosophy underlying traffic law enforcement is that compliance with traffic regulations will effect the safe and efficient movement of all road users. As the effectiveness of enforcement action is open to question and because of the large costs and administrative problems involved, policy decisions in this area are especially difficult. An overview of the major elements in the traffic law enforcement system is given, and a survey of national practice is included. A comprehensive review of research on the effects of enforcement of legislation on traffic offenses only, traffic accidents only, and both traffic offenses and accidents is carried out and the findings summarized. Research presently being undertaken is indicated. Guidelines based on the present state of the art and the collective expertise and experience of the group are set out and future research needs are identified. Aspects covered include the police, courts, road user and traffic enforcement systems.

112. Palmer, M. R. Regulations and enforcement. Traffic Research Report 15. Traffic Engineering Section, Road Transport Division, Ministry of Transport, New Zealand, 1975.

This paper provides a general review of the roles that traffic rules and their enforcement can reasonably be expected to play in the field of road safety. Since regulations must be learned by drivers, they need to be simple and also to lead to proven safe driving practices and to uniformity of driving behavior. There will be some cases where these objectives cannot be achieved simultaneously and other situations where, for the sake of uniformity and predictability, skilled drivers may have to tolerate regulations that they feel are unnecessarily restrictive. Enforcement is a limited resource. Because of this, rules and devices that depend heavily on enforcement should be used sparingly. As far as possible rules should be self-evident and not aim at major modifications of existing driver behavior. Enforcement and regulations must be recognized as merely two tools, each with its own proper but limited use, among many available for road safety.

120. Proceedings of National Highway Safety Bureau Priorities Seminar. Volume 7, Enforcement. Springfield, Va.: Clearinghouse, July 1969. PB 186-274.

The proceedings suggested that traffic codes and laws are ineffective and meaningless without enforcement. The highway transportation system, and the driver in particular, require regulation and continuous control. Enforcement is thus concerned with human behavior within the confines of the highway system. While driver licensing and public health departments, courts and safety groups conduct activities to regulate driver behavior, the police have the primary responsibility to make the system function. Police responsibility includes traffic law enforcement, accident management and investigation, and traffic direction and control. Costs and benefits for better traffic law enforcement were discussed as was the Connecticut speed crackdown campaign results. Relevant findings of the seminar included: 1) objective of enforcement is to create a perception of surveillance to induce most drivers to obey rules, 2) police traffic services goals were distant; diverted to more serious crimes and toward satisfying immediate public needs, 3) enforcement essential to success of highway safety program; threat of deterrent action with ability to apply it, followed by swift, fair and impartial administration of sanctions, and 4) effective enforcement requires good organization, adequate legislation to repeal obsolete laws and adequate procedures and appropriate action.

133. Shumate, R. P. Effect of increased patrol on accidents, diversion and speed. Northwestern University, Research Project R13, The Traffic Institute, 1958.

This paper reports on a controlled experiment, conducted in the '50's, designed to test the hypothesis that a reduction in accident frequency would follow an increase in the amount of enforcement. The primary questions addressed included: 1) exploration of the quantitative relationship between enforcement and accidents, 2) the effect of increased number of patrol units on use by traffic of less desirable routes, and 3) the effect of increased numbers of patrol units on vehicle speeds. The following conclusions were reported: 1) adding patrol units to stretch of road reduces frequency of fatal and personal injury accidents but not frequency of property damage accidents; more pronounced in second year, 2) adding patrol units does not cause change in travel habits, 3) proportion of passenger vehicles exceeding legal limit reduced as patrol units added but not the same proportion of trucks, and 4) average speeds not affected by adding patrol units.

139. Smith, R. D. The effect of enforcement on driving behavior. Police Chief, 1962, 29(12).

A series of experiments conducted in 1962 on the effects of enforcement on driving behavior used cameras and radar speed meters to collect data. Since this method permitted identifying specific vehicles, elapsed travel time could be used as the measurement of effect. Smith considered this to be a better measure than mean spot speeds because it is "more stable in space and less sensitive to temporary random influence." The study used three test sites, each three miles long, to measure the effects of eight different treatment conditions: 1) a marked patrol unit parked both parallel and perpendicular to the roadway and placed alternately on both sides of the road; 2) an unmarked unit parked parallel on both sides of the road; and 3) a marked unit parked on either side of the road which enters the right flowing lane of traffic.

These experiments indicated that the only significant single factor is the presence of the enforcement symbol. A marked unit was most effective when moving with the predominant traffic flow. A stationary enforcement symbol was most effective when positioned on the side of the roadway with the predominant traffic flow. The results which showed significant reductions in mean speed are subject to some question, since the largest effect was a reduction from 58 to 56 miles per hour, a variance of 4 percent, while the timing error contained in the measurements ranged from 1.7 to 3.3 percent. The author raised another question regarding these results. He proposed that mean speed or travel time may not be an appropriate measure of the effects of enforcement, since the speed limit observed was 65 miles per hour and the majority of vehicles traveling below this limit should not be affected by the presence of the enforcement symbol. Another suggestive result, though also not strongly supported, was that the number of vehicles exceeding the speed limit was significantly reduced.

This experiment also attempted to measure the duration of the effect of the enforcement symbol. A marked vehicle was placed at the beginning of each test range and the speeds after exposure were measured throughout the three mile range. The author concluded from the observations of spot speed that the effect of the symbol was maintained for a distance of at least three miles.

142. Stigler, G. J. The optimum enforcement of laws. Journal of Political Economics, 1970, 78, 526-536.

The author contended that there is widespread failure to achieve an optimum level of enforcement, which results from two principal deficiencies: 1) insufficient enforcement cost data and 2) inadequate methods for determining the proper extent of enforcement.

Two recommendations were offered to combat these deficiencies. First, the level of enforcement should be determined as that quantity that the marginal return would be equal to the marginal cost of the final increment of enforcement activity. Second, enforcement efforts should be directed at detection and pursuit of the frequent violator, especially in criminal cases.

Arguments expressed in the article were based on the concept that the goal of enforcement should be to achieve that degree of compliance with the prescribed (or proscribed) behavior that the society believes it can afford. Two approaches were suggested to assist in implementing the goal of rational enforcement. First, the general public should be convinced of the extensive gains which could result from a rational design of enforcement. Second, the inertia of the legislative process must be circumvented since it delays the reform process necessary for an optimum level of law enforcement. Since cost limitations prevent society from forestalling, detecting and punishing all offenders, the problem of determining the most efficient penalty remains. It is concluded that it is in society's best interests to measure the individual's propensity to offend and then to determine how this propensity responds to flexible cost-effective penalties. It is by means of these methods that a cost-effective and rational level of law enforcement may be developed and employed by the society which it is supposed to serve.

144. Syvanen, M. Effect of police supervision on the perception of traffic signs and driving habits. Helsinki, Finland: Statistical and Research Bureau, The Central Organisation for Traffic Safety in Finland, 1968.

The effects of police supervision on driver perception of a traffic sign were studied. If a police car was parked near the traffic sign, drivers observed the car but only 29.2% observed the sign. If the car was parked further from the sign, 52% of the drivers noticed the sign. Other aspects of the influence of police supervision on driver behavior are also discussed. Presence of a patrol car causes a decrease in poor driving habits.