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THE SOCIETAL COSTS OF CONGESTION IN NEW YORK CITY

WITH APPENDICES

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IN

NEW YORK CITY

(WITH APPENDICES)

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TABLE OF CONTENTS

TABLES AND FIGURES

Page

INTRODUCTION

Traffic congestion is the common cold of cities and as seemingly incurable.

In Paris, London, Los Angeles, Singapore, Tokyo - in almost all the large cities of the world - moving and commuting are commonplace hardships. In Cairo, where vehicles still encounter occasional livestock, a blue haze suffuses even the side streets and the traffic fatality rate is many times that of New York City. In Teheran, a New York Times reporter wrote that before the revolution congestion prevented friends from dining together, lovers from sleeping together, and the suddenly ill from arriving at hospitals. In Lagos, Nigeria, traffic police have from time to time been ordered to publicly whip moving offenders as examples. Madrid, faced with an influx of a million cars a day and a thick veil of smog, has decided to relieve the pressure by building an entirely new city on its northern outskirts.

New York City is no exception. In Manhattan, particularly in midtown, the daily crush is unequaled among American cities in volume, variety, and intensity. It induces more pollution and imposes more societal and economic costs on its inhabitants than any other locality in the country. People, private cars, buses, taxis, motorcycles, bicycles, trucks of all shapes and sizes, pushcarts, repair crews, construction workers, and the specially priviliged compete for space along arteries so overcrowded that the word "transportation" no longer fully describes what is taking place.

Almost perversely, no one knows what this congestion costs though its causes, characteristics and effects have been studied for more than 70 years. "Pollutants may be quantified to parts per billion," complained one engineer, "but the costs of congestion are not quantified at all."[1] Nor is there general agreement about what the term means. Like "art", congestion has come to stand for a commonplace experience of extraordinary complexity. Yet because urban congestion is an imposition, by definition, upon multitudes of people, its costs, in New York as elsewhere, are considerable.

Because they are largely unknown, they are largely ingored: by government planners who annually dispense millions of public dollars and alter lifestyles by their policies; in the countless daily decisions made by businesses that have no way of calculating how much of their time, labor, maintenance and depreciation are chargeable to congestion; and by families that have no way of understanding the effects on their health and budgets of living in heavily congested areas.

This report is an attempt to address some of these issues - in particular, it is an attempt to begin to attach a price to the congestion in midtown Manhattan and to describe how such analyses can be made. Part I describes how Manhattan's congestion has grown and changed with the shaping of the city. Part II looks at transportation patterns in Manhattan as they currently exist, with emphasis on midtown, and then examines both the costs of traveling by motor vehicle and the additional costs incurred as a result of the city's chronic congestion. Part III recommends ways of relieving this congestion and equitably distributing the costs of moving about in New York City.

PART I

1. Horses to Transit

Manhattan has always been congested - and so badly and so consistently that many view congestion as a necessary evil, part and parcel of the city's growth, a negative indicator of an otherwise vigorous economy. Long before automobiles decisively shifted the burden of moving about from transit companies to individual drivers, Manhattan's great streets were famous for their tumult. Overhead railways, unpaved surfaces, horses, raised tracks, waves of immigrants, and a galloping technology little concerned with personal comfort all mitigated against orderly movement.

Throughout the Nineteenth Century, commercial drays and private coaches clogged the city's thoroughfares; the harbor was dense with ferries and vessels of every available kind. Everyone, except the wealthy, walked to work. Those who commuted from Brooklyn ferried across the East River, then walked. But the presence of dray animals, singly and in teams, and the crudity of the streets and their density made an excursion of any length into an expedition. Polluted air, even then, was a major irritant though much of it was caused by the stabling and excretia of many thousand horses.

In 1827, a 12-seat open stagecoach called The Accomodation gave New Yorkers their first taste of public transit. For a modest fare, a passenger was able to travel as far north as Bleecker Street which marked the beginning of suburban Greenwich Village.[2] Four years later, more advanced horse-drawn coaches called Omnibuses (from the Latin "for all") began regular runs. Though slow and awkward, they quickly became popular and by mid-century dominated an important new Manhattan industry - public transit.

Private coaches, horse-drawn rail cars, commercial haulers and pedestrians all claimed the same limited streets. The results were disastrous. One chronicler wrote that "lower Broadway was so overcrowded with omnibus traffic that a person could cross the street only at risk of life and limb." Another wrote that "It takes more skill to cross Broadway...than to cross the Atlantic in a clamboat." Still others described the thoroughfare as "A serried mass of seething humanity" or as a place where "even the nimblest of New Yorkers stands on the curbstone and lays out a plan before marching across..."[3]

The opinion was universal. Editorialists raged and newspapers routinely published schemes for reducing the congestion but conditions only worsened. Innovation, congestion, expansion and more innovation followed each other in a tireless cycle: by the turn of the century New Yorkers were using and testing river ferries, 8-seat winter sleighs, elevated railways (both cable and steam powered), electric railways, trolley cars with overhead and underground wires, and a secretly built and Tammany scuttled Broadway subway propelled by a giant electric fan.[4]

Manhattan, rapidly spreading north, became a jungle of pedestrians, coaches, horses, noise, dirt, elevateds, tracks, mud, wires, and iron. Every new transit scheme seemed to peak at the moment the ribbon was cut to inaugurate its service, presaging a new round of optimism and disappointment. Bodies and goods were successfully borne but rarely in comfort and rarely as efficiently as stockholders had promised - or had been promised. Only the route to public disenchantment was swiftly crossed, and the cause was always related to the overcrowding of streets by vehicles and of vehicles by people.

Writers began to apply "congestion" to the language of traffic as well as medicine and biology. The new usage proved all too appropriate. "People are packed into them (street railways) like sardines in a box with perspiration for oil...like smoked hams in a corner grocery," complained one contemporary.[5]

Yet it was more than physical comfort that angered the public. From the beginning, congestion was understood to be the end product of political corruption and incompetent planning. The April 16, 1859 New York Times, for example, complained that omnibus franchises were giveaways because of what they cost the city in street maintenance and that transit proposals were routinely made without:

> "reference to any comprehensive system, and the whole machinery of lobbying, and of grinding committees is set to work to carry out these ruinous plans...The consequence is the carrying out of scheme after scheme, no one having any relation to the other...with the least amount of public accomodation."[6]

Again and again, the New York press complained about the lack of a comprehensive transportation plan, warning that a chaotic city filled with chaotic transit systems would result.

Indeed, New York grew rapidly and anarchically. Between 1860 and 1901, 1,000 miles of railway track were laid within the city[7] and, while population increased by about 30 percent every ten years, ridership increased twice as fast.[8]

Even the definition of the city was changing. In 1864, 42nd Street was a northern boundary with everything beyond a wasteland inhabited by squatters. In 1883, the Brooklyn Bridge and its state-of-the-art cable car railway opened for business and profoundly changed travel in and between Brooklyn and Manhattan. In 1898, the City of Brooklyn became the Borough of Brooklyn as the City established its current boundaries.

By then traffic, including cattle, constantly jammed the Brooklyn Bridge at levels far higher than anticipated.

Meanwhile, the Broadway omnibuses had been replaced by horse cars in 1885, which were replaced by cable cars in 1893, which were replaced by electric cars in 1901. And by that year, 1901, the pattern of New York's creeping paralysis was becoming clear. The October issue of the Street Railway Journal observed that the worst congestion in the city was located, respectively, at the intersections of Broadway, 34th Street and Sixth Avenue; Fourth Avenue and 23rd Street; Columbus Circle; and Broadway and 23rd Street. The Journal also reported that public transit lines were running at capacity all day long and that midday traffic was always heavy because of the city's shopping and entertainment facilities.[9] A population of 3.5 million people was making more 1.1 billion passenger trips per year.[10]

It was widely believed about this time that New York was congested largely because its thoroughfares were still clotted with horses and their unwieldy loads. One 1908 study estimated that they cost the city $100 million a year in sanitation and related expenses.[11] In less abstract terms, this meant disposing of 912 million pounds of manure, 22 million gallons of urine, and 1,500 carcasses. But horses were on the way out, giving way before electric trains and gasoline powered vehicles. In 1904, New York welcomed its first practical subway; in 1905, the first motor bus route in the country was established along Fifth Avenue.

And automobiles, privately owned and driven (itself a revolutionary change), were appearing in greater numbers and proportions. Apart from their anticipated sanitary virtues, they were expected to eliminate congestion and "the nervousness, distraction, and strain of modern metropolitan life."[12]

But the reality was treacherous. By 1915, motor vehicles were causing so many accidents that New York City began to maintain traffic statistics. In December 1915, The World, summarizing the city's data, reported that 18,223 traffic accidents had occured that year and resulted in 21,723 injuries and 612 deaths.[13]

The figures also showed that 90 percent of all the traffic measured in the city lay within Manhattan and that the number of city auto licenses had increased by 270 percent since 1910 while the accident rate had increased by 893 percent. Rush hour congestion was blamed for much of the increase. With more than 100,000 cars licensed in the city, New Yorkers were beginning to realize that the new century's cure for arterial congestion was only a more virulent strain of the disease itself.

2. Flooded With Cars

By the mid-Twenties, congestion had become severe enough to warrant front page newspaper coverage. Clocking traffic jams and blaming them on poor roads even became a sort of editorial sport. But the coverage only reflected what readers were experiencing. Streets and avenues were swamped by an established cacophony of autos, trucks, carts, jitneys, trolleys, buses, elevateds, railways and people. Roads were too few and narrow; in terrible condition within the city and unpaved outside. In fact, from 1918 to 1932 New York City did not construct a single mile of arterial road within its boundaries.[14]

In 1934 Robert Moses rose to municipal power - and maintained that power for the next 34 years, until 1968. So extensive was his influence during this era, that the history of the city's transportation (and congestion) can justifiably be divided into three periods: Before Moses, During Moses, and After Moses.

During Moses, New York experienced an explosion of highway building such as no city in the world had ever seen. Moses built the Major Deegan, Van Wyck, Sheridan, Bruckner, Gowanus, Prospect, Whitestone, Clearview, Throgs Neck, Cross-Bronx, Brooklyn-Queens, Nassau, Staten Island and Long Island Expressways; the Belt Parkway, the Brooklyn-Battery Tunnel, the Hudson River Drive, and the West Side Highway; and the Triborough, Verrazano, Throgs Neck, Marine, Henry Hudson, Cross Bay, and Bronx-Whitestone Bridges - and the list is incomplete.[15] By 1964, he was responsible for 899 miles in the New York region, more than twice the amount any other American metropolis even possessed.[16]

For this entire tenure, Moses insisted one of his primary goals was to relieve congestion.

Moses appeared to maintain a distance from public transit but this posture concealed an antipathy from which the region's transit systems have yet to recover. For example, Moses deliberately built expressways with overpasses too low for passenger buses. He dismantled elevateds and trolley lines without replacing them. He diverted enormous funds from transit to highway uses, and he obstructed public transit funding efforts.[17]

The result was congestion raised to grand guignol, a tragic parody of planning. "By building his highways, Moses flooded the city with cars," wrote Robert Caro in his extraordinary biography:

> "by systematically starving the subways and the suburban commuter railroads, he swelled that flood to city-destroying dimensions. By making sure that the vast suburbs, rural and empty when he came to power, were filled on a sprawling, low-density development pattern relying primarily on roads instead of mass transportation, he insured that that flood would

> continue for generations...His highways and bridges and tunnels were awesome...but no aspect of those highways and bridges and tunnels was as awesome as the congestion on them."[18]

For years no one questioned Moses when he said one of his goals was to alleviate congestion. He was even considered a major authority on its relief despite the fact that his highways, bridges and tunnels routinely jammed without visible draining any traffic from the routes they were intended to free. In retrospect, it seems like a kind of mass hallucination in which an entire populace refused to believe the evidence of its own experience.

The only event which successfully decreased New York's congestion during this period was World War II. Gas and tire rationing, shortages, conscription, and the freeze on commercial auto production reduced traffic to tolerable levels. But it only seemed to make the shock that much greater when, following the war, congestion skyrocketed to new and intimidating levels. The public was outraged but confused. Meanwhile, assembly lines in Detroit began to pour 25,000 cars a day into an apparently bottomless market, and one which Robert Moses was paving the way for in New York.

A curiousity of the era is an article Moses wrote entitled "The Problem of Midtown Traffic."[19] "At most," explained Moses, "we can put an embargo on further mistakes," whereupon he proposed a plan to deal with the sudden onset of postwar congestion in midtown. His recommendations included zoning reforms, the provision of off-street loading facilities, synchronized traffic lights, stricter enforcement of existing regulations, night truck deliveries, arcades to create new lanes and sidewalk space, selective vehicle exclusion, restrictions on taxi cruising, and the installation of parking meters.

Sensible, progressive, prophetic; the article is a virtual preview of the transportation control plans that would begin to be written 37 years later to fulfill the requirements of the 1970 Clean Air Act. But Moses' article only served as a prelude for a follow-up article entitled "The Highway Maze."[20] This time, Moses outlined for the public his postwar highway program. It was a song of cement and its scale overwhelmed any thoughts he may have given to decongesting midtown. Boasted Moses: "...we shall have the finest collection of land bridges, intersections, clover leaves, chicken guts, ever conceived since Daedalus built the labyrinth for Minos of Crete, a 'mighty maze'." Moses neglected to mention that Daedalus' maze was designed to confuse and trap anyone unfortunate enough to enter.

3. Profiting From Congestion

As New York's highway builders long ago learned, congestion can be a profitable business. Though studies often neglect the enormous profits congested arteries generate, bodies such as the Port Authority of New York and New Jersey and powers such as Moses did not, though they proclaimed themselves to be above such concerns. Moses, for example, wrote that his program to relieve midtown congestion could only be implemented "in the teeth of powerful and bitter opposition, the opposition which makes money out of congestion."[21]

He meant himself, for it was his network of toll roads, bridges and tunnels - controlled largely through his chairmanship of the Triborough Bridge and Tunnel Authority - that provided the economic base for his influence. In 1941, the Authority's annual income was $8 million. By 1967, it was $75 million, exclusive of its capitalization potential.[22] The flow of coins from the morass of highway projects purportedly designed to relieve congestion was worth not millions but billions of dollars to both Triborough and its chief rival, the Port Authority.

In 1953, Triborough's surplus was $500 million while the Port Authority's surplus was $700 million.[23] Traffic, meanwhile, had by then increased by more than 450 percent over pre-war levels.[23] The year 1953 is noteworthy because it marks one of the few attempts to estimate how much congestion costs in dollars and cents.

The effort was by a businessman's association called the Citizens Traffic Safety Board, Inc. which published a study entitled, "The Cost of Traffic Congestion and Traffic Accidents in the City of New York."[25] Though it shied from analyses, the report concluded that congestion was then costing the city's people and businesses $1 billion a year. This is equivalent to $2.4 billion in 1978 dollars.

The study was based on a financial survey of more than 200 businesses, many of which operated both inside and outside of the city and were thus able to compare their expenses in both areas. Congestion was operationally defined as that level of crowding over and above normal traffic conditions. Unfortunately, "normal levels" were not defined. Costs were ascribed to congestion by deducting normal level costs. In this manner the Board concluded that congestion was responsible in 1953 for $350 million in additional wages, $100 million in retail sales losses, $175 million in accelerated vehicle depreciation, $75 million in additional fuel bills, $57 million in extra taxi fares, and $70 million in additional vehicle repairs and maintenance, plus a host of further costs.

Other attempts to quantify the cost of the city's congestion were made by the Regional Plan Association (RPA) in 1924,[26] the City Club of New York in 1973,[27] and Citizens for Clean Air in 1976.[28] RPA estimated that congestion cost New York $465 million in 1924, with half the total accruing in Manhattan. But this was based largely on an extrapolation of figures prepared for other cities.

The City Club's study estimated that roadway congestion cost New Yorkers $1 billion a year, recalling the conclusion of the earlier Citizens Board, and warned that there was still a tremendous latent demand for auto travel in the city and in the greater metropolitan area. It recommended a variety of remedies including the establishment of hack stands to replace taxi cruising, reforms in truck delivery and traffic management practices, public transit improvements, vehicle restrictions and additional vehicle charges.

The study also included a consideration of the societal costs imposed by congestion, which it noted were "the most difficult to quantify, but the heaviest in their impact on the public." Its analysis was limited to a look at vehicular air pollution but it reflected a growing public concern about the effect of congestion on the city's environmental quality.

In 1976 Citizens for Clean Air investigated these "difficult to quantify" costs. The study was the first attempt to price the cost to New York City of congestion-induced air, water, and noise pollution, increased stress and the subsidies that support unrestrained vehicle use. It also outlined a methodology by which such costs could be quantified and concluded that congestion was costing New York City $2 billion a year.

In the mid-Fifties, societal impacts, such as those produced by air pollution and stress, counted for little, if anything, in the public's perception of the problem. As the Citizens Board study illustrates, congestion was seen as a serious problem because of its effect on vehicle life, accident rates, and the efficient conduct of business. The solution was widely believed to be more highways and more parking space.

But those who built and financed highways and garages were aware that congested facilities were a highly profitable and reliable source of revenue. In 1959, for example, Dun & Bradstreet stated that "the success of toll facilities...is largely dependent upon the adequacy of the approaches and connecting highways. Thus...every improvement in this system of highways...is likely to increase to some extent the traffic on those facilities."[29] Dun & Bradstreet, therefore, recommended that more highways be built so as to better service the toll facilities.

4. "Body Crushed Against Body"

The rules changed as the stakes increased. In January 1955, the Triborough and Port Authorities published a "Joint Study of Arterial Facilities." Previously rivals, the two authorities had recognized their mutual interests and were now proposing to build an unprecedented series of bridges and expressways. These projects would enlarge and service their existing toll empire, criss-cross every borough and reach into Long Island and New Jersey.[30]

The Joint Program was a virtual blueprint to exploit the metropolitan area's enormous reserves of energy and industry. As Robert Caro concluded, "The two giant authorities were dividing the potential profits from the city's traffic as if congestion were a large and succulent pie."[31]

They largely succeeded. From 1955 to 1965, Triborough alone spent $755 million in Joint Program road projects and nothing on public transit. The federal and state governments spent $1.2 billion on Joint Program highway projects and nothing on public transit. The regional commuter railroads, unable to compete, slid toward bankruptcy. The city's subway system adopted "deferred maintenance," a euphemism for neglect, as policy. By 1965, the Joint Program had resulted in 439 miles of new metropolitan roadway and not one inch of new commuter rail or subway track.

One of the finest public transportation systems in the world was becoming one of the worst. Enough transit patrons to populate an additional city had been pressed either to switch from transit travel to travel by automobile or to abandon New York entirely. Meanwhile, congestion reached new heights - not because population was increasing, as had been assumed, but because commuters were moving out of reach of rail, bus and subway systems and into the scattered suburbs. Private cars provided the only means of going to and from work and the Joint Program's 439 miles of highways made the trip seem practical and appealing. Naturally congestion grew worse, especially in the central business districts.

Though the Joint Program accelerated this trend, it had already been well underway. In 1951, the Regional Plan Association reported that auto commuting into New York City had increased by 321 percent since 1930 while total commuting had only increased by 19 percent and while the number of families in the areas surrounding the city had increased by only 50 percent.[32] RPA made the implications of these increases graphically clear by pointing out that "The automobiles required to transport the equivalent of one trainload of commuters use about four acres of parking space in Manhattan." RPA explained that such space is about eight times the size of Grand Central Station's main concourse or equal to all the parking capacity along one side of Fifth Avenue from Washington Square to 68th Street.

In 1977, RPA updated its figures with startling results.[33] The Association reported that between 1950 and 1975 New York City had lost 324,000 people, 438,000 jobs below 60th Street in Manhattan, and 606 million annual subway rides. Nevertheless, 177,000 more people were entering Manhattan's central business district by car each workday. "Congestion" was becoming a euphemism.

One result of the discovery of these trends, which were not confined to New York, was that relieving urban congestion became a federal concern. The 1970 Clean Air Act and the Environmental Protection Agency's establishment of air quality standards reflected findings that vehicular congestion was responsible to a significant degree for urban air pollution. New York City, which suffered from some of the nation's worst congestion and most polluted air, responded by developing a Transportation Control Plan in 1973.[34] Its purpose was to enable the city to achieve national air quality standards by relieving traffic congestion. Its premise was that automotive activity must be limited while corresponding improvements were made in public transit systems. For perhaps the first time, a major American city had declared war on congestion by holding that unrestricted auto use and the construction of more highways and parking lots were part of the problem not the solution.

Unfortunately, the Plan was never put into effect. After the city and the state adopted it, and after EPA approved it, the new city administration of Mayor Abraham Beame went not into action but into court. The ensuing legal actions outlasted Beame's tenure and ended with the Supreme Court. Though the city lost at every step, it successfully avoided taking any action to relieve congestion during those years.

Throughout the period, the Plan never received widespread public support. Few New Yorkers understood its full scope and requirements while numerous special interest groups strongly opposed specific sections. Federal agencies, for their part, did little to educate the public or build a constituency while city and state agencies actively fought the Plan and frequently misrepresented its requirements and likely effects.

In 1977 Congress amended the Clean Air Act, having recognized that New York and other states were stonewalling the requirements of the Act. The Amendments included new requirements for the states to revise their transportation and air quality plans with the full participation of the public. The goal this time around was to establish a planning process that would produce plans to relieve congestion that could be implemented. One section, known as the Moynihan/Holtzman Amendment, was crafted to require New York City to improve its mass transit systems. By passing it, the Congress acknowledged for the first time that decent transit systems reduce urban congestion and air pollution.

New York's response was a new planning process coordinated by the Tri-State Regional Planning Commission and directed by the State Department of Transportation. On January 29, 1979, the bulk of the new plan was presented at a public hearing; 134 speakers testified against it, most recommending that it be disapproved by EPA and rewritten. No one testified in its behalf. On March 16, the State presented the transit element of the plan for public hearing. The results were almost identical and included a denunciation by Congresswoman Elizabeth Holtzman, the ammendment's co-sponsor.

As of this writing, the full Plan is awaiting action by EPA. Whatever the outcome, the reality is that transportation and planning for transportation in New York City long ago entered a crisis from which it has yet to emerge. No new highways are now under construction; the Second Avenue subway has been all but abandoned while other new lines face financial difficulties. Moses' empire has been fragmented among a host of other agencies so that the City lacks a comprehensive policy. The subways, meanwhile, have continued their decline only to be joined by the city's infrastructure of bridges, highways and local streets.[35]

After more than 100 years and five generations of verbal, financial, technological and behavioral acrobatics in the name of the relief of congestion, New York City remains at a standstill. Writers and travelers still refer to "cattle cars" and "sardine cans". Nor does it matter whether the vehicles in question are autos, trains or buses; even the best choice seems only the least evil. In 1975 Robert Caro described conditions in 1974:

> "...men and women pushed and shoved like irritable animals, rushing for seats as animals rush for a food trough, for without a seat they would have to stand - body crushed against body, strangers' smells in their nostrils, strangers' breath in their faces - in a press so dense that there could exist in it neither comfort nor dignity nor manners."[36]

And there it stands.

PART II

1. Manhattan

Despite its problems, Manhattan still possesses many advantages. Centered within one of the finest harbors in the world, surrounded by navigable rivers, its 22.9 square miles consist of rock formations ideally suited to support skyscrapers and dense development.

These characteristics still shape Manhattan life. Though it has but .3 percent of the metropolitan area's land, it encompasses 8 percent of its population, 12 percent of its floor space, and 30 percent of its jobs.[37] It supports a residential population of 1.5 million and a daily commuter and visitor influx of 2.85 million. The transportation infrastructure that services these 4.35 million people includes 533 miles of highways and and streets, 16 waterway bridges, four tunnels, 224 miles of subway and elevated track, plus many miles of underground walkway.

All of this is at the center of a 27-county, three state region that includes more than 18 million people. Like New York City, the region has declined in past years in employment and in the quality of its services. Its population, while steady, has shifted considerably; outer areas have grown while many city neighborhoods have seen poorer residents replace their middle class predecessors. Unless planning priorities change, these trends are expected to continue.

Manhattan is the region's most congested and diverse county but it is only the island's southern half that is a Central Business District (CBD). From the Battery to 60th Street, river to river, the daily crush is as dramatic and traumatic as any in America. Servicing this CBD on a 24-hour basis are 20 of the city's 28 subway routes, five commuter railroads, 56 private and Transit Authority bus routes, the major intracity bus companies, several thousand taxis, and a vast array of local and regional facilities.[38] Grand Central Station, the Port Authority Bus Terminal, Pennsylvania Station, the major subway complexes at 14th, 34th and 42nd Streets, and more than 70 other underground stations transport millions of passengers, house tens of thousands of businesses, and weave together almost all of the city's systems for moving people and goods.

Pennsylvania Station, for example, serves as a terminal for AMTRAK, Penn Central, and the Long Island Rail Road. Overhead is Madison Square Garden and its attached office tower. Herald Square, a major regional shopping district, lies only a block to the west. The station itself is serviced by three bus routes, all the West Side subway lines and the PATH rail system to New Jersey. The Port Authority Bus Terminal stands five blocks to the north. Though undergoing a major expansion, it is already the largest facility of its kind in the world and houses 184 loading bays, parking for cars, and direct access to subway lines and the Lincoln Tunnel.

Despite this wealth of facilities, Manhattan is still an island with a limited number of entry points. Sixteen bridges, four tunnels, and one ferry service comprise its links with the mainland and the city's other boroughs. All are used by motor vehicles.

And all of Manhattan's transportation facilities, vehicle and rail, suffer from severe congestion. A 1975 study of driving speeds for cars and buses in 26 cities found conditions most congested in the New York metropolitan area.[39] Table 1, drawn from this report, illustrates the extent of the problem here. Within Manhattan, congestion is even worse. In 1973, the Manhattan Auto Study reported that driving speeds in the island's CBD averaged 7 miles per hour with truck and bus speeds at

TABLE 1: DRIVING SPEEDS FOR SELECTED METROPOLITAN AREAS IN 1971

Metropolitan Area	Rush Hour Bus Transit Speed	Average Highway Driving Speed
Cleveland	15 mph	28 mph
Philadelphia	15	24
Phoenix	15	31
San Diego	15	36
Houston	14	31
Detroit	14	36
Denver	13	31
Kansas City	13	37
Los Angeles	13	33
New Orleans	13	36
St. Louis	13	32
Seattle	13	27
Atlanta	12	28
Baltimore	12	25
Boston	12	32
Chicago	12	25
Miami	12	24
Milwaukee	12	25
Minneapolis	12	26
Pittsburgh	12	26
San Francisco	12	29
Dallas	11	31
Indianapolis	11	35
Portland	11	33
Buffalo	10	27
New York (including Newark)	9	22

Source: Council on Municipal Performance, Municipal Performance Report, Vol. 1, No. 6.

6 and 4 mph, respectively.[40] A later study by Citizens for Clean Air recorded an average midtown driving speed of 5.5 mph, with specific avenues measuring as low as 2.4 mph.*

2. Changing Patterns of Travel

Midtown is that part of the Central Business District from 30th to 60th Streets, river to river. Only three square miles in size, it supports more than 1.3 million daily trips, more than 1.1 million workers, more than 400,000 daily subway riders, more than 110,000 residents, and more than 600,000 cars, trucks, taxis and buses during a typical weekday.[42] It is the nation's busiest, densest locale. As the city government is well aware:

> "It is the employment center for much of New York City, the shopping and commercial center - and the cultural and entertainment center as well. Access is easy. Almost every major transportation facility is either located within the area or passes through it.
>
> "With its concentration of activities, its network of transportation systems and its diversity of users, the Midtown area is a microcosm of the problems facing the City...which is beset with the need to maintain the flow of vehicles and users without overloading the existing transit systems and streets, and to remain dynamic and profitable."[43]

However, while trains carry most of midtown's travelers, autos dominate its landscape. In 1978, the Department of City Planning profiled midtown's weekday drivers.[44] It found that about 86,000 workers commute to the area by private car and that on a day-long basis private cars comprise 60 percent of the number of vehicles entering the area (another 25 percent are taxis, 12 percent are trucks, and 3 percent are buses).

The study also found that 70 percent of midtown's auto commuters are professionals: owners of businesses, managers, doctors, lawyers, business<u>men</u>, and the like. The masculine suffix is appropriate since

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* See Appendix 2.

more than three-quarters of all of midtown's drivers are men - men with an average age slightly over 40 and an average family income of $24,500.

Over the years, highway congestion to and in midtown and the CBD has increased both relatively - in terms of the percentage of commuters using vehicles rather than transit - and absolutely; that is, the actual number of vehicles competing for space. As in other cities, the mass transit systems have lost enormous numbers of riders to private autos. Similarly, much of the freight that once came to town by rail now comes by truck.

This increase in vehicle travel has been so inexorable that only the exigencies of history and physical collapse seem to have offered impediments. World War II halted auto production, imposed gasoline rationing and drafted thousands of would-be commuters. In 1974, the Arab oil embargo, the recession and the closing of much of the West Side Highway had a similar, if briefer and lesser, impact. The Tri-State Regional Planning Commission has succintly summarized these changes in travel. "Between the years 1924 and 1947," wrote the Commission's planners:

> "the total number of people entering the CBD increased substantially to a peak of 3.7 million. However, since 1948, person trips have been declining slightly, with some exceptions, leveling off to 2.8 million people in 1976 and 1977. Conversely, the number of motor vehicles entering the Manhattan CBD has grown since 1924 to a high of 660,000 daily vehicle entries in 1973. Subsequently, motor vehicle entries dropped to a 1976 low of 615,000. However, 1977 shows a rebound to pre-1973 numbers with an increase to 645,000 vehicles entering."[45]

The subway system, meanwhile, had essentially stopped expanding during the Forties. Under Mayor Laguardia the individual lines were bought from their private owners and unified into a single network. But in the next decade these lines began to lose riders. At its peak in 1948, the subway system carried 2,389,000 people into the CBD every full weekday. By 1977, the amount had slid by 38 percent to

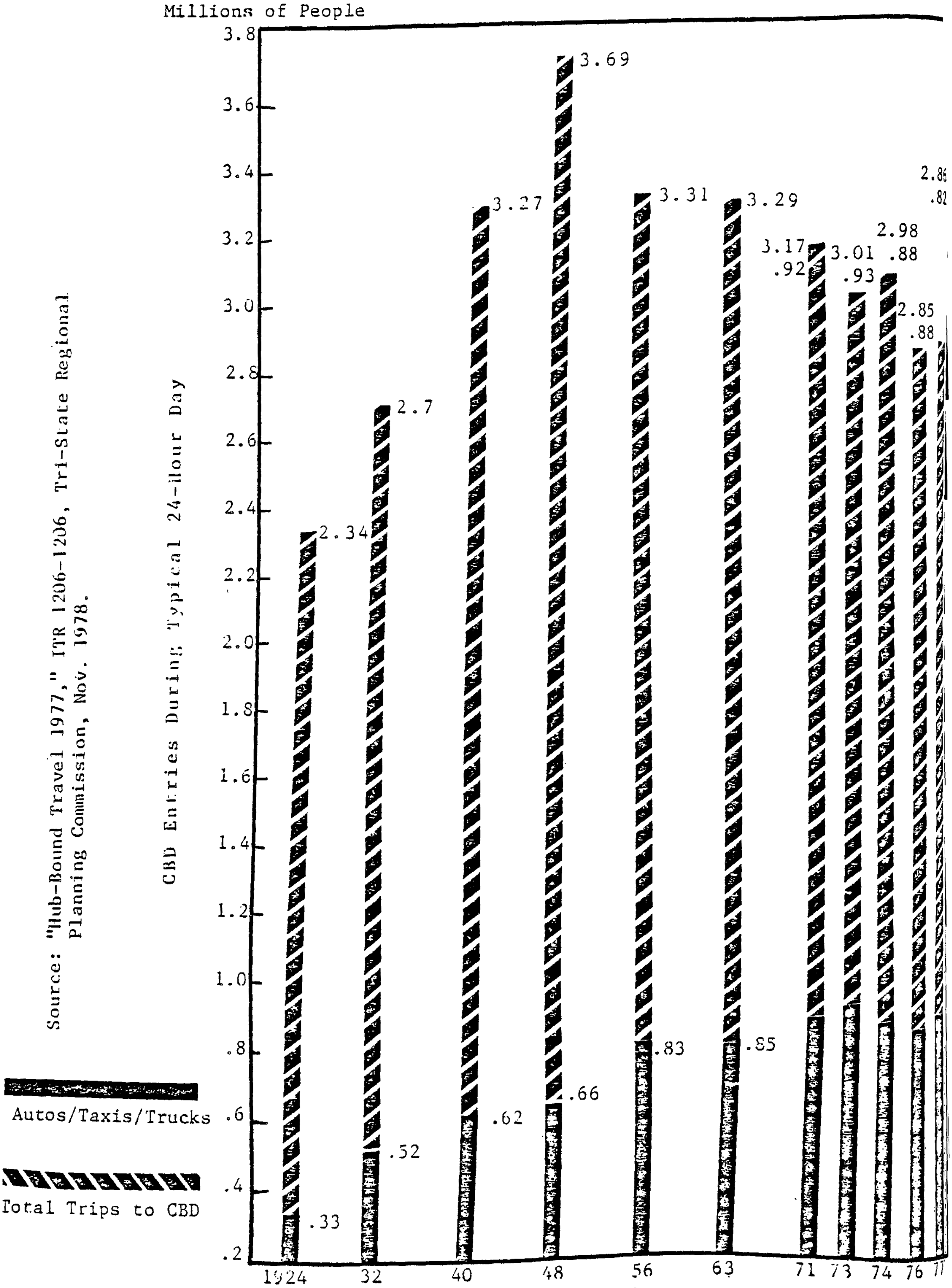
1,487,000.[46]

The declining job base in Manhattan is responsible for much of the decrease in the overall amount of travel to the CBD, But it has never been enough to offset the increases in driving and congestion. For example the shift from transit to autos is clearly apparent during the city's rush hours, when the impact of job losses on traffic should be strongest. Between 1948 and 1977 transit ridership into the CBD during the morning rush dropped by 25 percent. Auto, taxi and truck traffic into the CBD during this same period increased by 23 percent. Moreover, the number of people entering the CBD during the morning rush has remained stable when expressed as a fraction of all those who enter during a 24 hour period. Figure 1 illustrates the changes in these travel patterns.

A declining auto occupancy rate further contributed to the impact of private cars. In 1948 the rate was 1.69 passengers per vehicle. By 1977 the rate had crawled down to 1.43.[47]

As these figures illustrate, vehicle travel in the CBD is increasing both absolutely and relative to the number of people actually traveling. Fewer people are using transit and more people are driving. However, these trends have not gone so far as to make their impacts irreversible. The city's extensive transit systems are in place and available as alternatives to autos. Though in disrepair, they still transport the vast majority of the CBD's workforce and can be renovated for far less than the cost of equivalent new facilities. As energy grows more expensive, such renovation should look increasingly attractive.

FIGURE 1. PATTERNS OF TRAVEL TO THE CBD



Source: "Hub-Bound Travel 1977," ITR 1206-1206, Tri-State Regional Planning Commission, Nov. 1978.

3. The Midtown Commons

Like a shared pasture subjected to overgrazing, the CBD (with midtown in particular) is subjected to more use than it can adequately support. Fixed by geography, beseiged by vehicles of all sorts, constricted by the habits of priviliged motorists, lacking the funds for decent maintenance and repair, midtown's streets and avenues are becoming less efficient and more congested with every passing year. Yet the nature of its congestion is different from the kind experienced on highways. Given clear weather, a drive through midtown includes encounters with pedestrians, police, jaywalkers, other drivers and passengers, truckers, utility and construction workers, cyclists, and local merchants and peddlers. The variety of the city's life doesn't stop at the curb, and the density of the city's traffic encourages it in the streets.

None of this makes stop and go traffic pleasant but a drive through midtown reveals much about the quality of traffic management in the area. What is most apparent is that the direct cause of a great deal of midtown's congestion is the failure by the city to sufficiently enforce basic traffic regulations. Moving violations are only rarely given while meter maids and tow truck patrols have a limited and visibly weak effect. There are about 61,000 off-street parking spaces in midtown[48] and on-street parking is either prohibited or severely limited during workdays. Indeed, there are only about 800 free spaces and 670 metered spaces in all of midtown:[49] a plethora of restrictions and the annual issuance of tens of thousands of parking summons theoretically protects the remaining curb space. Yet it is exceedingly difficult to find even an illegal parking space during the day.

All of this helps to create in the CBD a Darwinian atmosphere in which aggressive, competitive, hurried driving and parking is considered not only normal but necessary. New York drivers long ago learned that the most efficient way to drive in Manhattan is to always take an opening and never give an inch. As one result, they are each other's worst impediments.

For example, drivers parking at curbs actively obstruct traffic, sometimes blocking two moving lanes at once. This blockage increases substantially during peak traffic hours. Truck drivers often double park even when curb space is available to insure that no else can block them in. Similarly, drivers (aware that traffic rules are fitfully enforced) routinely block intersections and jump red lights. These two simple violations occur so frequently that they cause considerable CBD congestion and interfered with a Planning Department study of traffic flow in 1978. (The City's Traffic Department believes that traffic agents, stationed at intersections, could control these violations and speed the flow by up to 40 percent. Indeed, their presence may help explain why midtown traffic moves faster during rush hours, when they are on the job, than during midday, when they are not.)

There are other factors. Roadway deterioration, to cite one, has become a major headache with many routes barely passable in good weather and impassable in bad weather. Drainage is often poor and major arteries, such as the FDR Drive routinely flood out and turn rush hours into chaos. Potholes are epidemic and vary in size from shallow depressions to axle-cracking pits. During seasonal changes, they reach crisis proportions. The City claims it fills in more than one million per year but since this averages out to 2,800 per day the claim is probably an exaggeration. Whatever the true repair level may be, the streets are still so badly pitted that British Leyland recently sent a team of experts to reproduce

New York's potholes for use at the company's British proving grounds.

Potholes are largely products of heavy truck use, often in violation of city rules, and sloppily filled utility cuts. According to the City's Bureau of Highway Operations, there are about 200,000 such openings each year for necessary underground repair. Each opening disrupts traffic for the hours or days it is in progress. Much of this is unavoidable. But each time a street is opened, its entire structure is weakened. This makes the rest of the street more susceptible to pothole formation. If the cut is poorly repaired - as the Comptroller's office indicates is common -[50] the street surface is further weakened. Again, the results are more potholes, more damage and more delay. Construction blockages are more chronic. Occasionally entire streets will be closed for a day or two. Often streets will be partially blocked for months at a time.

But vehicles, not roads, still cause most of Manhattan's congestion problems - and of all vehicles taxis may be the most impeding. About 3,500 of the city's 11,787 medallion cabs work midtown during normal weekdays. They often account for up to 75 percent of the vehicles on given streets. Since they carry 175,000 passengers per day in midtown alone,[51] they combine the carrying capacity of a transit mode with the congesting and polluting qualities of autos. Their impact is further increased by their drivers' intensely competitive habits and because they rarely park during the busiest hours.

Other kinds of vehicles create other problems. Bus and truck drivers, for example, create a multiplier effect in their wake when they drive aggressively. The size and slowness of their vehicles and the regularity with which they straddle lanes perceptibly slows those that follow.

Even bicyclists, though relatively few, tend to follow their own rules. This is partly explained by the city's general disregard for cyclists' needs and by the dangerous conditions that exist. The city has begun to address this problem by providing bike lanes on the Queensborough Bridge, Broadway, Sixth Avenue and elsewhere. But as bike use in the city increases, as seems likely, there will almost certainly be a heightened competition for lane space and a corresponding increase in injuries.

Pedestrians, tightly packed and perpetually jaywalking, impede traffic most frequently along the streets and avenues that service major shopping, entertainment and transportation facilities. However, the jammed state of the roads and the disproportionate space and services given over to vehicles encourage jaywalking and pedestrian crowding. As a result, a walk in the CBD can easily take twice as long as it should because of narrow sidewalks, heavy traffic, long lights and blocked crosswalks.

Manhattan's decayed streets and poorly managed traffic did not create its congestion but they have helped to increase it to levels that seriously harm the value and utility of the Island's transportation facilities, and undermine the area's economy.

4. The Cost of Auto/Highway Travel

It is well known that New York City has the largest public transit system in the country. Less well known is that the city also has the country's most extensive highway network, exceeding even Los Angeles'. But the great age of road construction has ended and today that network and its traffic cost the city more in maintenance than taxpayers appear to be willing to pay for.

The case against autos is not new but its quantification is. Intense vehicular traffic - such as New York's - brings with it high accident rates, air pollution and noise levels. It requires enormous subsidies from all levels of government. It increases the wear and tear on the urban infrastructure, and the cost of its maintenance and repair. It diverts money from more equitable public transit expenditures and distorts municipal planning. It moves people and goods about the city - but at a very high price. And, of course, it hogs increasingly expensive petroleum resources: this now has profound foreign policy implications and helps fuel the drive toward using nuclear energy and coal for power generation.

For 1978, the cost of auto and taxi travel in Manhattan was $1.5 billion just for the passengers traveling by these modes; for all of New York City, the cost was $3.21 billion. Indirect costs added $590 million to the Manhattan tab and $2.27 billion to the City's total.* "Indirect" in this sense refers to the costs incurred because of automotive air pollution, medical problems, governmental subsidies, traffic accidents, and the value of lost time. A summary of these costs appears in Table 2.

Economists and planners frequently call such factors "externalities". Too often, this is little more than a euphemism for factors they cannot quantify or would prefer to ignore. In terms of autos, leaving such factors out of calculations is a way of concealing the true costs of this type of transportation.

Careful analysis of highway transportation in New York, for example, reveals that motorists do not pay their own way, even for the costs of road construction and maintenance. Though the highway lobby boasts that gasoline taxes and the Interstate Trust Fund cover all costs, drivers receive extensive public subsidies. This is because road charges - such

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* See Appendix 1.

TABLE 2. HIGHWAY TRANSPORTATION COSTS FOR 1978
(Billions of Dollars)

Direct User Costs	Manhattan	New York City	Tri-State Region	United States
Private Cars	$ .37	$2.61	$17.41	$193.3
Taxis/Livery	.54	.80	.95	2.0
Buses	n/a	.48	.83	5.5
Freight Modes	1.50	4.43	12.55	159.5
DIRECT TOTAL:	n/a	$8.32	$31.74	$360.3
Indirect Costs				
Subsidies	.10	.46	1.00	9.4
Unpaid Travel Time	1.58	2.51	n/a	n/a
Traffic Accidents	.19	.83	2.85	45.4
Air Pollution	.21	.38	.47	6.0
INDIRECT TOTAL:	$2.08	$4.18	n/a	n/a
TOTAL COSTS:	n/a	$12.50	n/a	n/a

Source: Appendix 1. An Estimate of Some Direct and Indirect Costs of Highway Transportation in Manhattan, New York City, the Tri-State Region, and the United States for 1978.

as taxes and tolls - do not fully pay for such expenses as highway police, safety measures, road and vehicle administration, planning, design, bond debt interest, and debt administration.

In New York State, this direct public subsidy works out to about one third of the total highway bill.* For 1973, this meant that the amount of property taxes devoted to highway expenses was $266 million. The competitive edge these subsidies help autos maintain over other kinds of transit, such as railroads, forces the government to also subsidize - indeed, prop up - other modes; again, rail in particular.

Another example: auto related air pollution cost the nation about $5.75 billion in 1975. This was the price suggested by the National Academy of Sciences for the 4,000 deaths and four million sick days it estimated that air pollution caused.[52] Calculations based on New York's population lead to the conclusion that New York City's share is about $700 million and that the region's share is $1.7 billion - exclusive of suffering.* In 1978 dollars, these figures are equivalent to $6.7 billion, $845 million, and $2.1 billion, respectively.

The cost of air pollution is high because the term refers to a great many pollutants, with each class responsible for a variety of medical problems. Automobile exhaust is similarly complex and contains varying amounts of several of the major pollutants. Indeed, "Motor vehicles supply 75 - 95 percent of the carbon monoxide, 90 percent of the airborne lead, one half of the hydrocarbons and nitrogen dioxides, and 40 - 50 percent of the respirable fine particles found in urban air."[53]

All of these substances reach high concentrations in New York,

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* See Appendix 1.

with automobiles the single greatest source for many of them and an important contributing source for many others. Carbon monoxide affects human health by depriving the body of oxygen. Exposure in a closed area, such as a garage, can quickly kill a person; exposure in an open area, such as midtown, can cause dizziness, loss of motor responses, headaches and fatigue - and at levels which are not uncommon in dense traffic. Pregnant women, people with heart disease, anemia and respiratory problems are especially vulnerable to carbon monoxide's harmful effects.

Lead is emitted into the air by vehicles because it is used as a gasoline additive. Monitors have recorded ambient lead levels in the CBD in excess of permissible levels.[54] Exposure to this pollutant, which exists as tiny, respirable particles, can damage the central nervous system and cause behavioral and genetic changes. Severe poisoning can induce a host of illnesses, from mental retardation to death. But chronic exposure can cause symptoms that often go unrecognized and that are difficult to link to lead as a source. These include minimal brain damage, hyper-activity, and in utero impairments.

Fortunately New York City has taken a leadership role in addressing the issue of atmospheric lead. In 1971 the City adopted legislation that cut the allowable lead content of gasoline. This action reduced ambient lead levels by nearly 80 percent in most sections of the city.

Hydrocarbons is a class name for more than 1,000 different compounds, many of which have been associated with cancer and leukemia in high concentrations. They are emitted mainly from combustion processes of all kinds. With sunlight as a catalyst, they combine with nitrogen oxides to form smog and its constituents: ozone, aldehydes, and peroxyacylnitrate (PAN). Apart from their degenerative effect on respiratory systems, these constituents are also believed to contain a number of carcinogens. Moreover, nitrogen dioxide is itself capable of causing long-term respiratory problems at levels that have been measured in New York.

Particulate matter essentially means dust: particles of soil, soot, grime, chemicals, liquids, in general anything smaller than 44 microns (a micron is 0.000039ths of an inch). The particulate matter that is harmful to health is usually smaller than five microns. At this size, particles stay aloft for relatively long periods of time and are easily respirable. They are especially prevalent in cities where they can be generated by almost any activity including construction, demolition, traffic and transit.

Particulates reduce visibility, corrode metals and clothing, and seriously damage health, especially in combination with sulfur dioxide. The entire respiratory system is vulnerable and people with diseases such as bronchitis and asthma are chronically suseptible to high concentrations.

One variety of this pollutant that is likely to increase in New York is the particulate matter emitted from diesel engines. This material consists of more than 10,000 different compounds, some of which are known to cause cancer, some of which are suspected to, and others of which are just plain toxic.[55] Diesels emit from 15 to 60 times as much of this material as engines using unleaded gasoline. Unlike other auto pollutants it is still unregulated, though the federal government is now in the process of researching the health impacts of particulate matter and developing appropriate emissions standards.

The automobile industry is substantially increasing its production of diesel powered passenger cars partly as a way of preserving larger model cars. This anticipated increase in the number of diesels on the road threatens to make diesel particulate pollution a serious issue. Should a public health problem materialize, New Yorkers would bear the impact quickly and intensely.[56] Manhattan, in particular, is already thick with diesel fumes from thousands of trucks and municipal and private fleets of 7,000 badly maintained transit buses. In addition, the city's taxi fleet is considering converting to diesel engines. Given the area's congestion and density, these conditions strongly suggest that the City should be actively working to regulate diesel emissions within its boundaries before this problem fully matures and adds to the pollution burden New Yorkers already face.

Driving itself still kills and injures more people than most wars. Nationally, this meant more than 50,000 deaths in 1978, about 4 million injuries, and more than 22 million damaged vehicles. The societal cost for this carnage was $45.44 billion, mostly in foregone earnings.*

In New York there were 656 deaths, about 97,000 injuries, and more than 400,000 damaged vehicles in 1978 as a result of traffic accidents.* The pricetag? About $828 million. However, crime-ridden the subway system is or appears to be, the danger is nowhere near the automotive accident rate.

These are only examples. There are many other costs that cannot yet be quantified. The salt used to de-ice roads corrodes bridges and other structures, adding tens of millions to their repair and maintenance costs. In New York City such corrosion helped doom the West Side

* See Appendix 1.

Highway and is now eating away at the Franklin D. Roosevelt Drive and some of the city's other major routes and bridges.[57] The salt also seeps into water tables, contaminating them and necessitating expensive treatment plants. Meanwhile, crankcase oil drainings seep into water resources: the New York State Department of Environmental Conservation has reported that one third of the oil found in the region's waters comes from highway run-off.

Understanding the exact impact of congestion is more difficult than understanding the costs of vehicle travel but it is an important starting point in designing strategies to relieve congestion that make economic sense and do not merely transfer the burden.

5. Some Costs of Congestion

The cost of congestion is the amount by which congestion increases existing burdens and expenses. This figure has always been difficult to calculate because the effects of congestion are spread so broadly. Congestion increases air pollution, travel time, noise levels, and personal stress. It causes accidents. It disrupts the delivery of bus, fire, ambulance, police, sanitation and trucking services while increasing their expense. It increases fuel consumption, engine wear, and roadway deterioration. It discourages commuters from working in Manhattan and encourages businesses to leave.

In the New York metropolitan area, the costs of these increased expenses runs to billions of dollars every year.

In New York City alone, congestion costs more than $1 billion per year. Studies in 1953 and 1973 each concluded that this figure was a conservative estimate of the city's loss.[58] Citizens for Clean Air's present work includes an effort to understand the value of wasted time. It concluded that congestion cost drivers and passengers in New York City $562 million for the 260 business days of 1978.* Breaking this down, it was found that, in terms of time lost, private car drivers and passengers lost:

$ 48.7 million in midtown,
$151.3 million in Manhattan, and
$475.3 million in New York City;

that taxi and livery passengers lost:

$ 49.3 million in midtown,
$ 63.7 million in Manhattan, and
$ 77.9 million in New York City;

and that bus passengers lost:

$ 27.9 million in midtown,
$ 32.2 million in Manhattan, and
$ 38.5 million in New York City.

The cost to the public for the congestion it experienced while using these modes of transportation thus amounted to:

$126 million in midtown
$247 million in Manhattan, and
$592 million in New York City.

The amounts are estimates of the value of more than 493,000 man-hours lost to congestion for each workday in 1978.

In terms of wasted fuel, an earlier study by Citizens for Clean Air estimated that motorists and taxi drivers in Manhattan wasted about 18.5 million gallons of gasoline in 1975 because of traffic congestion.[59] In 1975 this equaled about $12.1 million, assuming a price of 65.4 cents per gallon. With gas now at or above a dollar a gallon, the value such waste represents is far more significant.

Most of these costs are equally applicable to the city's business

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* Work in progress.

community. A great many of the motorists in Manhattan are professional drivers; many others use vehicles for work related purposes, including commuting. All businesses depend on the city's transportation facilities for getting and shipping goods, employee commutation, and customer access. Many businesses, such as messinger and delivery firms, premise their livelihood on their ability to take advantage of the city's streets and unique transit network. The business community is well aware of its dependence on these facilities and of the higher costs that Manhattan's conditions impose but it is also pessimistic about the ability of the city, indeed anyone, to reduce these costs, particularly in the crucial area of goods movement.[60]

The above factors are only indices of the full cost of congestion but they are clearly a cause for concern. Were congestion's full costs more precisely known and considered seriously in transportation policy forums, their effect would almost certainly be to change the way transportation is planned and carried out.

PART III

1. To Gather, To Collect, To Heap Up, To Congest

Throughout New York's history, invention has been the mother of congestion. Though trolleys are better than omnibuses, bridges than ferries, subways than elevateds, and paved roads than no roads, each innovation, after an initial period of naive delight, has only seemed to make it more difficult for people to move about. The speed of crosstown traffic has not improved for more than 100 years. Yet the myth that technology can eliminate urban congestion never died. Meanwhile that very congestion has taken on the trappings and momentum of the technology that promised to end it.

Numbers are an easy way of calculating losses and gains but they never fully explain. What happens, for example, to the quality of a city's life when movement becomes unbearable while remaining essential? Do things fall apart or do people become like things?

"A city is the most complex artifact produced by mankind," wrote George Nelson who designed the first pedestrian mall:

> "an organism that lives, breathes and dies. If more and more cities have bad breath today, this is merely another example of getting what we pay for. What we want is unlimited private mobility: the price is congestion and pollution...
>
> "In this contest, the city has to give way since everyone wants the highways. There is no question of good or bad, but rather the observation of a transformation unprecedented in its scope and violence. The image presented by this aspect of the city is that of a society completely materialistic in its values, fundamentally uninterested in planning, wasteful in its handling of resources (the city is a vital resource), and oblivious of such concerns as quality of life."[61]

2. Managing Traffic and Transit

The most detailed program for reducing New York's City's congestion can be found in New York's now abandoned 1973 Transportation Control Plan.[62] Its various sections describe, evaluate and relate to each other dozens of reforms in traffic management, transit improvements and goods movement that are as relevent today as when the plan was approved.

The traffic management reforms are explicitly intended to reduce congestion and vehicle mileage within the city, particularly in Manhattan. They would have the additional effect of improving overall street and traffic conditions. Any of a number of actions could achieve these goals but to be effective they need to be implemented in an integrated manner. Thus a workable program, drawing on the 1973 plan, should include as a minimum the following reforms:

* Strict, continuing enforcement of existing traffic regulations.

* Restrictions on taxi cruising, particularly in midtown.

* Restrictions on parking in Manhattan combined with increased parking opportunities outside Manhattan.

* Restrictions on the use of passenger cars in the CBD.

* The establishment of special crosstown Manhattan through streets.

* Increases in express bus service and the establishment of exclusive bus lanes that reduce the need for commutation by passenger car.

* The restricting of certain streets to essential vehicles.

* The establishment of a uniform toll into Manhattan and the elimination of commuter discounts on Port Authority bridges and tunnels.

* Rebuilding streets for pedestrians, particularly in areas that are congested enough (with people as well as vehicles) to warrant that they be closed to cars and improved for people.

* The institution of attractive and publicly acceptable transit alternatives to automobile use.

Strict enforcement of traffic regulations is the key to making this or any similar program work. New regulations and traffic arrangements will be useless unless they are enforced. The present enforcement level is inadequate and contributes in no small measure to current congestion. Parking regulations must be similarly enforced. On-street parking is now illegal in almost all of Manhattan's CBD yet illegally parked cars constitute major traffic impediments. Insufficient staff and budgets are chronic problems but the city's episodic and usually short-lived crack-downs involving one or more regulations are simply not sufficient.

Because taxis constitute an inordinate amount of the CBD's traffic, they also inordinately contribute to its congestion. Creating a widespread network of cab stands in conjunction with curbs on cruising would contribute significantly to improving Manhattan's traffic flow, again particularly in midtown. The 34 midtown cab stands that have recently been created are worthwhile but unlikely to generate changes in taxi traffic patterns without recourse to complementary restrictions. Banning passenger cars from the CBD would have an even greater impact but would be extremely difficult to implement. Limiting their access, however, would not be impossible. Reducing the number of parking spaces in the CBD, shifting the remaining spaces to the area's periphery or outside the island, and limiting access to specific streets are all workable alternatives.

Establishing a uniform toll for entry into Manhattan would serve a number of purposes. It would reduce the number of vehicles entering Manhattan, raise substantial new funds for transit, and more equitably distribute the costs of transportation. This action is discussed in greater detail below. Eliminating the Port Authority's commuter discounts would serve similar purposes. A commuter discount only makes sense if the Authority's bridges and tunnels are under-utilized. However, the contrary situation exists, and they are overcrowded precisely because of commuter travel patterns: it is commuters that cause the Authority its heaviest expenses for the provision of lane space and maintenance.

None of these actions individually will induce a major diminution of traffic into and within Manhattan. To work properly, they must be implemented systematically and together with a program of improvements in the city's public transit systems. Any such program should increase the transit systems' carrying ability, attractiveness, ease of use and comfort. This means changes in management as well as in the capital plant. Many of the reforms necessary to such a program have already been initiated on a limited basis. These include changes in fare structures, efforts to stagger working hours through employer cooperation, and changes in bus routes to reflect truer travel patterns. A number of studies in these areas are also underway. While simple in theory, many available measures are difficult to implement because of the plethora of city and state agencies that must participate, and because of the complexity of the city's physical plant.

An additional failing is that the Metropolitan Transportation Authority does not aggressively market its services nor provide sufficient practical information about how to use them. The MTA's Transit Authority has recently taken some steps in this area. It has developed and distributed free of charge a new map of the subway system and embarked on new signage and advertising programs. The map is a genuine improvement. The Authority should distribute similar maps for its bus routes. The signage program is intended to key the subways' colors and codes to the new map. The marketing campaign, unfortunately, is superficial and unconvincing.

Part of the MTA's problem is that years of neglect, budget cuts, and "deferred maintenance" have left the city with a decrepit, broken-down product. Indeed, management reforms will have little impact - however well implemented - unless the city begins a major program of rehabilitation, increased maintenance, and capital improvements for its subway and bus systems. Numerous studies have detailed the enormous capital needs of the transit systems and describe sensible expenditure programs. Conservative estimates have placed these needs at from $20 - $40 billion over the next ten years.[63] Unfortunately, only a small portion of these funds can be expected to materialize. As a result, the condition of the city's transit infrastructure and, therefore, of the system itself is likely to continue to deteriorate and remain for many an unacceptable alternative to driving.

3. Delivering the Goods

The manner in which trucks operate within the city, their size and pattern of movement all contribute to the city's congestion and the environmental costs associated with it, particularly air pollution. This need not be the case. But trucking operations in the city continue to be characterized by excessively high total mileage relative to the ton-miles of service provided, by relatively small loads, and by a serious lack of parking space and loading facilities.[64]

The best way for the city to resolve these problems would be by consolidating much existing truck activity and by providing alternate modes of freight transport. This means rail and water routes. Yet the city, as the nation, has been experiencing inexorable reductions in these modes with corresponding increases in truck use. The trend is environmentally and economically unsound, particularly for New York City, four of whose boroughs are islands. Policies that would result in replacing 200 trucks by one train, in floating more goods across the harbor, or in creating rail freight access directly across the Hudson and East Rivers are badly needed. Apart from their contribution to congestion levels, the city's reliance on trucks is an important factor in the high cost of living in New York: the cost of moving goods into the New York area is far above the nationwide average.

Improvements in truck traffic need not wait for the development of new rail and water routes. Significant progress can be made through a number of practical management reforms. Among those that offer promise are the consolidation of existing terminal facilities, changes in delivery hours, and the provision of adequate off-street loading space.

Consolidating terminal facilities in the city offers an immediate return in terms of reduced truck mileage. Changing delivery hours from high traffic daytime periods to later, less congested hours is more problematic because of the strong industry opposition such plans arouse and because of the extra labor costs they incur. Providing off-street loading spaces is less controversial but requires a serious commitment by the city to design such spaces, set them aside and, in effect, to begin redistributing the use of its street space. Yet such facilities would take many trucks off the street and relieve them of the burden of jockeying for on-street and often illegal spaces.

A great deal of interagency and industry cooperation is needed to pursue any of these reforms but the returns should be worthwhile. The cost of inaction is already a burden New Yorkers could well do without.

4. Uniform Tolls and Free Fares

New York's 1973 Transportation Control Plan required the city to begin tolling its 12 free East and Harlem River bridges, in combination with other transportation reforms. This action is still an attractive way to reduce congestion while improving the island's overall environment.

Twenty bridges and tunnels connect Manhattan with the world. The Port Authority collects tolls on the George Washington Bridge and the Lincoln and Holland Tunnels. The Triborough Bridge and Tunnel Authority collects tolls on the Triborough Bridge, the Henry Hudson Bridge (at the northern tip of Manhattan), and the Queens Midtown and Battery Tunnels. A large portion of these monies is diverted from transportation needs to subsidize projects such as the World Trade Center, the Port Authority's planned industrial parks, and other port and area development plans.

But 12 East and Harlem River bridges are not tolled, even though they funnel a debilitating stream of 415,000 vehicles per day into Manhattan's overloaded streets and highways. Moreover, these bridges are rapidly deteriorating and require considerable sums to maintain and rehabilitate. That they are not tolled is testimony to the political clout of motorists.

Few traditions have withstood economic forces as well as this no tolls policy. However, it perpetuates an inequitible aspect of the city's transportation policy: the motorists using these East and Harlem River bridges are a priviliged group: unlike subway and bus riders, unlike all other persons entering and leaving Manhattan, they pay no toll, fee or fare to contribute to the costs of maintenance and operation.

A more productive and equitable policy would be to incorporate all of Manhattan's entrance routes into a single, comprehensive system having a uniform toll of $3 for passenger autos and an escalating toll for trucks. The truck toll could range from $6 to $18 depending on axle number, with the scale increasing by $3 for each axle. Existing tolls for buses should be eliminated; motorcycles could be tolled $1.50; trailers for passenger autos could be tolled from $5 to $9, again depending on axle number. Table 3 lists these existing and suggested tolls.

A preliminary analysis by Citizens for Clean Air indicates that the establishment of this toll structure would generate about $565 million a year while only negligibly increasing the overall cost in region of freight and personal transportation.[65] The analysis also shows that these uniform tolls would:

* Adequately subsidize the city's entire bus and subway system.

* Reduce passenger car trips to Manhattan by more than 78,000 per day.

* Increase average vehicle speeds in Manhattan by about 17 percent.

* Save the public and the business community more than $160 million per year in congestion related time expenses.

* Reduce gasoline use by about 70 million gallons a year.

* Reduce the city's air pollution and cut its related health costs by about $29 million a year.

* Stimulate about $28 million a year in increased transit fare revenues.

The key to making such a policy work would be to use the funds generated to improve Manhattan's street and transit environment. For

TABLE 3. EXISTING AND PROPOSED TOLLS FOR ACCESS TO MANHATTAN

Vehicle Classification	PA Tolls: G.W. Bridge, Lincoln & Holland Tunnels	TBTA Tolls: Triborough Bdge., Queens Midtown & Battery Tunnels	Proposed Tolls For All Routes Into & From Manhattan
Passenger Cars			
Cash Toll	$1.50	$1.50	$ 3.00
30 Day Commuter Ticket	1.00 @	n/a	n/a
Carpool Ticket	.50	n/a	n/a
25 Trip Ticket Book	1.35 @	n/a	n/a
Motorcycles	$ .75	$1.50	$ 1.50
Passenger Cars &:			
1 axle trailer	$2.25	$2.40	$ 5.00
2 axle trailer	2.25	3.20	7.00
3 axle trailer	2.25	4.50	9.00
Buses			
2 axle	$2.00	$3.00	free
3 axle	2.00	4.50	free
4 axle	2.00	6.00	free
Light Trucks	$1.50	$1.50	$ 3.00
Heavy Trucks			
2 axle	$2.25 - $3.00	$3.00	$ 6.00
3 axle	3.00	4.50	9.00
4 axle	4.50	6.00	12.00
5 axle	6.00	7.50	15.00
6 axle	6.00	9.00	18.00
Additional axles	Based on Vehicle Comb.	$1.50 @	$ 3.00 @

Source: Port Authority of New York and New Jersey.

example, the funds would be enough to turn Manhattan Island into a free transit zone; that is, to eliminate all bus and subway fares for travel within the island. This would increase the attractiveness of Manhattan's transit systems and further reduce congestion. Benefits to the tourist and entertainment industries would also be substantial.

5. The Pedestrian Option

Combining uniform tolls with a no fare policy within Manhattan would also give the City the means and the incentive to implement a series of visionary yet sensible proposals by George Haikalis of the Tri-State Regional Planning Commission.

Haikalis' proposals center around restructuring and restricting auto use in Manhattan as a means of reducing congestion while improving the environment for pedestrians and transit riders. "The notion is advanced," writes Haikalis, "that perhaps a new balance may be struck, with more street space for people, and somewhat less for vehicles."[66]

In "Towards an Auto-Free Manhattan," written in 1974, Haikalis proposed closings that would reduce street mileage in Manhattan by about 15 percent and vehicle mileage by about 25 percent. Figure 2, drawn from this report, shows suggested street patterns. Haikalis' plan recommends closing such major north/south avenues as Third, Lexington, Madison, portions of Fifth, Sixth, Seventh, and Broadway from Inwood to the Battery. The major commercial streets would also be converted for pedestrian use. These include all of 42nd and parts of 14th, 34th and 59th Streets. The longest, most continuous and heavily traveled arteries would be retained for vehicles as well as all of the streets in the industrial and warehousing districts.

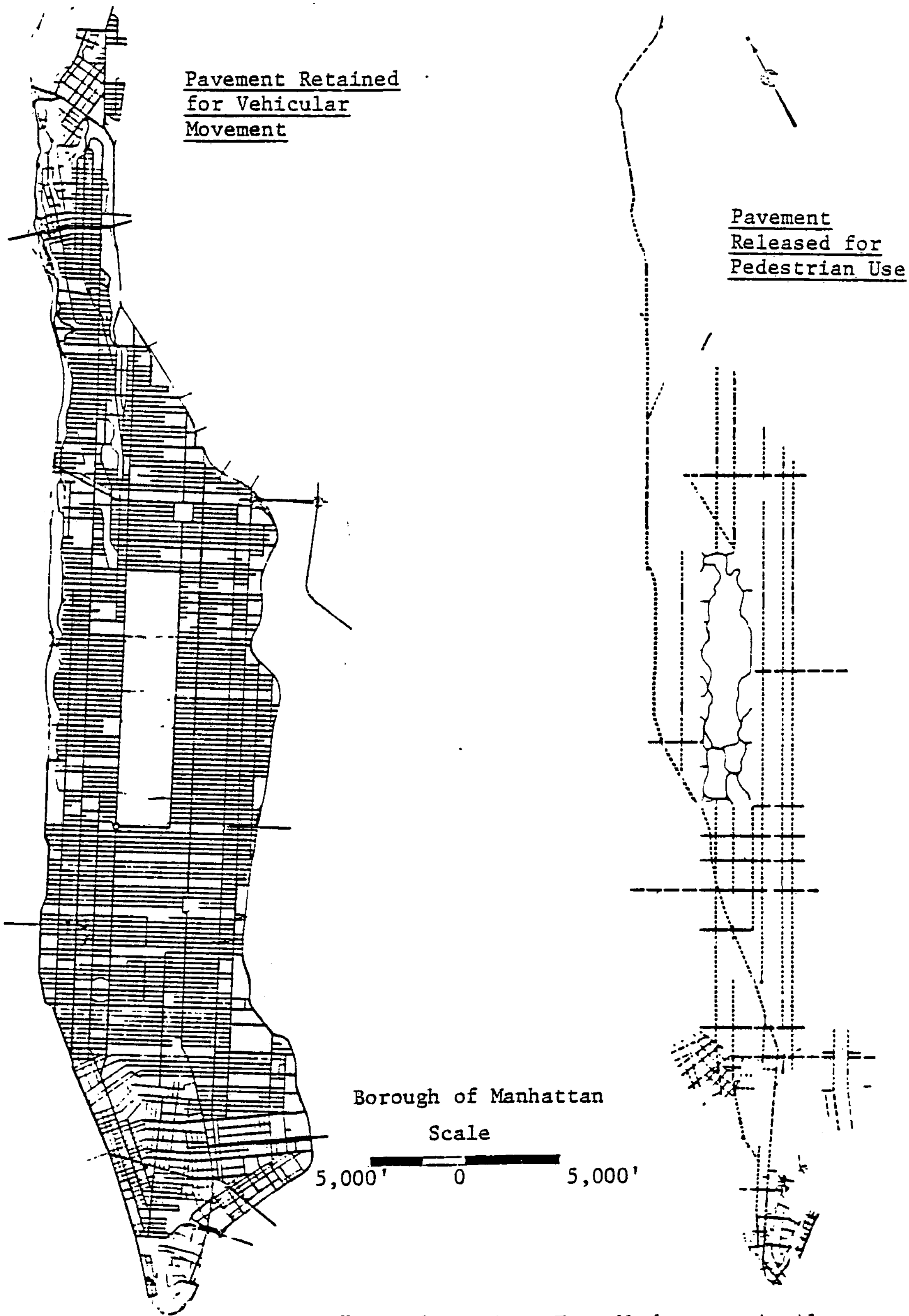
Haikalis emphasized that his proposal "is not intended as a punishment for auto, taxi and truck users, but only as a redistribution and reallocation of scarce resources."[67]

Haikalis has also proposed creating extensive pedestrian oases in especially dense parts of Manhattan such as midtown, downtown and Greenwich Village.[68] Figure 3 shows his recommendations for lower Manhattan. The focus of this plan is the financial district. Vehicles would be excluded from all of Wall Street and along Broadway from Worth Street, which is above City Hall, to Bowling Green. Additional street closings in the area would allow the existing public plazas of the World Trade Center, the U.S. Steel Building and the Marine Midland Bank to be unified into a single pedestrian system.

Haikalis recommends similar plans for Broadway at midtown, Fifth Avenue, 42nd Street and Lexington Avenue. "These four arteries," he writes, "contain the busiest, most overcrowded, and least comfortable pedestrian environments anywhere in the U.S. Creating pedestrian malls along these avenues will revolutionize the appearance of midtown, restoring and stabilizing the commercial and entertainment complex that is to vital to the city's health."[69]

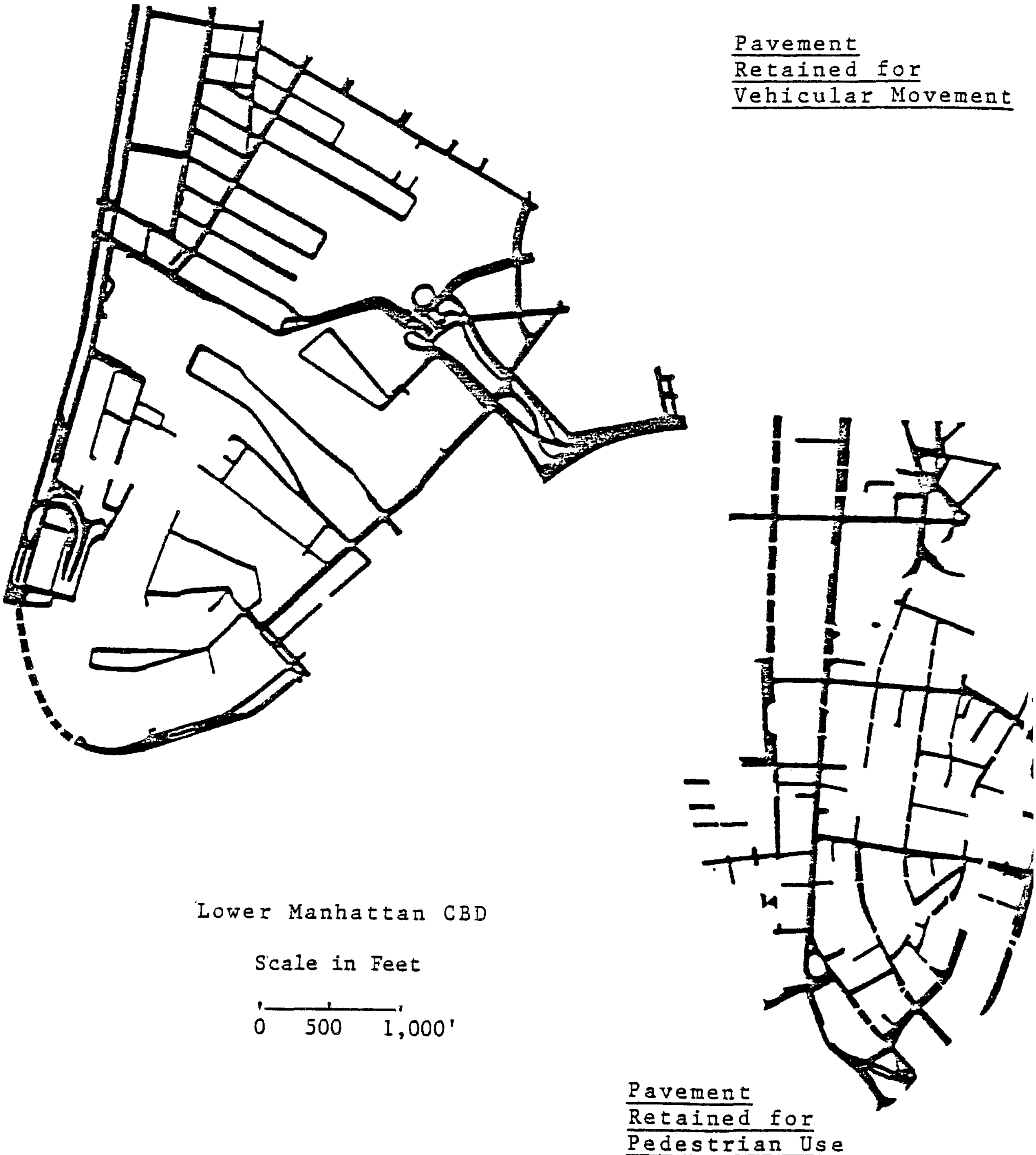
These plans also recognize the need for tolls on the East and Harlem River bridges. But Haikalis goes a step further and suggests changes in the patterns of traffic to and from Manhattan. Specifically, he recommends converting the Queens Midtown and Battery Tunnels into one-way inbound facilities, the Brooklyn and Queensboro Bridges into one-way outbound facilities, the Manhattan Bridge into a two-way route for trucks only, and restricting the Williamsburg Bridge to bicyclists, pedestrians and transit vehicles. Tolls would only be collected inbound.[70]

FIGURE 2. PEDESTRIANIZING THE BOROUGH OF MANHATTAN



Source: George Haikalis, "Towards an Auto Free Manhattan. An Alternative Strategy & a Proposed Study," Analysis Notes, Tri-State Regional Planning Commission, Dec. 1974.

FIGURE 3. PEDESTRIANIZING THE LOWER MANHATTAN CBD



Source: George Haikalis, "Auto-Free Zones in CBDs and an Example for Lower Manhattan," Interim Technical Report 4447-3306, Tri-State Regional Planning Commission, Dec. 1974.

Haikalis estimates this arrangement would reduce auto traffic into Manhattan and within the CBD and encourage greater transit use while generating nearly $100 million in new annual revenues. He also points out that this plan, or any similar rerouting, would require little or no new construction and, therefore, no major investment of capital.

6. Plus Ca Change...

Plus ca change, plus c'est meme chose; the more things change, the more they stay the same. New Yorkers grudgingly adjust to the congestion of their city, some even profit from it, but its stubborn presence has become emblematic of the failure of government to resolve the problems posed by transportation in an urban setting. As New York has grown, its congestion and the costs associated with it have also grown, though their characteristics have altered.

Over the last decades, for example, there has been a decisive shift away from mass transit to private autos. Similarly, much of the freight that once traveled to New York by rail now arrives by truck. Though the total number of people entering the CBD has remained stable since the early Sixties, the number of entering autos and taxis has increased year by year. Meanwhile, auto occupancy rates have decreased. This means that fewer people now use more vehicles, relatively and absolutely, to travel into the CBD than ever before.

Manhattan's population has always followed Manhattan's transportation. In its early days, transit lines were built with enough capacity to allow fairly dense residential development. This encouraged the city's rapid expansion, particularly in the first decades of this century. The mass transit lines were privately owned but the mode was en masse. Private cars were relatively few and roads were inadequate.

Conditions changed. Auto, truck and highway technologies matured; the city acquired no longer profitable private transit lines; more people purchased their own cars. After World War II, the automobile emerged as the dominant mode of transportation. Highways became the new axes around which development grew. For a time affluence increased steadily. The middle class drove its new cars over new roads and out of the city to be replaced by poorer people who traveled less but depended more on transit systems - buses and subways.

Many of those who moved out of the city continued to work, shop and play in the city, especially in Manhattan. Moreover, the island was changing from a blue-collar manfacturing locale into a white-collar corporate center. This conformed with the largely white-collar character of many of the city's suburbs. Since the vast majority of white collar jobs begin at 9 a.m. and end at 5 p.m., congestion during these commuter rush hours increased significantly. Yet none of the city's newer suburbs were dense enough to justify public transit. This further increased the pressure to drive into the city for all purposes.

There is no evidence to indicate these trends can be simply or easily reversed: people will not abandon their cars merely because available transit facilities have been improved. However, congestion and its associated economic and environmental costs are not inevitable. But what is needed is a broad, frontal attack on the very transportation practices that the city and the state have encouraged and nourished over the preceding years.

Such a program must consist of policies that restrict the entry and operation of vehicles in Manhattan, especially within the CBD and during peak hours. It must provide for massive improvements in the quality of the city's existing public transit systems in order to provide acceptable transportation alternatives. It must begin to pedestrianize congested districts in Manhattan by connecting existing plazas and pedestrian areas. This would permit alternate transit modes - such as bicycles, trolleys and shuttle buses - and obviate the need for passenger cars. It must include financial incentives and a more equitable distribution of the costs of transportation such as would be partially achieved by a uniform Manhattan entrance toll. It must include extensive public education and marketing campaigns; in effect, a major transportation consciousness raising. Most importantly, it must include personal commitments and leadership by the city's chief elected officials, particularly the Mayor.

Congestion has always proved intractable in Manhattan. The borough's density, the variety of transportation modes that co-exist within it, and the way that the city's transportation needs cross all demographic, geographic, cultural and political lines are constants in New York's equation. Today, however, the city must also deal with the continuing deterioration of its transportation infrastructure, the difficult financial constraints resulting from its near bankruptcy, and the impact of the growing energy crisis.

EPILOGUE: COMMONS SENSE

> "The tragedy of the commons develops in this way. Picture a pasture open to all. It is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satsifactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy."[71]

Manhattan's Central Business District is a contemporary commons. Its streets, avenues, highways and parking fields are limited facilities abused through chronic overuse. Its congestion is the most visible byproduct of this historic pattern. But unlike the classic scenario of Garret Hardin, this particular commons has been subject for many years to certain kinds of restrictions. Parking, traffic, zoning and environmental regulations are numerous, complicated, and subject to differing interpretations and degrees of enforcement. However, except for the City's Transportation Control Plan, they share the belief that vehicular access to the CBD may properly be regulated but should not be denied or discouraged. This approach seeks to moderate the undesirable impacts of street use, particularly congestion, by weighing public against private interests on a scale ranging from city-wide to block by block. As one result, there are more than 250 different parking situations, each covered by a specific regulation. These and other laws regulating the streets are in turn enforced with varying degrees of laxity and severity: one month there will be a crackdown on illegal parking in midtown, another month there will be a crackdown on drivers who block intersections, a third month will witness an effort to eliminate double and triple parking by truck drivers. The point is that the size and complexity of this body of law, the budgetary limitations and competing demands placed on enforcement agencies, as well as day to day political considerations, all combine to mitigate against an effective husbandry of Manhattan's limited street space.

The increasing domination of this space by automotive traffic has exacerbated demands on its use and may well have tipped the balance toward a physical collapse that will have severe economic repercussions. Arthur Laffer, the economist, uses an arch-shaped curve to show that if a government sets the tax rate at zero, no revenue will be collected and that if the tax rate is 100 percent, again, the government will collect no revenue, so completely would such a levy discourage open economic activity. Laffer concludes that the tax rate which generates the most revenue for the government is not 100 per cent but somewhere between zero and 100 percent.

The problem of determining this rate is analogous to the problem of regulating street use. If there are no pedestrians and no vehicles, there is no congestion. However, no one is benefiting from the existence of the streets. At the other extreme, if every lane, every street and every intersection in Manhattan were occupied by bumper to bumper traffic and by body to body crowds of pedestrians, no one would be able to move. The system would break down and, again, no one would benefit. The ideal, the maximum benefit a society can gain from the use of its public rights of way, is somewhere between these extremes. At present, however, traffic in Manhattan may have reached a level at which each additional vehicle entering the street system costs society more than it benefits its individual occupants or owners. For any single vehicle these costs are so small as to perhaps be unmeasureable in a realistic sense. But traffic in Manhattan is a matter of hundreds of thousands of vehicles and millions of people. The sum of the incremental societal costs imposed by so many vehicles upon a street network where the government is incapable of adequately managing their flow and servicing their needs is a serious social dilemma. At its heart is the quandary posed by a commons: what is good for an individual is not necessarily good for all.

Much of this report has dealt with the technical means for coping with this problem as it applies to traffic congestion in Manhattan. But the solution itself is not technical. It involves changes in values, changes in attitudes about public facilities, and changes in the way we apportion, use, share and protect limited resources. These changes can only be suggested here with the emphasis that the means for implementing them are available. Congestion in Manhattan has reached a point at which its effective regulation requires changes in our attitudes about how streets and automobiles should be used. These are fundamental social issues, not mechanical breakdowns amenable to a technological fix. Until they are confronted and resolved as social issues, congestion in Manhattan and the many costs associated with it are not likely to decline.

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THE SOCIETAL COSTS OF CONGESTION IN NEW YORK CITY

APPENDIX 1

AN ESTIMATE OF SOME DIRECT AND INDIRECT COSTS OF HIGHWAY TRANSPORTATION IN MANHATTAN, NEW YORK CITY, THE TRI-STATE REGION, AND THE UNITED STATES FOR 1978

December 1979

CONTENTS

LIST OF TABLES

INTRODUCTION

This is an accounting within the limits of available information of the estimated 1978 costs of highway-related transportation for Manhattan, New York City, the Tri-State Region and the United States. Cost estimates include both direct consumer expenditures and indirect costs such as subsidies and the externalities related to traffic congestion, traffic accidents and air pollution. In New York City, the magnitude of these indirect highway costs matches the sum of direct costs for all non-highway transportation.

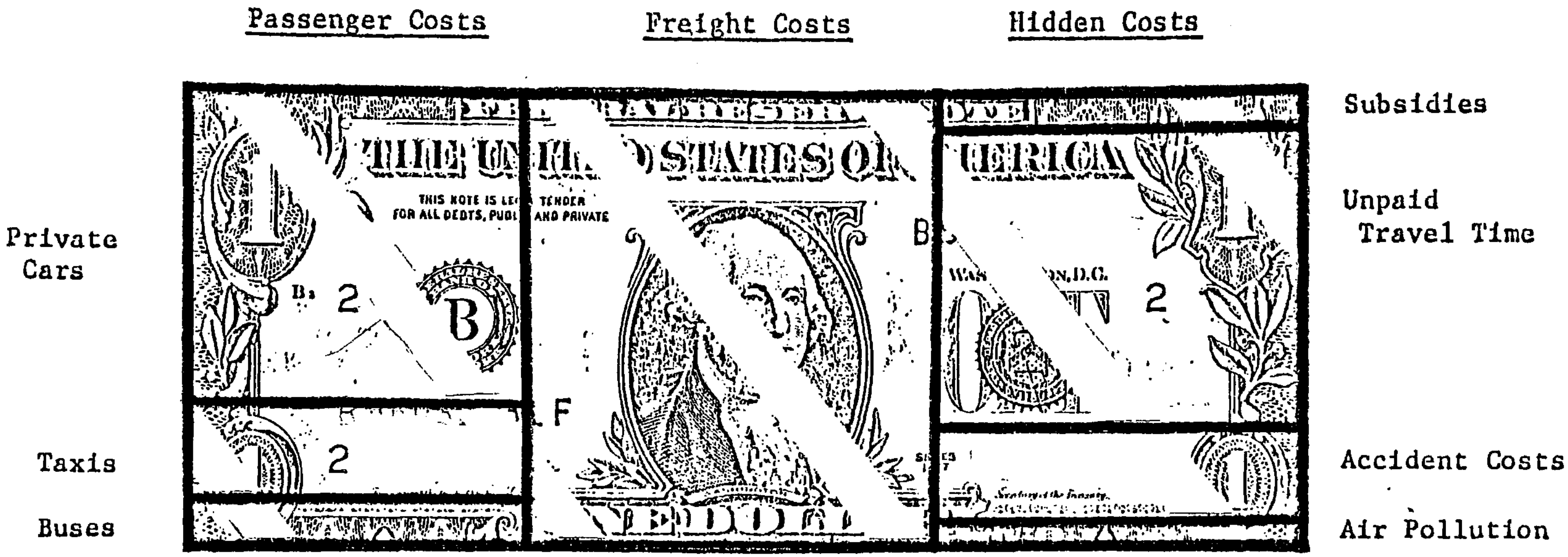
No attempt is made to place a value on traffic noise, vehicle-related water pollution, aesthetic values and the like, although we believe such costs are significant and worthy of investigation as the full cost of all modes of transportation is more fully developed and understood.

Figure 1 and Table 1 summarize both the Direct Costs (i.e. User Expenditures) and many of the Indirect or Societal Costs involved in highway movement of people and goods. They show, where data is available or calculations are feasible, such costs for Manhattan, New York City, the Tri-State Region (see Table 10 for a list of counties in the Region) and the United States. Table 2 augments this with non-highway direct expenditures. The text and following tables explain how our calculations are made and provide additional detail.

For consistency, all large dollar figures are in billions of dollars. For brevity, we designate this by using the capital letter "B" after the appropriate number; e.g., $0.6B means six hundred million dollars.

Common abbreviations we have used in this report include NYC (New York City), TSR (Tri-State Region), GNP (Gross National Product), mph (miles per hour), VMT (Vehicle-Miles Travelled, per weekday unless indicated otherwise) CBD (Central Business District; in Manhattan this means south of 60th Street and ITR (Interim Technical Report, an internal publication of the Tri-State Regional Planning Commission).

FIGURE 1: HOW NEW YORKERS SPEND THEIR HIGHWAY DOLLAR



Every dollar spent for highway transportation in New York City is split three ways: 31 cents are used for out of pocket personal expenses, 35 cents are spent on the shipping of goods, and 34 cents are hidden costs. They represent taxes paid to subsidize highways and buses, losses due to accidents, time spent traveling during business hours, and the costs of air pollution.

DIRECT COSTS

Direct User Expenditures

The righthand column in Table 2 lists by mode the estimated 1978 direct user expenditures for transportation in the United States. These are projected using a least-squares exponential regression of the 1965-1976 data in the Transportation Association of America's "Transportation Facts and Trends, Thirteenth Edition - 1976, July 1977," pp. 4-5, and the April 1978 Quarterly Supplement. Tables 3 and 4 summarize the TAA data. Tables 5 and 6 present the TAA's 1976 projections plus our exponential projections for the 1977-1982 period. Table 2's righthand column contains in rearranged format the 1978 projections from Tables 5 and 6. The left and middle columns in Table 2 show our estimates of New York City and Regional expenditures, which are developed in the following six sections. Table 2 also displays some non-highway user expenditures to place highway costs in perspective. However, the corresponding societal costs are not developed in this paper.

Private Car Expenditures

Private car costs in New York City and the Tri-State Region are developed from the Hertz Car Leasing Division's nationwide data (Table 7) and EPA data on mileage by model year (Table I-5, "Mobile Source Emission Factors," Jan., 1978). We judge Hertz's analysis to be superior to that in Tri-State's ITR 2104 ("Typical Automobile Operating Costs in the Tri-State Region," Feb. 1975) because of Tri-State's simplistic approach to details. However, we rely on Tri-State for estimates of charges for tolls and parking/garaging (0.45 and 2.35 cents per mile, respectively). GNP implicit deflators (Table 8) are used to restate Hertz's current-dollar costs for each model year in terms of third quarter 1978 dollars.

Available literature shows that a domestic car's first owner (be it person or corporation) trades it in when it is between 3.57 and 4.2 years old. Used cars are generally held for an average of 3.23 years. Our approach requires integer values; by assuming trade-ins, the calculated operating cost is underestimated. First and second owners are assumed to own cars for three years each. Third and subsequent owners are assumed to bear identical operating costs for each year that the car remains in service. The major source of the "second-hand effect" is the reduced annual depreciation taken by the new owner.

Each model year's cost per mile is multiplied by the fraction of annual VMT chargeable to that model year (pre-1970 cars being aggregated with 1970 cars) and these products are summed to obtain a typical private car operating cost of 24.83 cents per mile.

The VMT per 1978 weekday (Table 10) are derived from Tri-State's Highway Evaluation Model for the Region using linear interpolation between Tri-State's 1970 and 1980 projections and making corrections with further Tri-State data to separate out taxis, trucks and buses.

Because VMT are traditionally measured on weekdays (when congestion is most intense in CBDs), annualization would be exaggerated by using 365 days as a multiple. Like the NYC Department of Traffic, we use Manhattan CBD tunnel trips (which are tolled and thus counted) as a tool for establishing the travel rates in the Manhattan CBD on weekends and, therefore, for the entire week. According to Table 11, the week's vehicle count ranges from 6.46 to 6.80 times the average of the weekday count at the four tunnels (rather than 7 times). The weighted average is 6.69. Multiplying this by 365 and dividing by 7 yields 349 effective VMT-weekdays per year.

With this figure, we can now calculate private car user expenditures for Manhattan, New York City and the Tri-State Region by multiplying the private car VMT for each geographic area by 24.83 cents per mile and by 349 travel days per year. The results are $0.37B, $2.61B, and $17.41B, respectively. (Performing the same calculations with NYC Dept. of Air Resources 1973 Private Car VMT data yields $0.41B for Manhattan and $2.62B for New York City.)

Taxicab/Livery User Expenditures

According to a private communication from Murray Rosensweig, vice-president of Eden Transportation Systems, Inc. (the city's largest taxi fleet), the 2,500 taxis still operated by fleets (as opposed to the burgeoning mini-fleets) gross an average of $70 on the day shift and $80 on the night shift, exclusive of tips and regardless of the day of the week; the utilization rate averages about 92½% day and night. The annual gross for fleet taxis, assuming that tips run about 15%, is $0.15B.

Tri-State's ITR 1312, "Taxi Travel Survey Methodology and Findings," June 1978, uses 1977 data to show that owner/drivers and mini-fleet operators behave much the same, averaging 68 fares per day compared to 122 for the two-shifted fleet cabs. Since no formal data has been published on taxi revenues, we used the proportion of fares-per-day to calculate that these 9,300 privately owned taxis gross $0.26B per year. We adjusted for the fact that owner/mini-drivers drive only 6 days a week.

Table 10 of ITR 1312 indicates that 79.3% of all identifiable fare trips by New York City medallion taxis occur entirely within Manhattan and are, therefore, fully chargeable to Manhattan. An additional 5.6% begin and 3.6% end in Manhattan; these latter are thus half chargeable to Manhattan since a trip's costs should be charged half to its origin and half to its destination.

Only one trip in 1,000 leaves the city so the total New York City medallion gross of $0.40B can be fully charged to New York City, with $0.34B charged to Manhattan. We have assumed that trip charges are uniformly distributed regardless of borough of origin or destination. This slightly exaggerates the Manhattan share where many trips are relatively short.

ITR 1312 also refers to "about 20,000" non-medallion livery vehicles in New York City. There is no reliable data on these essentially unregulated vehicles which specialize in serving non-midtown areas where demand is too light to attract the high-investment medallion taxis. State registration data is weak because many livery owners use out-of-the-city addresses to obtain insurance at lower rates. In addition, many liveries are worked only part time. A 1972 report from the New York City Taxi & Limousine Commission ("The Non-Medallion Industry: A Transportation Phenomonen," Michael Lazar, project director) lists $250 to $300 as the range for weekly grosses. Updating this with the GNP Implicit Deflator (1.5356), we estimate that the annual gross is $22,000 per vehicle and that the annual citywide gross is $0.4B, of which perhaps half is chargeable to Manhattan.

While livery vehicles include chauffer-driven limousines that are for hire (and that are identifiable by the letter 'Z' in their license plates), there is yet another category of livery - gypsy cabs. These are private cars that are used to carry passengers for hire in contravention of their registration rules and insurance policies. Although there is no accurate data available for gypsy cab activity, it is included in the Private Car category because that is how such vehicles are registered.

Although Tri-State's VMT data shows zero taxi/livery mileage outside the city, there clearly is some. According to Tri-State's Technical Bulletin ("Findings of a Taxi Survey," Vol. 4, No. 3, April 1963), taxi VMT in the Region outside New York City was 24.2% of city taxi VMT in 1963. Assuming that the proportion has not changed in the last 15 years and that user expenditures are proportional to taxi

VMT, we calculate an outside the city taxi expenditure of $0.15B, which brings the Tri-State Regional total to $0.95B, nearly half of the separately estimated national figure.

School Bus Expenditures

According to Nicolas Pileggi's "Warily We Roll Along on Our Way to School" (New York magazine, June 19, 1978), New York City spent $0.073B in 1977 to transport 133,000 students to public schools, about $550 per student. We assume 1978 costs will be the same.

For that part of the Tri-State Region outside of New York City, unpublished Tri-State statistics show that $60,867,308 was spent in New Jersey's 10 Tri-State Region counties to transport 373,130 pupils in 1976-1977 ($163.13 per pupil) and that $17,844,564 was spent in 52 Connecticut town and rural school districts to transport 188,432 pupils in 1976-1977 ($94.70 per pupil).

Based on a least-squares power regression of data in Table VII of Tri-State's ITR 1206 ("Public Transportation Operational and Financial Statistics in the Tri-State Region - 1976," June 1978), we estimate that 1.3 million pupils will be transported by school bus throughout the Region in 1978. Subtracting the total students from the city, New Jersey and Connecticut leaves 600,000 for the remainder of the Region within New York State. However, busing cost data are not available for these students. Estimating costs at $130 per pupil for a total of $0.078B, the Regional total comes to $0.23B. This is exclusive of the cost of busing students to private schools, for which we found no data.

Local Bus, Subway and Commuter Rail User Expenditures

Tri-State's ITR 1206 reports Regular Route Revenue for 1973-1976. Least-squares exponential regressions yield the 1978 estimates shown in

Table 12. Note that subsidies are not included. Regular Route Revenue is the direct expenditure by users. Half of Commuter Rail is charged to New York City, specifically Manhattan, because most passenger trips are to or from Manhattan: the other half would be charged to the suburban end of the trip.

Intercity Bus and Rail, Aviation and Marine User Expenditures

The 1978 national projections of the TAA's historical data for these categories are allocated to the City and the Region on a per capita basis. A more rigorous breakdown is beyond the scope of this report. Using 1976 population data from Tri-State (1,416,700 for Manhattan, 7,453,600 for New York City, and 18,437,800 for the Region), assuming zero growth in the past two years, and comparing these figures with the Census Bureau's latest 1978 United States figure of 217,941,000 yields the following per capita user expenditure percentages: 0.65% for Manhattan, 3.42% for New York City, and 8.46% for the Region.

Freight Transportation User Expenditures

Freight costs in the Tri-State Region are allocated to modes using the proportions in Robert T. Wood's paper for Tri-State, "The Urban Freight System: Why It Doesn't Work Better," which was delivered at the 1973 International Physical Distribution Management Conference, Tokyo. The Manhattan and New York City shares of the Region's costs are apportioned in accordance with the inter-county matrix of 1961-1964 freight movement in Tri-State's ITR 4105-6591 ("Application of the Input-Output Technique to Regional Freight Forecasting," Dec. 1968), which is the latest comprehensive data available. This report gives annual tonnage totals for truck and for all freight. We assume that costs are proportional to tonnage and that the proportions have remained unchanged since 1968. Freight forwarding is charged to local trucking and the operation of traffic departments is split equally between railroads and trucking. See Table 13.

INDIRECT COSTS

Transportation Subsidies

Highway subsidy figures are taken from the Federal Highway Administration's Feb. 9, 1978 Press Release 10-78, Table HF-11, which details government funds available for highway construction and maintenance in excess of fees and user taxes at all levels: federal, state, county and the like.

For 1978, the FHWA's forecast for all levels of government is: $1.860B for property taxes and assessments; $6.652B for general fund appropriations; $1.915B for investment income, less an estimated $1.090B placed in reserves; and, at the federal level only, $0.021B for miscellaneous taxes and fees. (At state and local levels, this latter category includes sales tax revenues which are already counted in user expenditures as direct costs.) The total forecast is thus $9.36B. When apportioned to Manhattan, New York City and the Tri-State Region on a per capita basis, the results are: $0.061B, $0.320B, $0.792B, respectively. Data for a more rigorous analysis are unavailable.

The only other government subsidy for highway sector operations for which information is available is for local bus use. The amount can be determined by taking the excess of total expenses over total revenues (from Table 12). The expenses are paid somehow and the extent by which they exceed farebox collections constitutes a subsidy. We used Total Revenues instead of Regular Route Revenues so that the subsidizing effect of transit advertising and other revenues, if any, is excluded here.

Using least-squares regressions on Tri-State's 1973-1976 data in ITR 1206, the projected subsidies (excess of expenses over total revenues) for bus operations in 1978 are $0.091B for New York City and $0.153B for the Region (Table 12). The midtown and Manhattan shares of the New York City figure can be apportioned per bus VMT (8.85% and 28.47%, respectively, on a 24-hour weekday basis). The resulting figures are $0.008B for midtown and $0.026B for Manhattan.

The above considers operating subsidies but there is also the matter of capital subsidies. Again, information is skimpy. For the 1977-1978 fiscal year, the NYC Transit Authority's capital budget included $0.0487B for the bus system. Because farebox receipts do not even cover the operating budget, these capital expenditures are totally subsidized and, therefore, indirect expenses to the users.

Since we do not have capital budget data for other bus activities within the region, we estimate the total at $0.050B. We use the same 8.85% and 28.47% figures for bus capital items as were used to assign bus operating expenses to midtown and Manhattan; this yields respective amounts of $0.004B and $0.014B.

The Cost of Unpaid Travel Time

Table 15 presents data excerpted from the NYC Department of Air Resources' automotive modeling data base. It presents VMT by vehicle mode during the hours noted on classes of roadway as well as overall average speeds (regardless of mode) for four sections of Manhattan and for the four other boroughs for a weekday in 1973. These data are used to calculate the unpaid time spent in highway travel in each geographic area except midtown Manhattan's arterial and local streets; for these latter, see below.

Our calculations consider only the morning and evening rush "hours" on expressways and only the "business day" (7 a.m. to 6 p.m.) on arterial and local streets. Since data is available for the expressways in the outer boroughs only for the morning rush hours, the morning delays are assumed to be duplicated in the evening. Note that the rush "hour" is longer in the outer boroughs. Other time periods are omitted because the value of a person's time when he or she is neither working nor commuting may be lower and is certainly not easily computed. Since it does have some value, this is an extremely conservative omission.

The Dept. of Air Resources' Automotive Modelling Data (Table 15) presents only one average speed for all modes (private car, taxi/livery, truck or bus) in each time and territory. On crowded streets, it is evident to even a casual observer that buses do not keep up with private cars and taxis. Since it is demonstrated below that buses are higher value vehicles than taxis and cars, it is conservative to neglect this disparity. This we have done except for midtown Manhattan's arterial and local streets where we were able (see Appendix 2) to gather our own passenger car speed data and thereby estimate bus speeds. Our test of a 7-mile loop connecting 57th Street with Fifth and Sixth Avenues yielded a 7 a.m. to 6 p.m. business day average speed of only 5.5 mph. We estimate that buses, which comprise 3.97% of the business day VMT, average 4.5 mph and that trucks, which comprise 16.53%, average 5.5 mph.

For midtown Manhattan we have used our data for passenger cars and taxis and our estimates for buses and trucks. For the rest of the city, we used the Department of Air Resources' automotive modeling data presented in Table 15.

Vehicle Occupancy

According to the NYC Department of Transportation, private cars average 1.6 occupants: the driver plus 0.6 passenger. The national average is 1.5.

According to Tri-State's ITR 1312, New York City taxi fare-carrying trips average 1.38 passengers and make up 57% of taxi mileage. This yields an effective average load of 0.79 passenger. In the absence of formal data, non-medallion livery vehicles are presumed to have the same characteristics as taxis.

Buses average 12 passengers in New York City. This is based on a comparison of passenger-mile and bus-mile totals in Tri-State's ITR 1206.

Since the driver of a taxi/livery or a bus is being paid for his or her time, this cost is already included in direct expenditures. However, since drivers of private cars are not paid, the value of their time will be included in these calculations.

Value of Time

According to Tri-State's Highway Evaluation Model, the average worker in the Tri-State Region was paid $5.35 per hour in October-November 1975. According to the U.S. Bureau of Labor Statistics' Northeast Regional Employment Cost Index, increases between then and March 1978 amounted to 15.5%, bringing the rate to $6.16 per hour. Assuming that the 1973 percentage of the population employed in the Tri-State Region remains at 44.7% and accepting that the value of the time of unemployed dependents is a burden on wage earners, the average value of time is $6.18 x 0.447 = $2.76 per hour. However, this figure is conservative since children are under-represented in private car occupancy during the school day portion of the business day, especially in midtown.

This $2.76/hour value is assigned to both drivers and passengers in private cars, even though they make no out-of-pocket expenditures. (Other costs of congestion delays - such as increased fuel consumption and accelerated brake and transmission wear - are covered in direct expenditures though they are not separately identified.)

Judging by their fares, taxi passengers appear to value their time more highly. According to the Metropolitan Taxicab Board of Trade, the industry group representing fleet operators, the typical New York City taxi trip takes between 7 and 15 minutes. Using the median value, a typical trip in midtown Manhattan at the 5.5 mph speed we observed (see Appendix 2) would, therefore, travel just over 1 mile in 11 minutes, or 11.5 minutes if we include 30 seconds for seeking the taxi.

By contrast, walking is slower but costs nothing. Equating taxi fares with the time saved relative to walking yields a value for that time. (We are ignoring the health benefits of walking as a factor; since any such benefits would add to the value of the time considered, this is a conservative omission.)

An average walk at 2.5 mph means that 1 mile would take 24 minutes. This rate allows for delays on crowded sidewalks and occasional red lights. A 1 mile taxi ride thus saves 12.5 minutes for 1.38 passengers. We calculate (see below) that a typical midtown Manhattan taxi trip costs $2.25, including tip, and that each passenger's time is being saved at a cost of (and is therefore worth) $7.83 per hour.

Outside of midtown, an 11 minute ride would cover 2.61 miles at 14.25 mph (a VMT weighted non-midtown average taxi/livery speed derived from Table 15). Such a trip would cost $3.00, including tip (see below). If this distance could be walked at 3 mph, the taxi would be saving its

1.38 passengers 41.2 minutes, indicating that each passenger's time is worth $3.17 per hour.

Similar calculations to determine the value of a bus passenger's time yields $2.78 per hour. This is less than 1% more than the $2.76 per hour wage-based estimate used for motorists. We have used the latter figure in order to remain conservative in our calculations.

Since buses average 12 passengers (at 24 hours, 7 days a week), buses have a time value 7.5 times greater than passenger cars. During "business days" it should be even higher but an analysis of time-specific bus load factors was beyond the scope of this study.

Structure of New York City Taxi Fares - And Taxi Meters

In New York City, where taxi charges are determined by a taxi meter, the fare is not as simply calculated as the display rate suggests. The official rate card on the dashboard reads "75¢ for the first 1/7th mile, 10¢ for each additional 1/7th mile." But there is also, as stated, a charge of 10¢ per minute for waiting time. However, the rate-card does not define "waiting time", nor do the regulations of the NYC Taxi & Limousine Commission. Waiting time is defined de facto by the makers of taxi meters in a way that, not surprisingly, favors taxi operators.

One might reasonably assume that waiting time is time spent at a standstill - while a second passenger is entering or leaving, while a parcel is delivered, at a red light, stuck in traffic, and so on.
In fact, waiting time is any period when a taxi is travelling slower than 8.57 mph. This is the speed at which the 10¢ charge for going 1/7th of a mile takes exactly 1 minute to earn. At slower speeds, the meter is driven by its built-in clock as if the cab weremoving at 8.57 mph.

Mechanically, the meter receives inputs from its clock and its speedometer. Each drives through an overrunning clutch so that the meter is driven by the faster of the two inputs with the fare displayed in dime increments. This type of meter is now decades old. When it was introduced, the Police Department's Hack Bureau (predecessor of the Taxi Commission) may well have overlooked its generous definition of waiting time.

However, because waiting time is so structured, a simple trip over a known distance (such as 20 blocks along a midtown avenue, exactly 1 mile) almost always costs more than the $1.35 one would calculate from the posted fare. In addition, the meter may legally read as much as 2.8% fast on distance and 10% fast on waiting time, tolerances well within the adjustment accuracy of a taxi meter.

Calculation of Taxi Fares

To calculate the expected fare for the 1.008 mile, 11 minute typical taxi trip in midtown Manhattan, where business day traffic is unremittingly stop and go, we assume that half the distance is covered with the taxi moving faster than 8.57 mph and half slower; also, that the fast stretch, when only distance drives the meter, is covered at an average speed of 12 mph. Even though actual speeds will vary continuously, it is reasonable to split the trip into these two modes for analytical purposes.

The first charge is the 75¢ meter drop. Looking first at the fast mode, there will be 10¢ increments at 1/7th, 2/7ths and 3/7ths of a mile distances for a meter reading of $1.05. Since the meter only records dime increments, a charge of 5¢ for the additional 1/14 mile in the fast mode is stored within the meter.

The slow mode occupies 8.5 minutes of the trip. Including the stored 5¢, this brings the final meter reading to $1.95. A reasonable tip would be 30¢, bringing the total cost to $2.25. (In New York City, there is no charge for additional passengers.)

We calculate that a typical trip length outside midtown is 2.61 miles, using the same 11 minute estimate and deriving a VMT-weighted average speed for taxi/livery vehicles of 14.25 mph from Table 15. The fare for such a trip should be $2.65, assuming very few stops and delays and between 45 and 100 seconds spent at under 8.57 mph. With tip, the total cost could be as low as $3.00.

Traffic Accident Costs

In her "Societal Costs of Motor Vehicle Accidents - 1975" (published by the National Highway Traffic Safety Administration, Dec. 1976), Barbara Faigin offers two basic criteria for identifying loss components: "(1) resources consumed in the repair of damage to people and vehicles that could be shifted in the long run to welfare-producing activities and (2) the consumption losses of individuals and society at large caused by losses in production and the ability to produce."

The first category simply consists of the many bills that must be paid by victims, successors, insurance companies, and the like. The second category essentially represents the present value of the foregone future earnings together with an opportunity-cost evaluation of home, family and community services provided outside the paid cost period. This category ranges from 4% to 27% of the total costs of injuries that are not a threat to life but from 83% to 96% of the total costs of injuries that are.

The total figures for both categories are $287,174 per fatality,

$3,185 per injury for a weighted average of a range of injuries, and $520 per vehicle for property damage only (PDO) accidents. Using a GNP implicit deflator factor of 1.2074 to convert these 1975 costs to 1978 third quarter dollars yields $346,735, per fatality, $3,846 per injury, and $628 per vehicle involved in a PDO accident.

We ignore any local differences in wages, medical or repair costs and assume, in the absence of useful local data and despite the lower speeds typical of New York City, that the distribution of levels of injury severity is the same as for the nation.

For the city and Manhattan, we assume that 1978 will equal 1977 in its number of deaths and injuries due to traffic accidents as reported by the New York State Department of Motor Vehicles on Form MV 144a. For the Region as a whole, we use Tri-State's Highway Evaluation Model, interpolating between the 1970 and 1980 estimates of 2,274 and 3,031 fatalities, respectively, to arrive at 2,940 for 1978. We assume that injuries and PDO vehicle counts are in the same proportion to fatalities as is the case nationwide; again, in the absence of local data.

PDO accidents can only be estimated since New York State requires a police report only if property damage per accident exceeds $200 (in 1978 the figure was raised to $400). In a personal communication, Jack Yasnowsky, acting director of the Office of Program Planning at the National Highway Traffic Safety Administration, gave us the following national vehicle figures for 1975: 45,700 fatalities, 4 million injuries, and 22 million vehicles in PDO accidents. (The national ratio of injuries to fatalities is thus 87.5:1; for New York City, it is 106.7:1. This difference seems consistent with the city's lower average speeds and, therefore, lower impact energies.) Assuming that the total number of PDO vehicles (reported officially or not) in Manhattan and New York City is in the same proportion to the combined total of deaths and injuries as it is nationally, then there were 104,000 PDO vehicles in Manhattan and 362,000 in New York City in 1975. The city's MV-144a forms report only 19,309 and 97,660 PDO vehicles for Manhattan and citywide, respectively, but we suspect the difference reflects both the disinclination to fill out the forms and the $200 threshold.

Table 19 tabulates the total societal (direct plus indirect) costs of traffic accidents in Manhattan, New York City, the Tri-State Region, and the U.S.

Air Pollution Costs

An updated and revised extension of Kenneth A. Small's approach ("Estimating the Air Pollution Costs of Transport Modes," Journal of Transport Economics and Policy, May 1977, pp. 109-132) is used in a work in progress by the authors of this report. In it we estimate the costs to human health and property imposed by automotive air pollution in Midtown, in Manhattan, in New York City and in the Tri-State Region.

Small's assumption that urban air is uniformly polluted is used to estimate Tri-State's portion of nationwide costs on a per capita basis. However, for assignments of costs within Tri-State, we created instead a simple model based on average speeds in five specific areas and on the resulting average emissions per vehicle-mile travelled. Generated from this model are emissions costs for the five specific areas:

* Midtown Manhattan
* The rest of the CBD (Downtown and the Valley)
* The rest of Manhattan (Uptown)
* The rest of New York City (Brooklyn, Queens, The Bronx and Staten Island)

* The rest of the Tri-State Region.

These area costs are then summed to produce costs which are displayed in Table 20 for the CBD, Manhattan, New York City and the Region.

THE COSTS OF CONGESTION

APPENDIX 1

*

TABLES 1 - 20

TABLE 1: SUMMARY OF HIGHWAY TRANSPORTATION COSTS FOR 1978
(Billions of Dollars)

	Manhattan	New York City	Tri-State Region	U.S.A[a]
DIRECT COSTS (USER EXPENDITURES)				
Passenger Modes				
Private Cars[b]	$ .37	$2.61	$17.41	$193.3
Taxicabs/Livery	.54	.80	.95	2.0
School Buses		.07	.23	2.9
Local Buses[c]		.37	.50	1.4
Intercity Buses		.04	.10	1.2
SUBTOTAL:		3.89	19.19	200.8
Freight[d]	1.50	4.43	12.55	159.5
TOTAL DIRECT COSTS:		8.32	31.74	360.3
INDIRECT COSTS				
Subsidies[e]	.10	.46	1.00	9.4+
Unpaid Travel Time[f]	1.58	2.51		
Traffic Accidents[g]	.19	.83	2.85	45.4
Air Pollution[h]	.21	.38	.47	6.0
TOTAL INDIRECT COSTS:	2.08	4.18		
Indirect Costs as a Percent of Total Costs		33%		
TOTAL HIGHWAY TRANSPORTATION COSTS:		$12.50		

a. Tables 3 - 6
b. Tables 7 - 11
c. Table 12
d. Table 13
e. Table 14
f. Tables 15 - 18
g. Table 19
h. Table 20

TABLE 2: DIRECT USER COSTS OF TRANSPORTATION FOR 1978 BY MODE
(Billions of Dollars)

	New York City	Tri-State Region	United States
Passenger Services			
Private Car[a]	$2.61	$17.41	$193.3
Taxi[b]	.80	.95	2.0
School Bus[b]	.07	.23	2.9
Local Bus[c,g]	.37	.50	1.4
Intercity Bus[d]	.04	.10	1.2
Subtotal:	3.89	19.19	200.8
Subway/Rapid Rail[d,g]	.54	.55	.8
Commuter Rail[d]	.12	.25	.2
Intercity Rail[e]	.01	.03	.3
Air[e]	1.02	2.57	29.6
Marine[e]	.01	.03	.3
Subtotal:	1.61	3.43	31.2
TOTAL:	5.50	22.62	232.0
% by Roadway	71%	85%	87%
Freight Services[f]			
Highway	$4.43	$12.55	159.5
Rail	.15	.53	21.3
Marine	.42	1.54	10.0
Pipeline	.02	.06	2.6
Air	.15	.55	2.4
TOTAL:	5.16	15.23	195.8
GRAND TOTAL	$10.66	$37.85	$427.8
% by Roadway	78%	84%	84%

a. Tables 7 - 11.
b. See Text.
c. Table 12.
d. Tri-State's ITR 1206, Table VI. Data for 1073-1975 was projected to 1978 using linear least-squares regression.
e. National data assigned per capita.
f. Table 13.
g. The Transportation Association of America's data presents Local Bus and Transit as a single entry. Its projected 1978 national value is 2.2. We estimate the bus and subway portions as 1.8 and 0.8, respectively.

TABLE 3: THE NATION'S ESTIMATED PASSENGER BILL*

(Billions of Dollars)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Private Transportation											
Automobile											
New & Used Cars	$30.4	$29.9	$29.1	$35.5	$37.0	$32.7	$42.0	$47.0	$51.4	$44.2	$48.6
Tires, Tubes, Accessories	3.8	4.0	4.2	4.6	5.1	5.4	6.0	6.7	7.5	8.1	8.9
Gasoline & Oil	19.6	21.3	22.7	24.6	27.2	29.3	31.2	33.2	37.1	48.5	52.1
Tolls	.5	.6	.6	.7	.7	.8	.8	.9	.9	.9	1.0
Insurance (less claims)	2.8	3.3	3.6	3.5	3.5	4.3	5.6	6.2	6.0	5.8	4.3
Interest on Debt	3.5	3.9	4.0	4.2	4.6	4.7	4.8	5.6	6.5	7.3	7.5
Registration Fees	1.1	1.3	1.3	1.4	1.5	1.2	1.7	1.8	2.0	2.0	2.1
Operator's Permit Fees	.1	.2	.2	.2	.2	.2	.2	.2	.2	.3	.3
Repairs, Greasing, Washing, Parking, Storage, Rent	8.1	8.7	9.4	10.4	11.7	13.2	14.7	16.4	18.1	20.8	23.7
SUBTOTAL:	70.0	73.1	75.0	85.1	91.5	92.3	107.1	117.9	129.8	137.8	148.2
Air	1.4	1.8	1.8	2.1	2.6	2.6	3.1	3.5	4.1	4.4	4.7
TOTAL, PRIVATE MODES:	71.4	74.9	76.8	87.2	94.1	94.9	110.2	121.4	133.9	142.5	154.4
For Hire Transportation											
Local Bus & Transit	1.4	1.5	1.6	1.6	1.6	1.7	1.7	1.7	1.8	1.9	2.0
Taxi	.9	.9	1.0	1.3	1.4	1.4	1.5	1.5	1.5	1.6	1.6
Railroad Commutation	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.2
School Bus	.7	.8	.9	1.0	1.1	1.2	1.3	1.5	1.6	1.9	2.2
Intercity Bus	.6	.7	.7	.7	.7	.8	.8	.8	.9	1.0	1.0
Intercity Rail	.5	.4	.4	.3	.3	.3	.2	.2	.3	.4	.3
Air	4.3	4.8	5.7	6.7	8.0	8.5	9.4	10.8	11.8	13.8	15.0
Marine	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3	.3
TOTAL, FOR HIRE:	8.9	9.6	10.7	12.0	13.6	14.4	15.5	17.1	18.4	21.0	22.6
GRAND TOTAL:	80.3	84.5	87.5	99.2	107.7	109.3	125.7	138.5	152.4	163.3	175.6

* Excerpted from the Transportation Association of America's "Transportation Facts & Figures, Thirteenth Edition – 1976," July 1977, p. 5.

TABLE 4: THE NATION'S ESTIMATED FREIGHT BILL*
(Billions of Dollars)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Highway											
Intercity Trucking	$23.6	$26.6	$28.9	$30.0	$31.4	$33.6	$37.6	$41.7	$44.7	$48.8	$47.3
Local Trucking	23.0	22.9	24.5	27.9	30.4	35.5	41.6	50.3	57.7	58.8	64.6
Buses	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.2
SUBTOTAL:	46.7	49.6	53.5	58.0	61.9	69.2	79.3	92.1	102.5	107.7	112.0
Rail	9.9	10.4	10.1	10.7	11.3	11.9	12.7	13.1	14.8	16.9	16.3
Marine											
Domestic	1.7	1.7	1.7	1.7	1.7	1.9	2.0	2.1	2.3	2.8	2.8
International	2.1	2.5	2.6	2.9	3.0	3.2	3.2	3.5	4.5	5.3	4.9
SUBTOTAL:	3.8	4.2	4.3	4.6	4.7	5.1	5.2	5.6	6.8	8.0	7.7
Oil Pipe Line	1.1	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.2
Air											
Domestic	.4	.5	.5	.6	.7	.7	.8	.8	1.0	1.0	1.1
International	.3	.4	.5	.5	.5	.5	.5	.6	.6	.7	.8
SUBTOTAL:	.7	.9	1.1	1.1	1.2	1.2	1.3	1.5	1.6	1.7	1.8
Freight Forwarders & REA	.5	.5	.5	.5	.5	.4	.3	.3	.4	.5	.4
Other Shipper Costs											
Loading & Unloading	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.3	1.3	1.3
Operation of Traffic Depts.	.3	.3	.3	.3	.4	.4	.4	.4	.4	.5	.5
SUBTOTAL:	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.7	1.8	1.8
GRAND TOTAL:	64.0	68.1	72.1	77.5	82.3	90.5	101.8	115.8	129.5	138.6	142.6

* Columns may appear not to add due to rounding. Original Table is in millions of dollars.

TABLE 5: THE NATION'S PROJECTED PASSENGER BILL
(Billions of Dollars)

	1976*	1977	1978	1979	1980	1981	1982
Private Transportation							
Automobile							
New & Used Cars	$63.9	$60.3	$64.3	$68.6	$73.1	$78.0	$83.1
Tires, Tubes, Accessories	9.9	10.6	11.6	12.6	13.8	15.1	16.6
Gasoline & Oil	55.2	59.0	64.9	71.5	78.7	86.6	95.4
Tolls	.9	1.1	1.1	1.2	1.3	1.3	1.4
Insurance (less claims)	6.2	6.8	7.3	7.8	8.3	8.9	9.5
Interest on Debt	7.8	8.5	9.2	9.9	10.7	11.5	12.4
Registration Fees	2.4	2.5	2.6	2.8	3.0	3.2	3.4
Operator's Permit Fees	.3	.3	.3	.4	.4	.4	.4
Repairs, Greasing, Washing, Parking, Storage, Rent	26.3	28.7	32.0	35.7	39.9	44.5	49.6
SUBTOTAL:	172.9	177.8	193.3	210.5	229.2	249.5	271.8
Air	5.1	6.4	7.3	8.2	9.3	10.5	12.0
TOTAL, PRIVATE MODES:	178.0	184.2	200.6	218.7	238.5	260.0	283.8
For Hire Transportation							
Local Bus & Transit	2.2	2.1	2.2	2.3	2.4	2.4	2.5
Taxi	1.5	1.9	2.0	2.1	2.2	2.4	2.5
Railroad Commutation	.2	.2	.2	.2	.3	.3	.3
School Bus	2.4	2.6	2.9	3.3	3.6	4.0	4.5
Intercity Bus	1.1	1.1	1.2	1.2	1.3	1.3	1.4
Intercity Rail	.4	.3	.3	.3	.3	.3	.2
Air	13.3	15.3	17.3	19.6	22.2	25.1	28.4
Marine	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TOTAL, FOR HIRE:	25.1	23.5	26.1	29.0	32.3	35.8	40.0
GRAND TOTAL:	199.0	207.1	226.7	247.7	270.8	295.8	323.6

* Projected by The Transportation Association of America, "Transportation Facts and Trends, Quarterly Supplement," Jan. 19, 1978.

TABLE 6: THE NATION'S PROJECTED FREIGHT BILL
(Billions of Dollars)

	1976*	1977	1978	1979	1980	1981	1982
Highway							
Intercity Trucking	$ 56.0	$ 59.0	$ 63.6	$ 68.7	$ 74.1	$ 79.8	$ 86.2
Local Trucking	74.5	84.4	94.9	106.7	135.1	135.1	152.0
Buses	.2	.2	.2	.2	.2	.3	.3
SUBTOTAL:	130.7	143.6	158.7	175.6	194.4	215.2	238.5
Rail	18.5	18.7	19.8	21.0	22.2	23.6	25.0
Marine							
Domestic	3.5	3.3	3.5	3.7	3.9	4.3	4.5
International	5.4	6.0	6.5	7.0	7.7	8.3	9.1
SUBTOTAL:	8.9	9.3	10.0	10.7	11.6	12.6	13.6
Oil Pipe Line	2.5	2.5	2.6	2.9	3.1	3.4	3.6
Air							
Domestic	1.2	1.4	1.5	1.6	1.8	2.0	2.2
International	.8	.9	.9	1.0	1.1	1.1	1.2
SUBTOTAL:	2.0	2.3	2.4	2.6	2.9	3.1	3.4
Freight Forwarders & REA	.5	.4	.4	.4	.4	.4	.4
Other Shipper Costs							
Loading/Unloading Freight Cars	1.4	1.3	1.3	1.4	1.4	1.4	1.5
Operation of Traffic Depts.	.6	.6	.6	.6	.7	.7	.8
SUBTOTAL:	2.0	1.9	1.9	2.0	2.1	2.1	2.3
GRAND TOTAL:	165.2	178.7	195.8	215.2	236.7	260.4	286.8

* Projected by The Transportation Association of America, "Transportation Facts and Trends, Quarterly Supplement," Jan. 19, 1978.

TABLE 7

A) OPERATING COSTS FOR PRIVATE CARS*

Model Year	Cents Per Mile**
1978	33.1
1977	30.1
1976	28.1
1975	27.2
1974	23.8
1973	20.2
1972	19.7
1971	18.7
1970	19.0
----	----
1960	14.4
1950	10.9

B) PERCENTAGE OF DIRECT OPERATING COSTS SAVED BY BUYING A USED CAR*

Age of Car at Second or Third Purchase	Percent Saved
1 year	10%
2	30
3	48
4	51
5	52
6	53
7	53

* Data supplied by Hertz Car Leasing Division; refers to a typically equipped new car at the currently dominant size.

** In current dollars and assuming car is driven 10,000 miles per year for three years, then sold.

TABLE 8: GROSS NATIONAL PRODUCT IMPLICIT DEFLATORS

	Relative to 1972*	Inversely Relative to 3Q78
1978, Third Qtr.	153.46	1.0000
1977	141.29	1.0868
1976	133.88	1.1470
1975	127.18	1.2074
1974	116.20	1.3215
1973	105.92	1.4498
1972	100.00	1.5356
1971	96.02	1.5993
1970	91.36	1.6808

* U.S. Department of Commerce Library, NYC.

TABLE 9: OWNERSHIP COSTS PER MILE

Model Year	Current Year Dollar Cost[a]	GNP Deflator Relative to Third Qtr. 1978	Second & Third Hand Effect[a]	1978 Cost Per Mile
1978	$ .331	1.0000	1.00	$ .331
1977	.301	1.0868	1.00	.327
1976	.281	1.1470	1.00	.322
1975	.272	1.2074	0.52	.171
1974	.238	1.3215	0.52	.164
1973	.202	1.4498	0.52	.152
1972	.197	1.5356	0.47	.142
1971	.187	1.5993	0.47	.141
1970 & Earlier[b]	.190	1.6808	0.47	.150

Model Year	1978 Cost Per Mile Including Parking, Garaging & Tolls	Fraction of Annual VMT Driven by Cars of Each Model Year[c]	Portion of 1978 Cost Per Mile Chargeable to Each Model Year
1978	$ .359	.106	$ .0381
1977	.355	.142	.0504
1976	.350	.133	.0466
1975	.199	.123	.0245
1974	.192	.108	.0207
1973	.180	.092	.0166
1972	.170	.077	.0131
1971	.169	.064	.0108
1970 & Earlier	.178	.155	.0276
		Total	$ .2483

a. Hertz Car Leasing Division Data. We assume that first and second owners retain cars for 3 years each, and that third owners retain cars for 4 years. Hertz omits the costs of parking and tolls which are 2.35 and 0.45 cents per mile, respectively, according to Tri-State's ITR 2104.

b. Assumes all previous model year costs to be the same as 1970.

c. Table I-5, "Mobile Source Emission Factors," U.S. EPA, Jan. 1978. Entry for 1970 model year includes all previous model years.

TABLE 10: MILES TRAVELED PER WEEKDAY IN THE TRI-STATE REGION

	1978 VMT*	Percent VMT By Private Cars**	Private Car VMT Per Day
Manhattan	6,430,886	68.69%	4,417,376
Bronx	6,091,653	81.80	4,982,972
Brooklyn	8,494,421	74.00	6,285,872
Queens	14,440,146	89.00	12,851,730
Staten Island	2,977,130	87.10	2,593,080
NEW YORK CITY	38,434,218		31,131,030
Nassau	18,993,617	91.18	17,318,380
Suffolk	24,704,907	90.70	22,407,351
Westchester	14,243,616	91.57	13,042,879
Rockland	4,705,240	92.33	4,344,348
Putnam	1,677,008	91.28	1,530,773
Dutchess	6,658,652	91.28	6,078,018
Orange	8,536,112	91.28	7,791,763
NEW YORK SUBURBS	79,519,107		72,513,512
NEW YORK STATE	117,945,325		103,644,542
Hudson	5,073,859	84.20	4,272,189
Essex	10,990,108	88.50	9,726,246
Bergen	15,470,725	89.56	13,855,581
Passaic	6,780,737	88.60	6,007,733
Morris	9,118,716	90.99	8,297,120
Union	8,151,722	89.84	7,323,507
Somerset	6,415,122	90.61	5,812,742
Middlesex	13,173,762	89.94	11,848,482
Monmouth	9,346,816	91.28	8,531,774
Ocean	n/a	n/a	n/a
NEW JERSEY	85,321,562		75,675,374
Southwestern	7,234,841	90.80	6,569,236
G. Bridgeport	4,727,164	90.51	4,278,556
Valley	1,197,278	90.90	1,088,326
South Central	10,168,387	90.90	9,243,064
C. Naugatuck	4,673,152	90.99	4,252,101
Housatonic	3,433,886	91.18	3,131,017
CONNECTICUT	31,434,698		28,562,300
TRI-STATE REGION	234,709,585		207,882,216

* Uses linear interpolation of 1970-1980 data in the Tri-State Regional Planning Commission's Highway Evaluation Model.

** Tri-State Regional Planning Commission, personal communication.

TABLE 11: TUNNEL CROSSINGS BY DAY OF WEEK

Day of Week	Percentage of Average Weekday Tunnel Trips*			
	Lincoln	Holland	Queens-Midtown	Brooklyn-Battery
Sunday	0.82	0.87	0.81	0.71
Monday	0.94	0.94	0.94	0.94
Tuesday	0.98	0.97	0.97	0.97
Wednesday	1.02	1.00	1.01	1.00
Thursday	1.02	1.02	1.03	1.03
Friday	1.04	1.06	1.04	1.06
Saturday	0.93	0.94	0.88	0.75
TOTAL:	6.75	6.80	6.68	6.46
Average Weekday Crossings	101,451	64,663	65,881	52,444

* New York City Department of Traffic.

TABLE 12: LOCAL BUS EXPENSE AND REVENUE DATA AND PROJECTIONS

	Bus Transit	
Year	New York City	Tri-State Region
TOTAL EXPENSES		
1973	.355	.562
1974	.402	.642
1975	.432	.683
1976	.422	.668
----	----	----
1978 (p)	.461 (a)	.730 (c)
TOTAL REVENUE		
1973	.311	.501
1974	.313	.527
1975	.341	.561
1976	.341	.549
----	----	----
1978 (p)	.370 (b)	.577 (d)
REGULAR ROUTE REVENUE		
1973	.301	.449
1974	.309	.465
1975	.331	.484
1976	.338	.486
----	----	----
1978 (p)	.366 (a)	.500 (d)

(p) Projections are based on best fitting least-squares regressions (a: linear; b: exponential; c: Logarithmic; d: power) on the 1973-1976 data shown in Table VI in the 1977-1978 editions of Tri-State's ITR 1206, "Public Transportation Operational and Financial Statistics in the Tri-State Region."

TABLE 13: FREIGHT EXPENDITURES ALLOCATED BY MODE IN THE TRI STATE-REGION
(Billions of Dollars)

Mode	1978 Projections for U.S.*	Regional % of National Total**	Tri-State Region	NYC % of Regional Total	New York City***	Manhattan
Intercity Trucking	$63.6 + 0.2[a] + 0.2[d] = $64.0	2.3%	$ 1.47	35.3%	$ .52	$ .18
Local Trucking	94.9 + 0.4[b] + 0.2[d] = 95.5	11.6	11.08	35.3	3.91	1.32
Rail	19.8 + 1.3[c] + 0.2[d] = 21.3	2.5	.53	27.3	.15	.03
Marine	10.0	15.4	1.54	27.3	.42	.08
Pipeline	2.6	2.3	.06	27.3	.02	.003
Air	2.4	22.9	.55	27.3	.15	.03
TOTAL:	$195.8		$15.23		$5.16	$1.64

* See Table 6
** Wood, R.T. "The Urban Freight System: Why It Doesn't Work Better," 1973, International Physical Distribution Management Conference, Tokyo.
*** Costs are allocated to New York City and Manhattan in accordance with the data in Tri-State's ITR 4105-6591, "Application of the Input-Output Technique to Regional Freight Forecasting," Dec. 1968.

a. Bus freight is treated the same as Intercity Trucking.
b. Forwarders are treated the same as Local Trucking.
c. The loading/unloading of freight cars is charged to rail.
d. The cost of the operation of traffic departments is divided equally between Local and Intercity Trucking and Rail.

TABLE 14: ESTIMATED 1978 HIGHWAY AND BUS SUBSIDIES
(Billions of Dollars)

	Manhattan	New York City	Tri-State Region	U.S.A.
Percent of U.S. population.	0.65%	3.42%	8.46%	100%
Expenditures at all levels of government for highway construction and maintenance in excess of user fees and user taxes.	$ .061	$ .320	$ .792	$9.36
Local bus operating subsidy (excess of total expenses over total revenues).	.026	.091	.153	n/a
Capital subsidy for bus operation.	.014	.049	.050	n/a
TOTAL:	$ .101	$ .460	$ .995	$9.36+

TABLE 15: VMT BY MODE IN NEW YORK CITY [a]

Location & Time of Day	Weekday VMT By Mode				Average Speed (mph)
	Autos	Taxi/Livery	Trucks	Buses	
Manhattan Above 60th St.					
Arterial & Local, 7am-6pm	506,823	352,010	174,786	43,810	12.3
Expressway, 7-9am	246,230	24,452	2,955	184	15.4
Expressway, 4-6pm	267,102	26,446	3,013	220	15.0
Midtown Manhattan					
Arterial & Local, 7am-6pm	299,093	232,468	110,533	26,546	6.5[c]
Expressway, 7-9am	65,176	5,743	2,328	1,184	14.0
Expressway, 4-6pm	67,984	3,659	2,045	1,128	16.4
Manhattan, Canal to 30th St.					
Arterial & Local, 7am-6pm	279,590	110,725	127,446	16,955	9.3
Expressway, 7-9am	63,655	8,909	1,573	58	18.6
Expressway, 4-6pm	64,700	9,012	1,605	55	15.6
Downtown Manhattan					
Arterial & Local, 7am-6pm	138,701	13,364	38,176	5,744	7.1
Expressway, 7-9am	37,684	3,595	2,202	29	30.3
Expressway, 4-6pm	37,660	2,562	2,265	30	33.3
The Bronx					
Local, 7am-6pm	259,324	36,246	45,559	6,090	10.0
Arterial, 7am-6pm	594,110	84,216	104,541	13,976	17.8
Expressway, 6-9am[b]	562,335	38,598	56,965	6,807	31.4
Brooklyn					
Local, 7am-6pm	651,767	167,587	222,672	26,134	9.2
Arterial, 7 am-6pm	1,340,476	344,346	457,884	53,739	15.3
Expressway, 6-9am[b]	596,424	27,658	39,889	4,111	29.6
Queens					
Local, 7am-6pm	1,053,843	31,284	210,114	25,181	10.2
Arterial, 7am-6pm	2,115,597	62,705	421,794	50,549	16.9
Expressway, 6-9am[b]	1,246,225	17,701	57,042	8,748	30.6
Staten Island					
Local, 7am-6pm	338,067	2,579	54,230	3,538	13.4
Arterial, 7am-6pm	655,443	4,740	105,099	6,857	23.5
Expressway, 6-9am[b]	104,369	72	25,323	568	34.9

a. Excerpted from New York City Division of Air Resources Automotive Modeling Data Base.

b. Since evening rush hour data is unavailable for the outer boroughs, morning rush hour VMT will be doubled in subsequent calculations.

c. See Appendix 2 and discussion in text about midtown speeds.

TABLE 16: HIGHWAY VEHICLE HOURS IN NYC - BY MODE AND PER BUSINESS DAY

Mode	Midtown Arterial/Local	Rest of Manhattan	Rest of New York City
Private Car	54,381[a]	1,148,517	662,938
Taxi/Livery	42,267[a]	47,643	61,738
Bus	4,827[b]	6,382	15,079

a. Speeds of 5.5 mph, as observed (see Appendix 2), are used for private cars and taxis.

b. We estimate 4.5 mph for buses in midtown.

TABLE 17: DOLLAR VALUE PER HOUR OF VEHICLE TRAVEL BY MODE IN NYC

Mode	Value Per Passenger-Hour	Average Occupancy	Value Per Vehicle-Hour
Private Car	$2.76	1.6	$4.416
Taxi/Livery	$3.17 ($7.83 in Midtown)	0.79	$2.504 ($6.186 in Midtown
Bus	$2.76	12.0	$33.12

TABLE 18: ANNUAL VALUE OF BUSINESS DAY TRAVEL TIME ON HIGHWAYS[a]
(Billions of Dollars)

Mode	Midtown Arterial/Local	Rest of Manhattan	Rest of New York City
Private Car	$.0624	$1.3187	$.7612
Taxi/Livery	.0680	.0310	.0402
Bus	.0416	.0550	.1298
Totals:	$.1720	$1.4047	$.9312
		All of Manhattan	All of New York City
		$1.5767	$2.5079

a. 260 business days per year.

TABLE 19: SOCIETAL COSTS OF HIGHWAY ACCIDENTS, INJURIES, DEATHS & PROPERTY DAMAGE FOR 1978
(Billions of Dollars)

	Manhattan	New York City	Tri-State Region[a]	U.S.A.
Number of Deaths	156[b]	656[b]	2,940	46,87
Number of Injuries	18,970[b]	97,142[b]	250,875	4,000,00
Number of PDO Vehicles	104,000	362,000	1,380,000	22,000,00
Societal Costs[d]				
Deaths	$ .054[b]	$ .227	$1.019	$16.25
Injuries	.073	.374	.965	15.38
PDO Vehicles	.065	.227	.866	13.81
TOTAL SOCIETAL COST:	$ .192	$ .828	$2.850	$45.44

a. Fatalities projected from Tri-State Highway Evaluation Model. Injuries and PDO vehicle count assumed to be in the same proportion to U.S.A. totals as deaths.

b. Actual 1977 data; remaining figures are estimates for 1978. See Text.

c. Based on 1975 National Safety Council Data in "Accident Facts"; with more vehicles on the road in 1978, this may be conservative.

d. National Highway Traffic Safety Administration, "Societal Costs of Motor Vehicle Accidents - 1975," Washington, D.C., Dec. 1976. Area totals are based on value assumptions of $346,735 per death, $3,846 per injury, and $628 per PDO vehicle. See Text for details.

TABLE 20: COSTS OF AUTOMOTIVE AIR POLLUTION
(Billions of Dollars)

Health Costs

Pollutant	Midtown	Manhattan	New York York	Tri-State Region
Hydrocarbons	$.0035B	$.0099B	$.0275B	$.0325B
Carbon Monoxide	.0444	.0675	.0919	.0996
Nitrous Oxides	.0040	.0113	.0317	.0410
Sulfur Oxides	.0058	.0110	.0185	.0222
Particulate Matter	.0418	.0793	.01332	.1589
Subtotal:	.0995	.1790	.3029	.3542

Property Costs

Pollutant	Midtown	Manhattan	New York York	Tri-State Region
Hydrocarbons	$.0013	$.0037	$.0102	$.0120
Nitrous Oxides	.0071	.0201	.0560	.0560
Sulfur Oxides	.0015	.0043	.0122	.0306
Particulate Matter[a]				
Subtotal:	$.0099	$.0281	$.0784	$.1140
TOTAL COSTS:	$.1094	$.2071	$.3813	$.4682

a. Omitted from calculations-

THE SOCIETAL COSTS OF CONGESTION IN NEW YORK CITY

APPENDIX 2

A STUDY OF TRAVEL TIMES AND SPEEDS IN MIDTOWN MANHATTAN

December 1979

CONTENTS

FIGURES

INTRODUCTION

In November 1977, Citizens for Clean Air spent 48 hours driving a passenger car in midtown Manhattan under a variety of weather and traffic conditions. Our goal was to collect data which would help us:

* Determine average speeds and fuel economy on selected midtown Manhattan streets, and

* Determine whether the two 1972 traffic analyses by the New York City Traffic Department and the West Side Highway Project (WSHP) report higher speeds in midtown than is now the case.

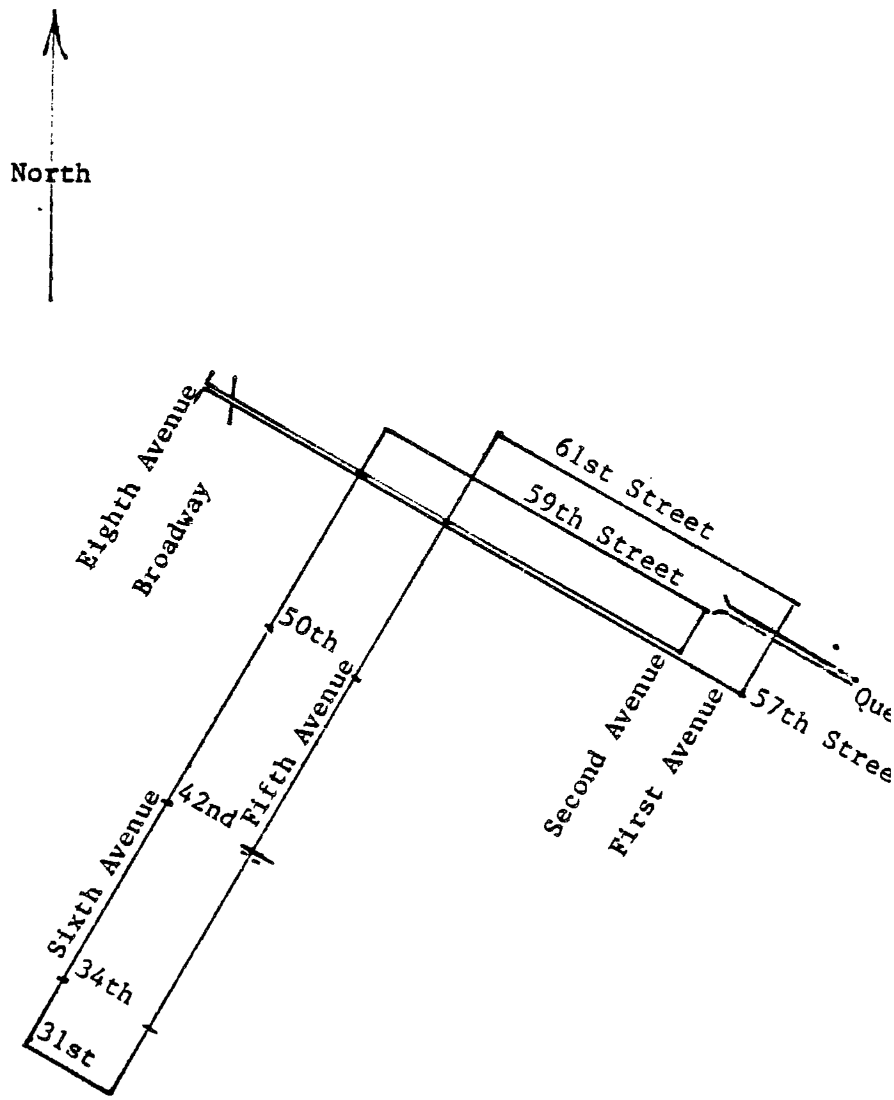
We designed a 7.00 mile loop based on four straight arterial legs suggested by the Traffic Department, and on which it and the WSHP had substantial data. Two legs ran east and west on 57th Street between Second and Eighth Avenues, two ran south and north on Fifth and Sixth Avenues between 34th and 57th Streets. Connecting links (see map, p. 2) were selected to create a loop for the sake of driving convenience. Times were recorded at the start and finish of each arterial leg and at many intermediate points. The centers of intersections were used as measurement points for time and distance.

Our methods were taken directly from Traffic Dept. procedures. The intermediate measurements for segments of the arterial legs were necessary for comparing our data with the WSHP's.

The legs and segments varied in length. The legs measured 1.055 miles on 57th Street and 1.150 miles on each of the two avenues. The segments ranged from 0.192 mile between Fifth and Sixth to 0.750 mile between 42nd and 57th Streets.

We measured running times, distances and fuel consumed.[1] For easy comprehension and comparison with published data, we will discuss average speeds (miles per hour), although our calculations and statistical tests were performed - except as noted - on the travel time rate (minutes per mile).

The Traffic Dept. cooperated with us by placing rubber hose traffic counters



MAP OF TEST ROUTE

on the Queensboro Bridge and on three sides of the 57th Street/Fifth Avenue intersection. The counters accumulated and recorded east, west, and southbound vehicle crossings at 15-minute intervals.

Weather conditions ranged from terrible to excellent. Monday and Tuesday were days of extraordinarily heavy and persistent rain. According to the National Weather Service, 5.29 inches of rain fell between 7 a.m. and 4 p.m. on Tuesday. The following days' weather ranged from drizzly to clear.

DEFINITIONS

The Loop is the full 7.00-mile route shown in the Map.

Leg refers to 57th Street between Second and Eighth Avenues, and to Fifth or Sixth Avenue between 34th and 57th Streets.

Segments are portions of legs; for example, 57th Street between Sixth Avenue and Broadway.

Travel Time Rate is the inverse of average speed. For a specific event, it is the travel time in minutes divided by the length in miles. Travel time rates may be averaged conventionally, whereas speeds should not be.

Net Accumulation in Manhattan of Queensboro Bridge users refers to the sum of all vehicle crossings into Manhattan via the Bridge minus the outbound crossings. The starting point for obtaining this figure is 5 a.m. of a given day. This is the time at which inflow begins to exceed outflow.

Average speed data supplied by the Traffic Dept. and the WSHP rounds down all times of day to the preceding hour; e.g., a run starting at 9:34 a.m. is referred to only as the 9-10 a.m. period. We call this latter time a Clock Hour.

GENERAL OBSERVATIONS

* Speeds varied substantially, whether measured on the complete loop, its arterial legs, or on segments of the latter. This is best understood by referring to Table I (p. 5) and Figures 1 - 5. The only indication that Tuesday's extraordinary rain affected traffic was the high midday speeds on Fifth Avenue (Fig. 4). This may have been because so few shoppers ventured out.

* On 57th Street, traffic moved significantly faster during the morning and evening rush hours than during midday (Figs. 2 and 3). The possible causes of this include the fact that pedestrian and taxi activity have strong midday peaks and that parking lots are most nearly filled during midday.[2]

* Speeds on the two Avenues were significantly higher than on 57th Street.

* No correlation was found on any leg between average speed and the pertinent 15-minute traffic counts.

* A strong correlation was found between average speeds on 57th Street and the net accumulation in Manhattan of Queensboro Bridge users (Figs. 6 - 8).[3]

* Despite our equipment's limitations,[4] we found strong correlation between fuel economy (mpg) and speed (mph). The linear regression line in Figure 9 covers 61 data pairs.[5] However, the best correlation was discovered by taking the reciprocals of both variables. Including an outlying 62nd data point, the correlation coefficient was 0.91. The equation was:[6]

$$\frac{1}{MPG} = 0.0286 + \frac{0.238}{MPH} \qquad (1)$$

TABLE I. SUMMARY OF AVERAGE SPEEDS

	Number Of Runs	Minimum Speeds	Harmonic Mean Speeds	Maximum Speeds
Weekday Runs Between 7 a.m. and 6 p.m.				
Complete Loops	14	4.2 mph	5.5 mph	7.4 mph
57th Street Westbound	25	2.4	4.1	9.8
57th Street Eastbound	27	2.6	5.3	13.1
Fifth Avenue	23	4.8	7.3	12.8
Sixth Avenue	23	3.0	8.1	13.4
All Weekday Runs				
Complete Loops	21	4.2	6.0	11.3
57th Street Westbound	33	2.4	4.6	11.5
57th Street Eastbound	32	2.6	5.6	13.1
Fifth Avenue	30	4.8	8.3	28.0
Sixth Avenue	30	3.0	8.6	28.8
Sunday Morning Runs				
Complete Loops	2	13.7	14.2	14.7
57th Street Westbound	2	11.4	12.5	13.9
57th Street Eastbound	2	12.1	14.3	17.4
Fifth Avenue	2	27.6	27.6	27.6
Sixth Avenue	2	23.9	26.8	30.4

COMPARISON WITH NEW YORK CITY TRAFFIC DEPARTMENT DATA

The New York City Traffic Department provided us with summary sheets of 58 runs in each direction on 57th Street, 130 runs on Fifth Avenue, and 125 runs on Sixth Avenue. They were originally compiled in July and August, 1972 for the Madison Avenue Mall Study. The data consisted of travel times (to the nearest tenth of a minute) between Second and Eighth Avenues on 57th Street, and between 34th and 57th Streets on Fifth and Sixth Avenues. Times of day were identified only by the hour long periods during which a run started; e.g., 5-6 p.m., 6-7 p.m., etc.

Sorting our data similarly, we plotted hourly averages of observed average speeds between 8 a.m. and 7 p.m. for both sets of data (Figs. 10 - 13). The Student's t distribution test was applied to data on each arterial for each of the 37 hours in which we made two or more runs. Our measurements of average speeds were significantly lower ($P < .05$) than the Traffic Department's in 13 of the 37 comparisons (and higher in none).

Two additional analyses were made, one using matched pairs of hourly average speeds and the other using an unweighted average of all runs starting between 8 a.m. and 7 p.m. In both cases we found that our observations on 57th Street westbound and on Sixth Avenue show vehicles in 1977 moving significantly slower ($P < .05$) than the Traffic Department's 1972 data indicate.

Finally, 11 hourly comparisons were tested using matched pairs of data from each of the four arterials. In three of the 11 hours (10-11 a.m., noon-1 p.m., and 3-4 p.m.), the observed data showed traffic moving slower than the Traffic Department's data indicated. It is noteworthy that two of these three hours are during midday when traffic, especially on 57th Street, is at its slowest.

But what explains the increases in travel times on the major arteries we observed in midtown Manhattan? Was it driving style? One of the authors did all the weekday driving. Our consensus was that he drove more aggressively than an average driver. This could tend to reduce travel times.

Have traffic counts increased since the Traffic Department's 1972 surveys? The Department's own 60th Street cordon counts indicate that vehicle entries actually declined. Since peak vehicle accumulation in Manhattan south of 60th Street declined by more than 5% between Oct. 1973 and Oct. 1975, travel times in midtown should be less than in 1972, not greater, as was observed.

Was it weather? We do not believe so since the day to day variations (see Figs. 2 - 5) do not single out either Monday or Tuesday as a slow day but, if anything, the opposite.

Had traffic management declined? We observed very few traffic control agents and traffic cops during our runs. Their ability to regulate spillover at key intersections is an important tool for keeping dense traffic from congesting. The City's financial problems led to devastating personnel cuts that were in effect by late 1977, and we believe that the observed increases in travel times in midtown Manhattan are a direct result of these decreases in traffic control personnel.

COMPARISON WITH WEST SIDE HIGHWAY PROJECT DATA

The 1972 data from Parsons Brinkerhoff Quade & Douglas, Inc. for the West Side Highway Project is available only on maps which show average speeds in ranges (0-5 mph, 6-10 mph, 11-15 mph, etc.) for various segments of Manhattan arterials. There are three such maps covering the "A.M. Peak Period", the "Off Peak Period", and the "P.M. Peak Period". These terms refer to 7 to 9 a.m., 10 a.m. to 3 p.m., and 4 to 6 p.m., respectively.

The segments were between 34th, 42nd and 57th Streets on Fifth and Sixth Avenues; and between Second, Fifth and Sixth Avenues, Broadway and Eighth Avenue on 57th Street. We omitted the brief segment from Broadway to Eighth Avenue from our comparison because the Project's maps were illegible.

We plotted hourly averages of the average speeds we observed on these segments, together with boxes representing the ranges of the WSHP data (Figs. 14 We assumed that the Project's quoted ranges were rounded from actual ranges of 0 - 5.499 mph, 5.5 - 10.499, etc.

We then computed unweighted averages of our hourly figures for each of these periods and compared them with the WSHP data ranges. In the resulting 30 comparisons of the 10 segments for each of three time periods, the averages of our observations indicate traffic was slower than the lower limit of the WSHP ranges in 12 instances, faster than the upper limit in 3 instances, and within the range in 15 instances.

While this is an impressive discrepancy, we are unable to test its statistical significance because we do not have the Project's actual averages, standard deviations and number of runs.

The reasons for the discrepencies are discussed above in the comparison with Traffic Department data.

CONGESTION AS AN URBAN EXPERIENCE

It was our secondary goal to collect some impressions about congestion as an urban experience: what it means to drive and survive in heavy traffic. We wanted a broader, more human perspective from which to analyze the quantitative data we were also gathering. Too often, traffic studies appear to be written in a vacuum from which relevant human behavior has been excluded because of the difficulty or impossibility of precisely measuring it.

We observed that:

* The failure of the City to enforce its own most basic traffic regulations

directly caused most of the instances of congestion we experienced in the area we were studying. This failure is exemplified by the drastic decline in personnel assigned to control traffic at intersections.

* Drivers who ignored red lights or who entered intersections they could not immediately leave were a major cause of congestion. In this regard, studies by the City's Traffic Dept. indicate that traffic control agents at intersections increase the vehicle flow through those intersections by 30 to 40%. Their presence may help explain why rush hour traffic moves faster than midday traffic.

* Drivers in the act of parking at curbs actively obstruct traffic, sometimes blocking two moving lanes at once. This increases substantially during peak congestion periods but the accumulated effect is difficult to measure.

* Off-street parking facilities also frequently impede traffic. When the rate at which cars arrive to be parked exceeds the ability of a given facility's staff to store them, a queue forms. We often observed such queues, particularly in midday on 57th Street, reach out into the street and block a full lane of traffic. We suspect this - combined with extensive illegal parking - is one reason our 57th Street segment between Fifth and Sixth Avenues showed average speeds of 2 mph between noon and 2 p.m.

* Illegally parked cars remove complete lanes of traffic from use: many of these are parked by so-called priviliged parkers - doctors, diplomats, and federal, state and city employees. Double parked trucks grossly impede those faced with having to maneuver around them.

* Street openings and construction blockages constitute a continual cause of congestion. According to the City's Bureau of Highway Operations, there are 200,000 such openings annually throughout the city for necessary underground work and repair. While some open and close within a few hours, others last for weeks.

* Pot holes slow all vehicles, threaten and actually damage some of them, and sometimes cause drivers to swerve suddenly and disrupt the traffic flow.

* There are a number of midtown intersections with apparently intractable problems. For example, the City allows a left turn off 57th Street westbound onto Lexington Avenue. This removes half of 57th Street's westbound capacity at that point but forbidding such a turn might only transfer the problem to another intersection.

* There is a multiplier effect created by aggressively driven buses and large trucks which try to maneuver through heavy congestion as if they were small cars. Though they often cut and swerve successfully, their size, their slowness and the frequency with which they straddle two lanes creates greater delays for those vehicles behind them than ordinary cars driven equally aggressively.

* Taxis cause a great deal of midtown's congestion because of their number (11,787 medallions). About 3,000 of these can be found in the midtown core area at any given time during the 7 a.m. to 6 p.m. working day. Occasionally, they make up as much as three-quarters of the vehicle traffic on a given street. Their impact is exacerbated by their drivers' intensely competitive, undisciplined behavior and the city's failure to enforce pertinent regulations.

* Traffic congestion in midtown is not always the impersonal, alienating experience it seems and which freeway congestion far more frequently is. To slowly proceed through a series of choked midtown streets is to engage in a series of brief encounters with pedestrians, police, jaywalkers, fellow drivers and passengers, truckers, utility and construction workers, and street and news peddlers. For the most part, such encounters consist of eye contacts, verbal exchanges, non-verbal signaling, flirtations, exhortations, and the like. But the amount and variety of this activity suggests that midtown urban congestion, at least in Manhattan, may have unique sociological characteristics that would reward

further, more formal, study.

* Professional drivers, because they are on midtown streets for hours at a time, are more exposed to exhaust fumes than pedestrians. Because they are in the street and nearer to tailpipes, they are exposed to more concentrated pollutants.

* Pedestrians frequently jaywalk but it is the jammed state of traffic, with frequent blockages of pedestrian crossings, that encourages much of the jaywalking. Pedestrians also frequently jump signal changes en masse. We, therefore, recommend an analysis of the possible benefits of well-placed pedestrian crossings at mid-block points along 57th Street, particularly between Fifth and Sixth Avenues, as well as at other major crosstown arterials.

* Bicyclists, though relatively few in number, tend to create their own driving rules, disproportionately jeopardizing themselves and pedestrians. This is partly explainable, though not excusable, by the dangerous conditions which exist for cycling. However, since cyclists seem to seek out and take advantage of the interstices of moter vehicle traffic, and since they are still a tiny minority, the effect they have on motor vehicle traffic is very small and perhaps negligible.

* Congestion debilitates the driving quality of those who are trapped in it - which, of course, tends to increase the congestion. Specifically, this results in more instances of rash action, bad judgement, and selfish and anarchistic behavior. While it may be impossible to quantify the effects of such stress related patterns on traffic speed and mileage, they almost certainly have some impact and should be examined in more detail in this regard.

* Finally, we learned that rush hour traffic streams move significantly faster than midday traffic. This may be due to the presence in midtown of more vehicles between the rush hours than at any other time of day. While many of these

vehicles are parked on-street and off-street, legally and illegally, they continue to impede traffic because of the lane space they occupy and the congestion they generate within garages, congestion which spills over into streets.

CONCLUSIONS AND RECOMMENDATIONS

We believe there may be an upper limit to the number of vehicles Manhattan can accomodate before the congestion which they create costs more in delays and fuel than the economic benefit of their presence.

This, in turn, suggests there is a need to:

* Define congestion, both qualitatively and quantitatively, in a way that would allow its costs and benefits to be measured and compared.

* Develop a method by which Manhattan (and other municipalities) could simply and quickly monitor congestion levels to determine those times, places, and/or conditions at which intense vehicle use is more harmful than productive. For example it may eventually be possible to assign "congestion ratings" to impediments such as utility cuts. Such ratings would numerically describe the impact on times and speeds of a given impediment on traffic within a given range.

* Either limit vehicle entries into Manhattan or adopt other measures which would prevent the costs of intensive vehicle use from overwhelming its benefits.

* Inaugurate a full scale data collection effort on a broad variety of Manhattan and city streets. Our limited work in midtown suggests that New York's street traffic data base is inaccurate and inadequate.

Because these figures have been used in the past to assess the impact of travel on air quality and because of the disparity between our and their findings, it is our preliminary conclusion (pending further study) that the WSHP and the City's Bureau of Air Resourses, using Traffic Dept. data, have underestimated New York City's air pollution problem, perhaps by as much as a factor of two or thr

We, therefore, also recommend that all participating city, state and federal agencies undertake to fully characterize air pollution in Manhattan; specifically, as part of the ongoing revision of the city's air pollution Transportation Control Plan.

The decisions made using this base affect not only the way traffic is managed but the city's very economy. It is vital that traffic data therefore be accurate and it is our belief that accuracy in this area requires significantly more field observation and data gathering than is currently the norm. A meaningful improvement will require the preparation of speed and time maps, their correlation against vehicle flows, and the development of New York City capacity/speed curves.

FOOTNOTES

1. We used a 1977 Honda Accord with semi-automatic transmission and 14,000 miles on the odometer, a Kent-Moore "Electrotest" Electric Gas-per-Mile Gauge, and a Digitime watch which displayed hours, minutes and seconds. Distances were scaled from the United States Geodetic Survey 1:24,000 map entitled "Central Park, N.Y. - N.J." and checked with Traffic Dept. measurements and odometer readings. The data gathering team consisted of the authors. Times, mileages and driving conditions were recorded, as were traffic impediments and their apparent causes. Times of day were entered on worksheets in a bottom-up format to simplify subtractions to obtain travel times for each loop, leg or segment. We conducted our data gathering daily from Monday, Nov. 7, 1977, to Friday, Nov. 11, from about 8 a.m. to 8 p.m. Baseline data for relatively uncongested operation was obtained by making runs on the following Sunday between 10 and 11 a.m. when traffic was light.

2. We frequently found - on our westbound, midday trips across 57th Street - a queue of cars lined up in the righthand "moving" lane and waiting to enter the basement garage at 9 West 57th Street. As a result, we averaged as little as 2 mph between Fifth and Sixth Avenues. When a parking lot is nearly full, as this was, internal retrieval and parking is impeded and service time increases. We suspect that as service at nearly full parking lots and garages deteriorates, illegal street parking becomes more tempting, regardless of its traffic impeding nature.

3. Although Traffic Dept. data on Queensboro Bridge crossings was available only from Thursday onward, the negative direction of the correlations is significant with 95% confidence.

4. We calculated fuel consumption by using the Honda's odometer (which read 1% high) to measure the distance traveled on 0.1 gallon of gasoline, the amount

contained in the fuel meter's glass container between two scribed lines. We frequently completed the mile-plus legs before consuming that much gasoline. In several such cases, we estimated the amount of fuel consumed and ended the fuel test because we had originally expected to find differences in the amount of fuel used on the avenues and streets. (Separate analyses of our data from 57th Street and the two Avenues did not show statistically significant differences ($P < .05$) in the fuel/speed relationship.) We noted the time and odometer readings for the start and finish of each fuel run in order to calculate the average speed on the actual distance during which the measured fuel was consumed. The nature of the meter prevented us from getting fuel data for the complete loop or for any particular distance. A continuous flow device with a cumulative readout like an odometer, which would have enabled us to do that, is available from Fluidyne Instrumentation for $4,995.

5. We intentionally omitted one outlying data point (27.2 mpg at 22.2 mph) from the linear regression analysis because it changes the slope 21% and cuts the r^2 to .81. That particular run was made in extremely light traffic between 11 p.m. and midnight and involved very few stops and starts; it was mostly a cruise in the 25 to 35 mph range. The results of that run, incidently, are close to the EPA's city mileage rating (26 mpg at 19. 6 mph).

6. A predictive formula developed at General Motors Research Laboratories ("Estimates of Fuel Savings Through Improved Traffic Flow in Seven U.S. Cities," GMR-2801, M.F. Chang, A.J. Horowitz, Aug. 18, 1978) produces values within 25% of the desired relationship in Equation 1:

$$\frac{1}{\text{MPG}} = 0.0234 + \frac{0.308}{\text{MPH}}$$

This formula is constructed around the idle fuel consumption rate and test weight. We estimated the idle consumption at 0.05 gallon (½ the burette) in 12 minutes, used a published figure of 2,018 lbs. for the Accord, and added 480 lbs. for the 3 occupants.

FIGURES (1 - 23)

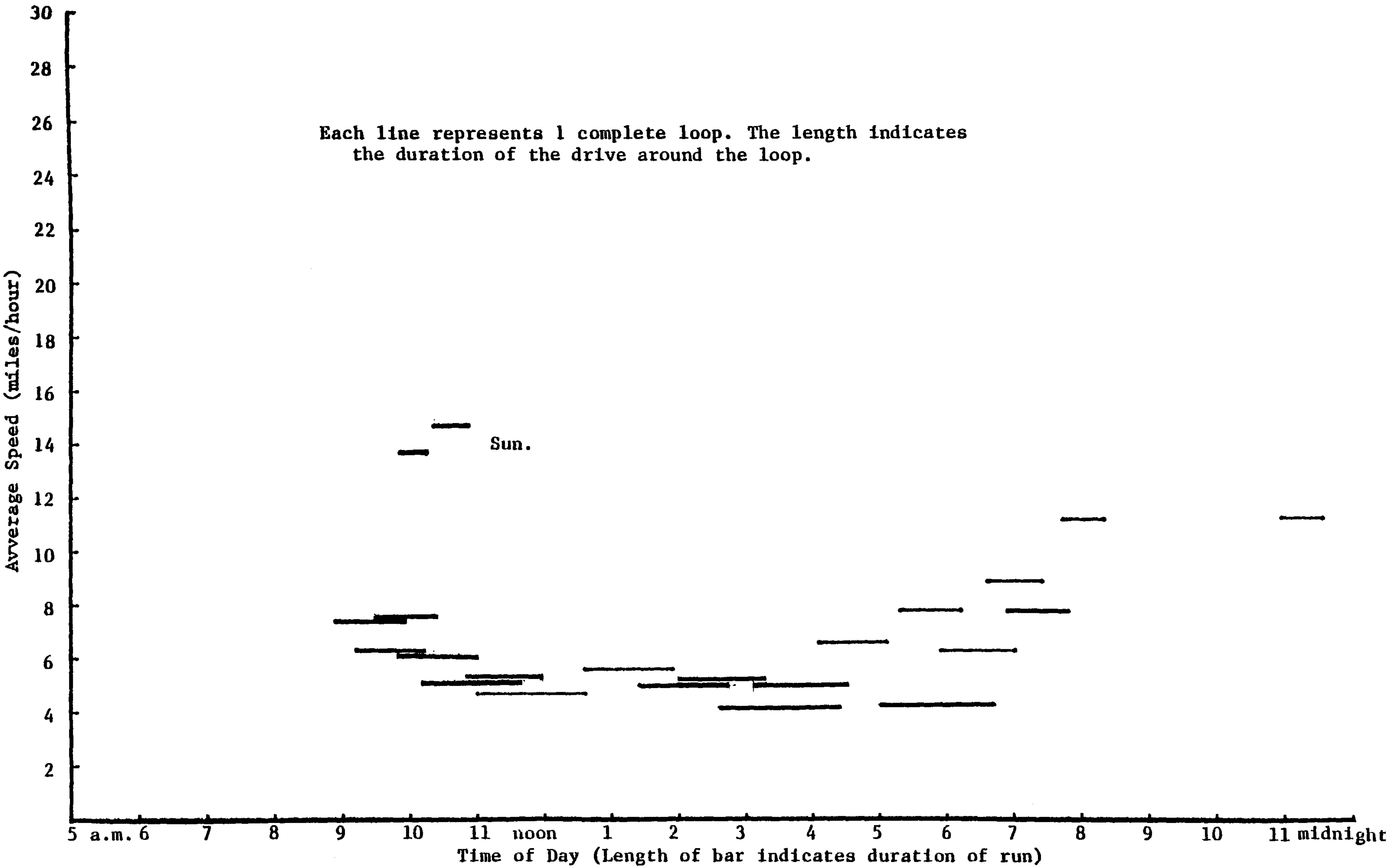


Fig. 1. AVERAGE SPEED ON MIDTOWN LOOP PLOTTED AGAINST TIME OF DAY

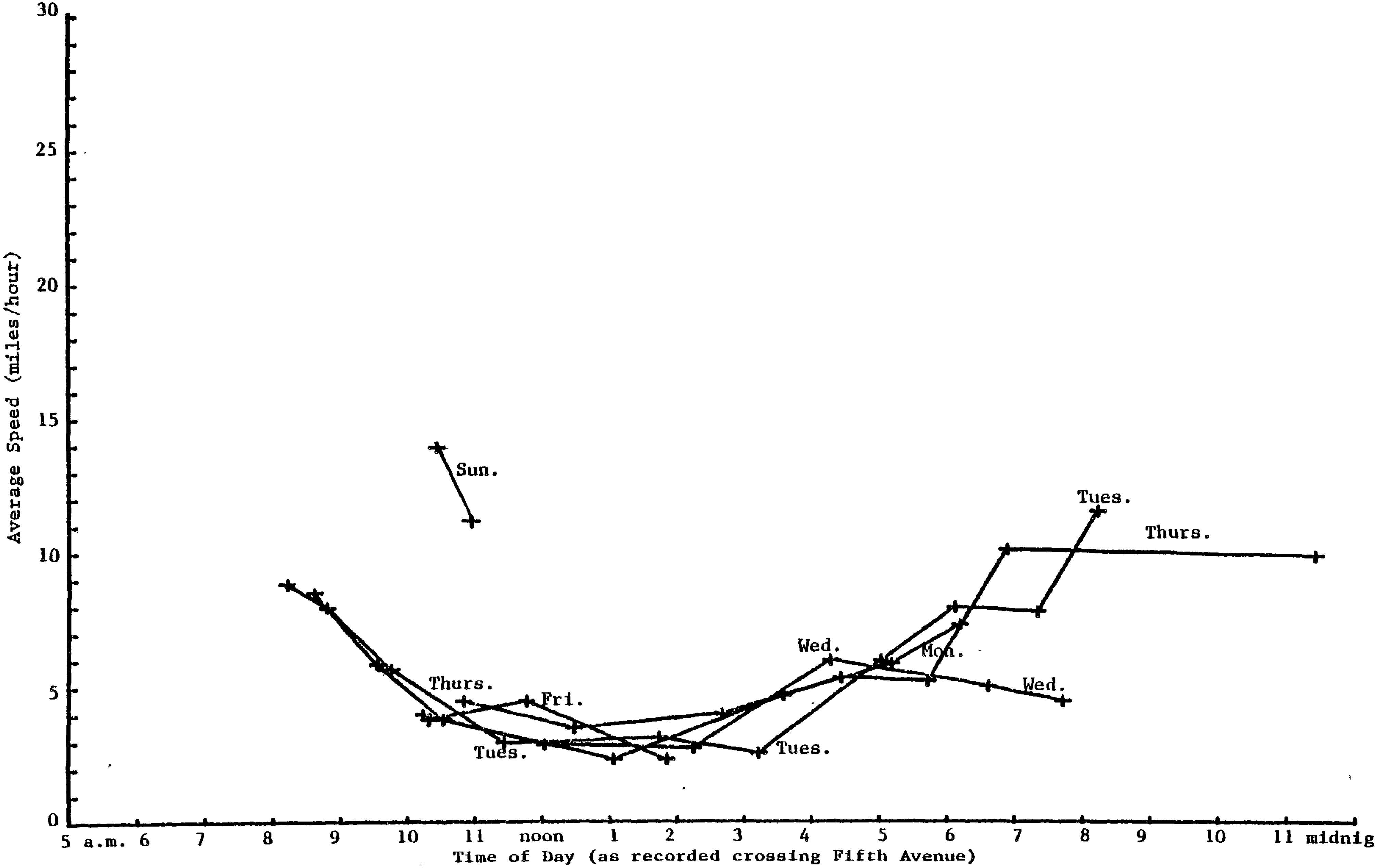


Fig. 2. AVERAGE SPEED WESTBOUND ON 57th STREET PLOTTED AGAINST TIME OF DAY

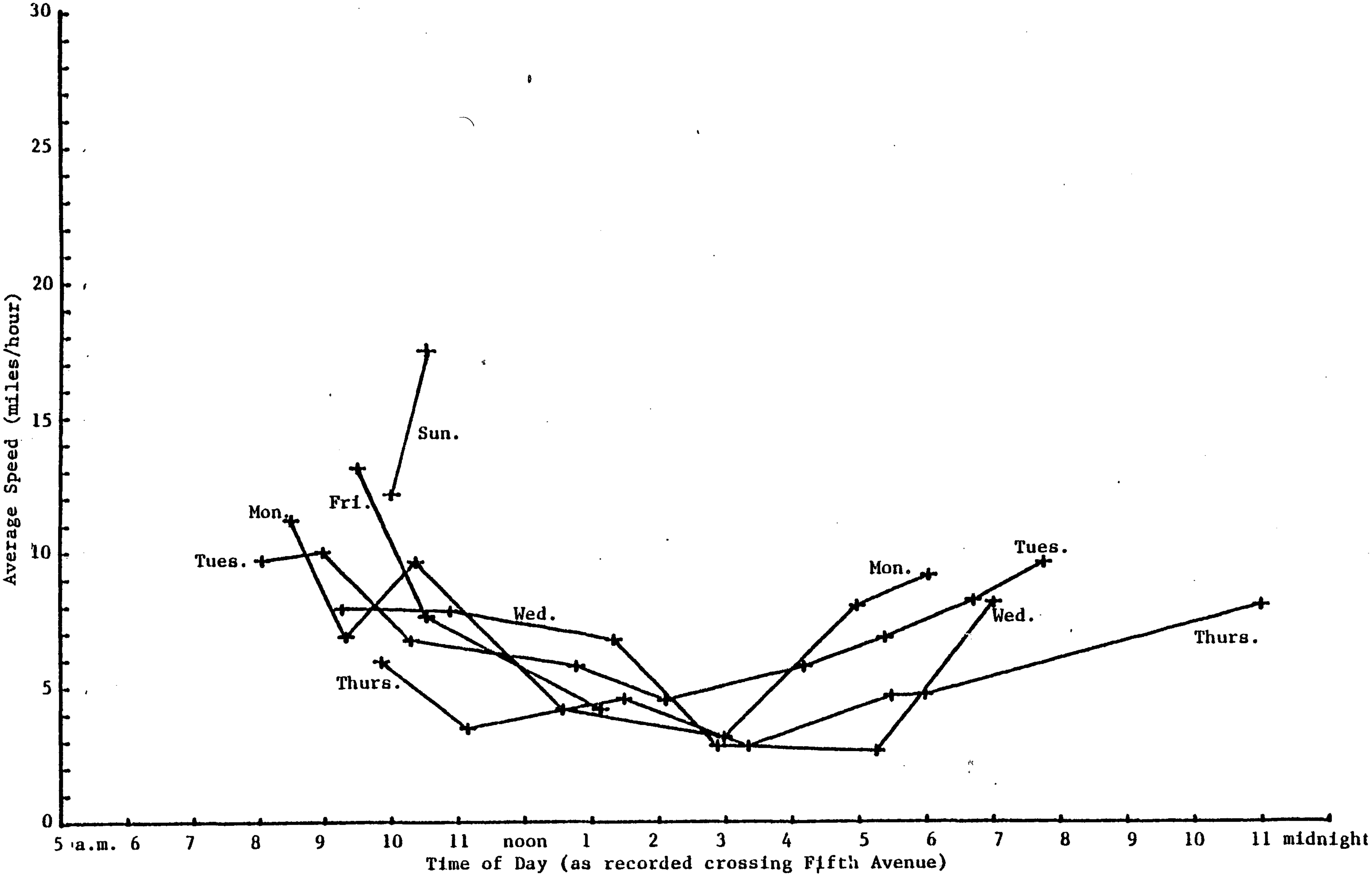
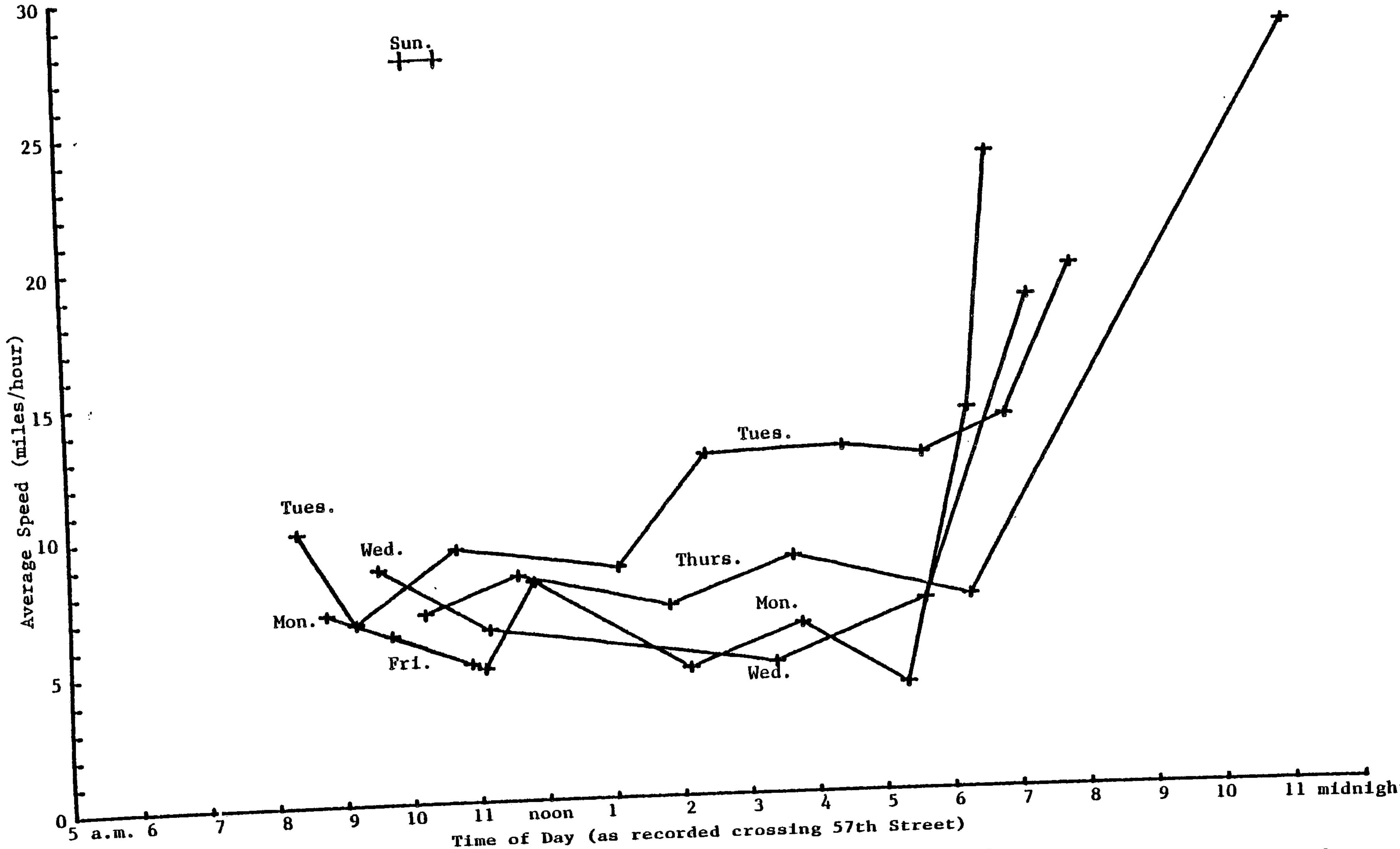


Fig. 3. AVERAGE SPEED EASTBOUND ON 57th STREET PLOTTED AGAINST TIME OF DAY
(from Eighth Avenue to Second Avenue)



Average Speed (miles/hour)
30
25
20
15
10
5
0
Sun.
Tues.
Tues.
Wed.
Thurs.
Mon.
Mon.
Fri.
Wed.
5 a.m. 6
7
8
9
10
11
noon
1
2
3
4
5
6
7
8
9
10
11 midnigh
Time of Day (as recorded crossing 57th Street)

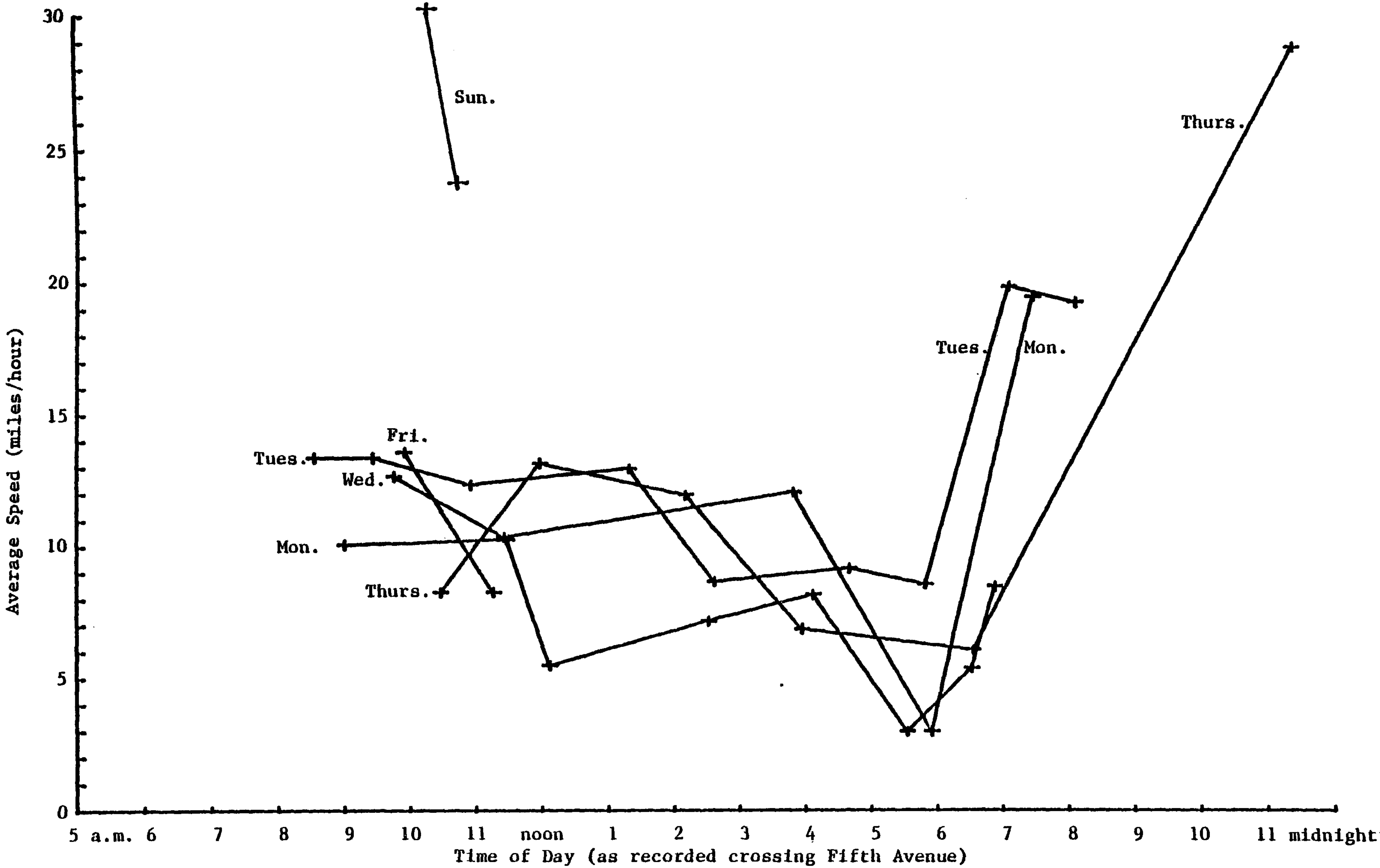


Fig. 5. AVERAGE SPEED NORTHBOUND ON SIXTH AVENUE PLOTTED AGAINST TIME OF DAY
(from 34th Street to 57th Street)

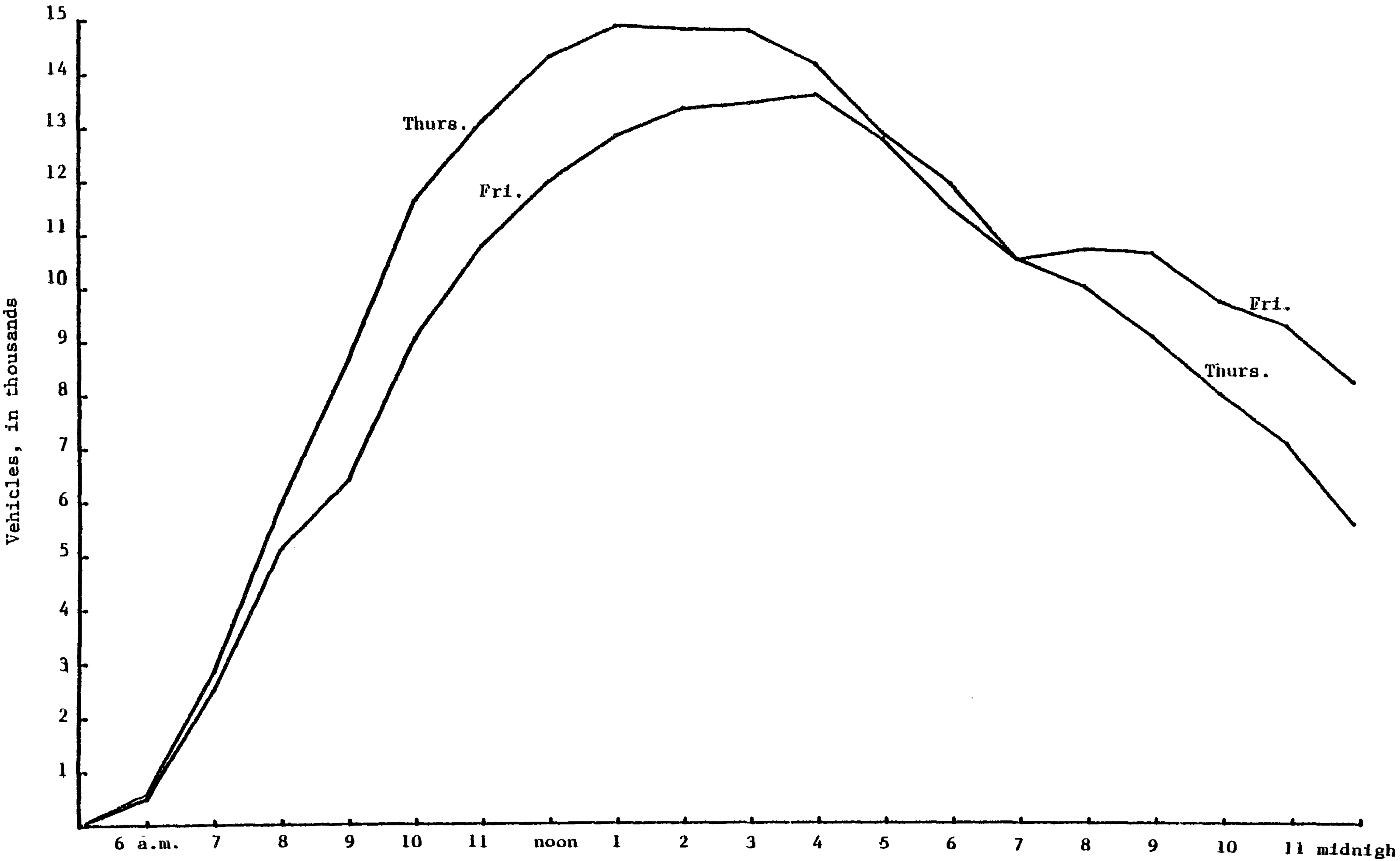
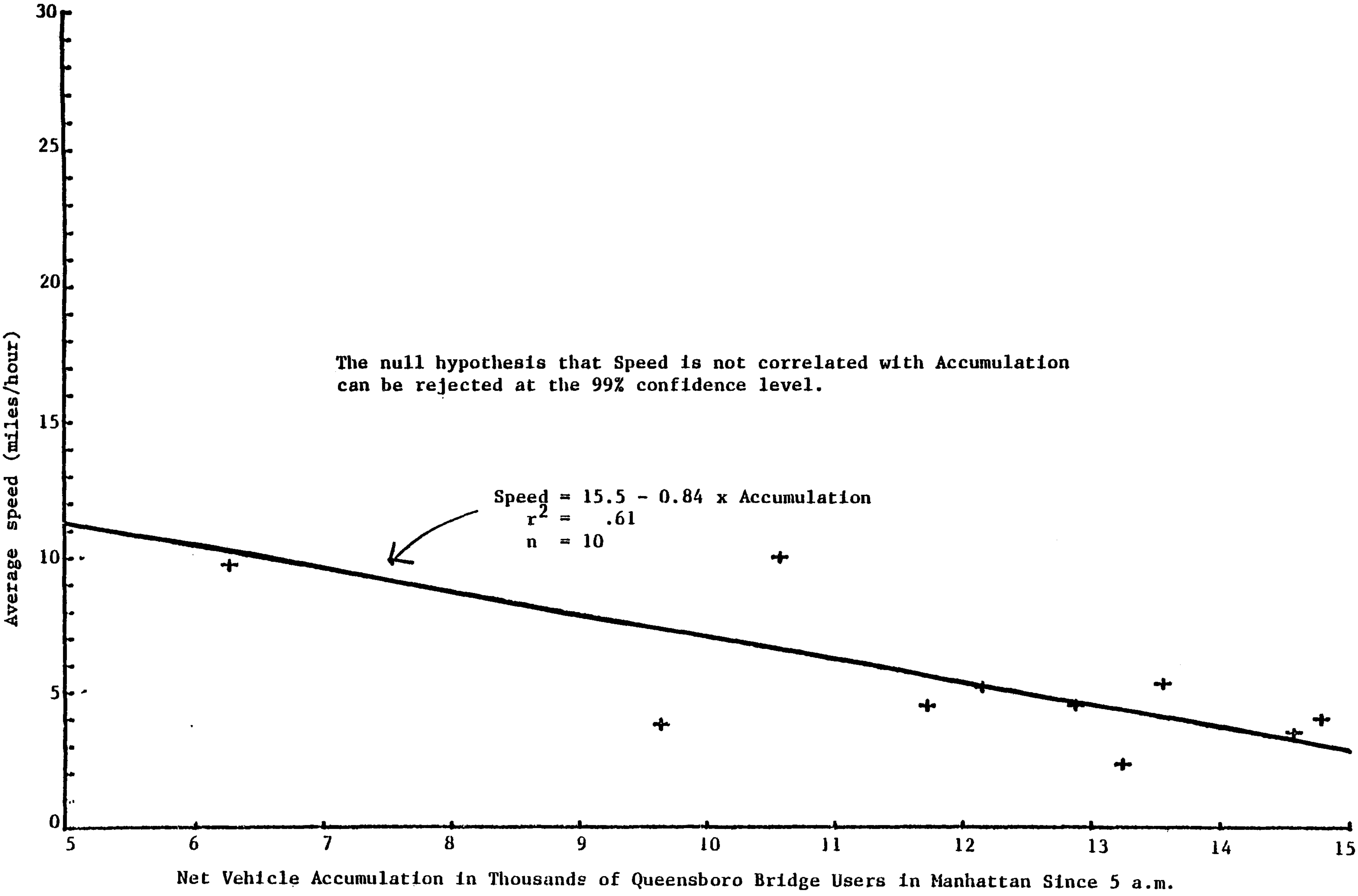
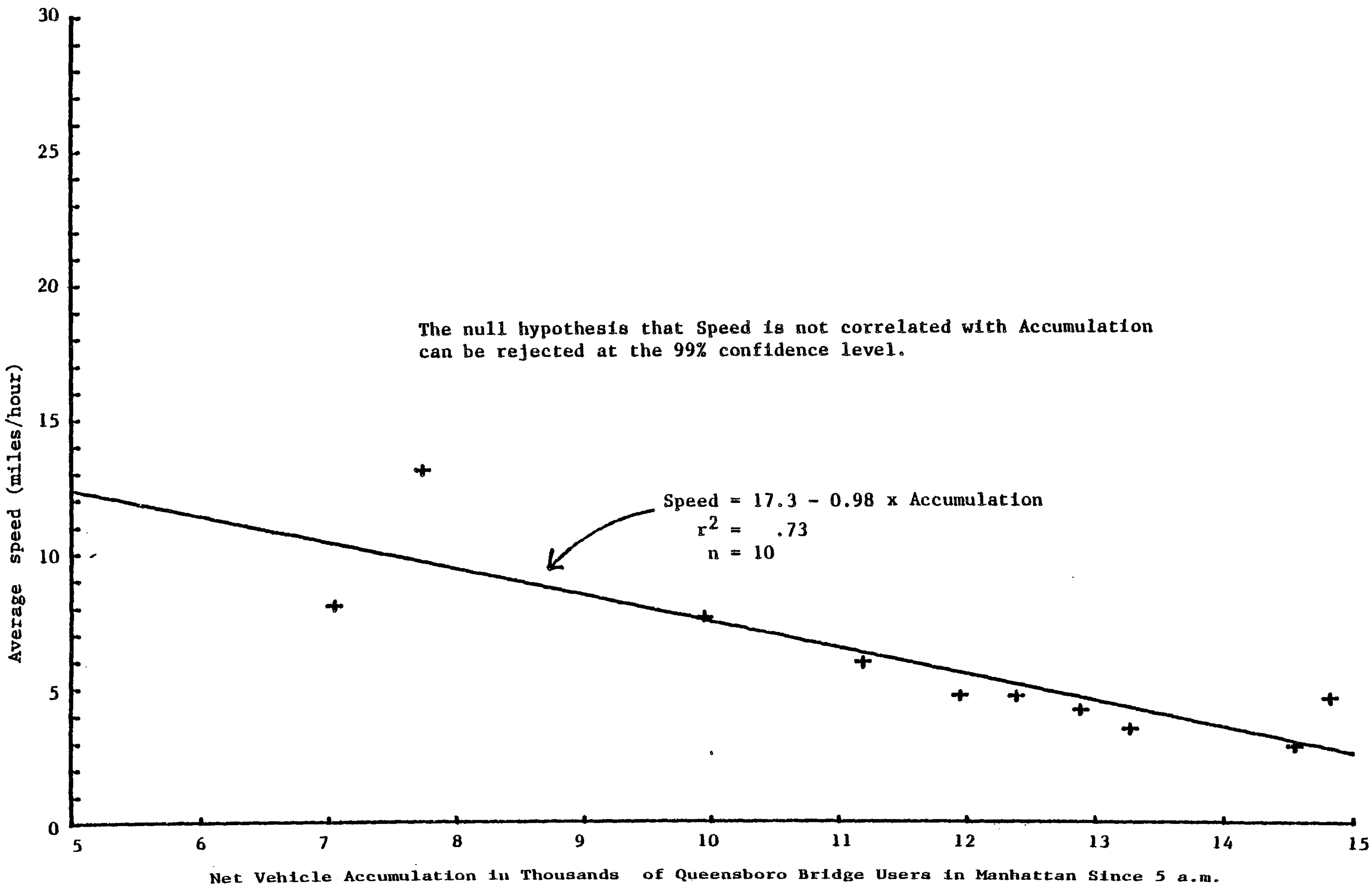


Fig. 6.— NET ACCUMULATION IN MANHATTAN OF [illegible]



30
25
20
15
10
5
0
Average speed (miles/hour)
The null hypothesis that Speed is not correlated with Accumulation can be rejected at the 99% confidence level.
Speed = 15.5 - 0.84 x Accumulation
r2 = .61
n = 10
5
6
7
8
9
10
11
12
13
14
15
Net Vehicle Accumulation in Thousands of Queensboro Bridge Users in Manhattan Since 5 a.m.



30
25
20
15
10
5
0
Average speed (miles/hour)
The null hypothesis that Speed is not correlated with Accumulation can be rejected at the 99% confidence level.
Speed = 17.3 - 0.98 x Accumulation
r^2 = .73
n = 10
5
6
7
8
9
10
11
12
13
14
15
Net Vehicle Accumulation in Thousands of Queensboro Bridge Users in Manhattan Since 5 a.m.

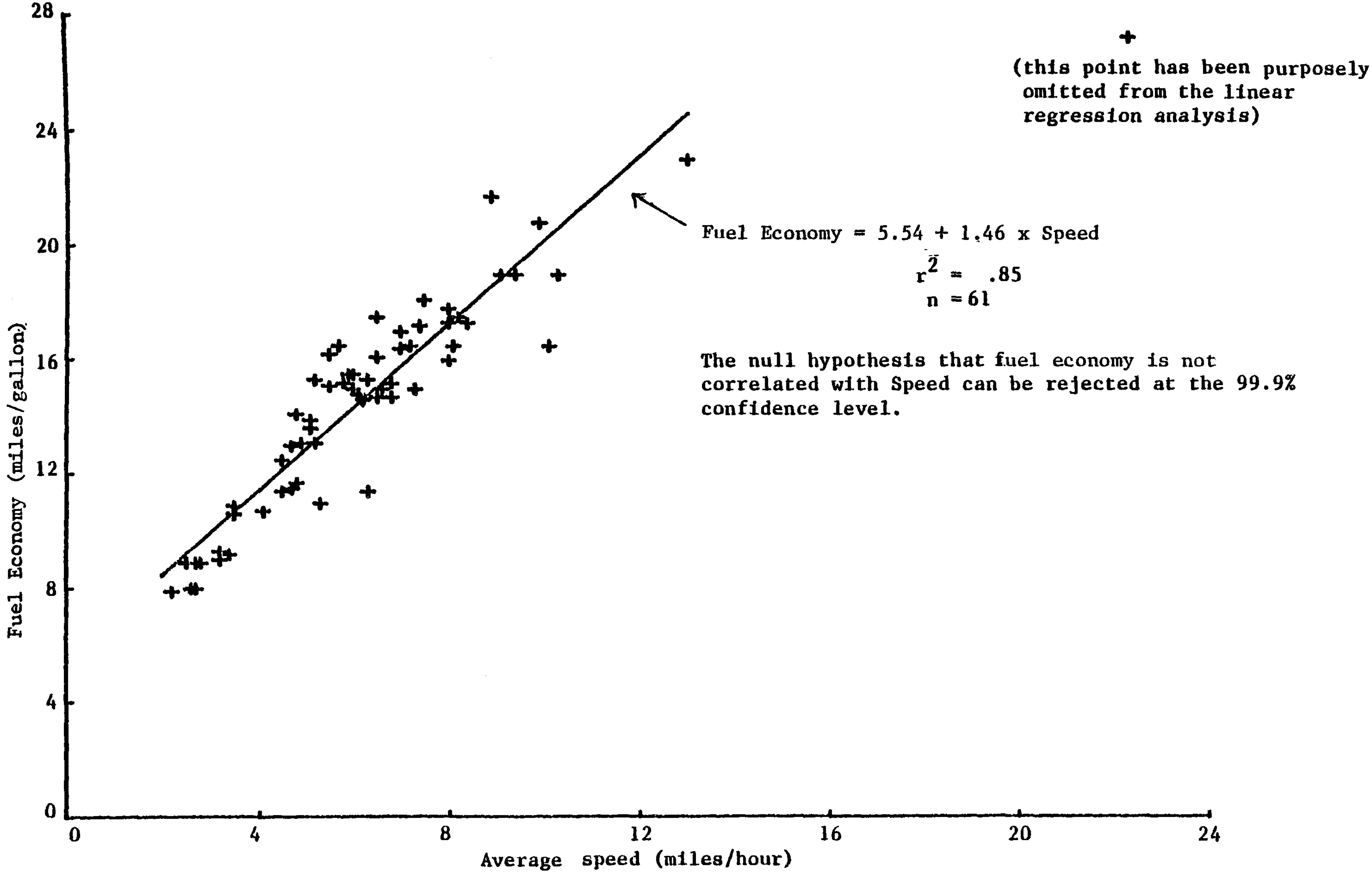
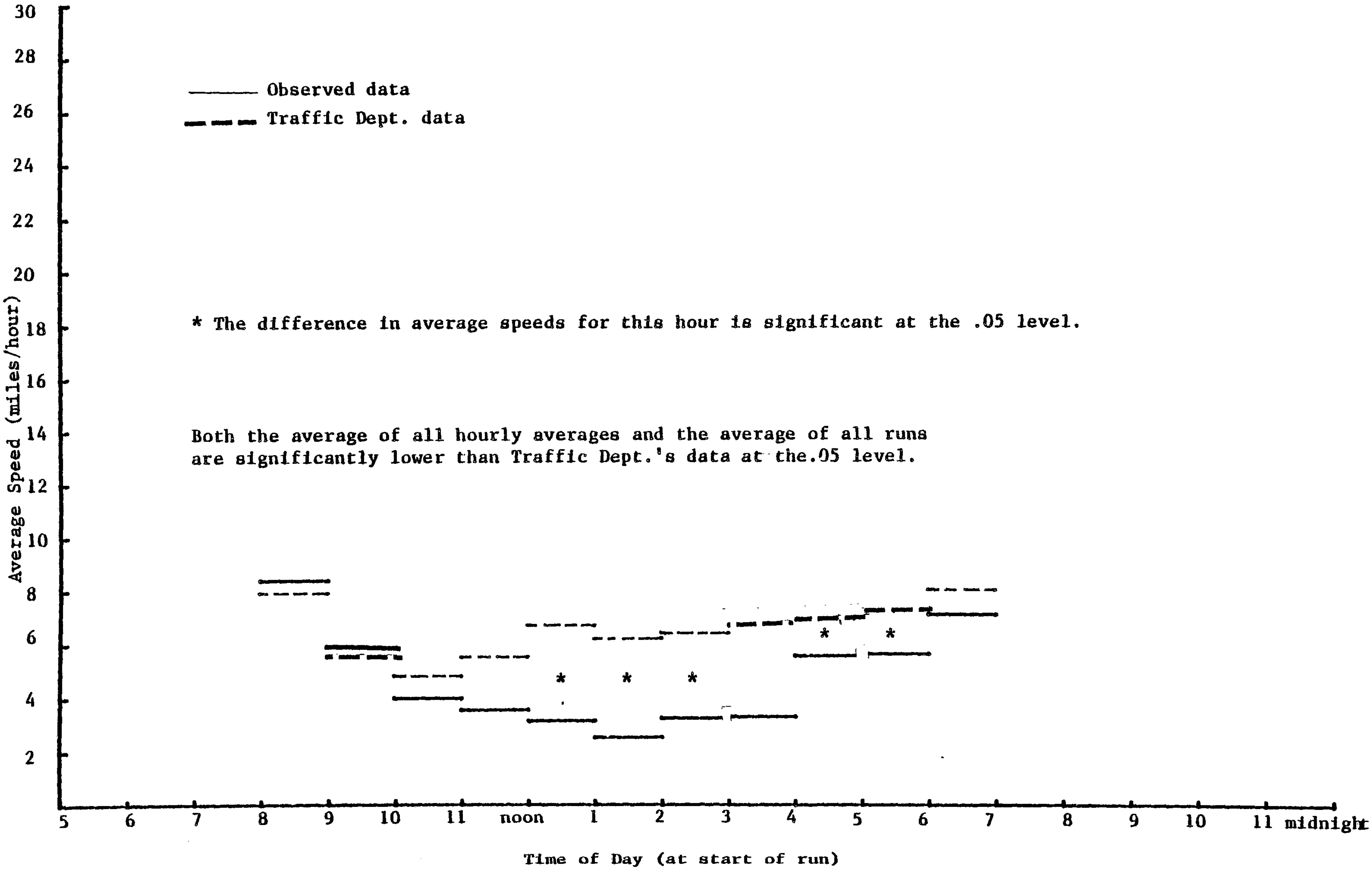


Fig. 9, FUEL ECONOMY AS A FUNCTION OF AVERAGE SPEED IN MIDTOWN MANHATTAN TRAFFIC



Observed data
Traffic Dept. data
* The difference in average speeds for this hour is significant at the .05 level.
Both the average of all hourly averages and the average of all runs
are significantly lower than Traffic Dept.'s data at the .05 level.
Average Speed (miles/hour)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
5
6
7
8
9
10
11
noon
1
2
3
4
5
6
7
8
9
10
11 midnight
Time of Day (at start of run)

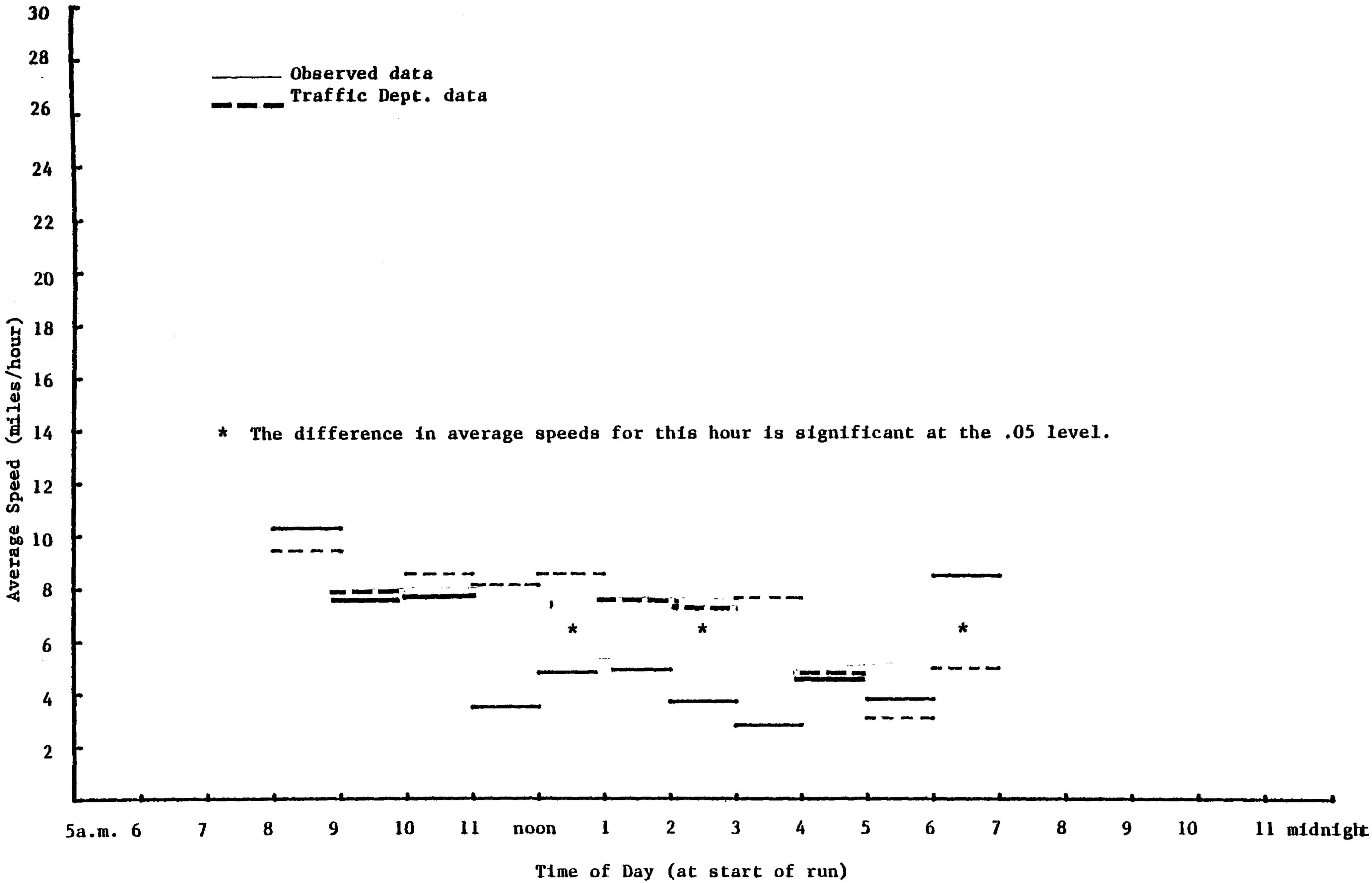
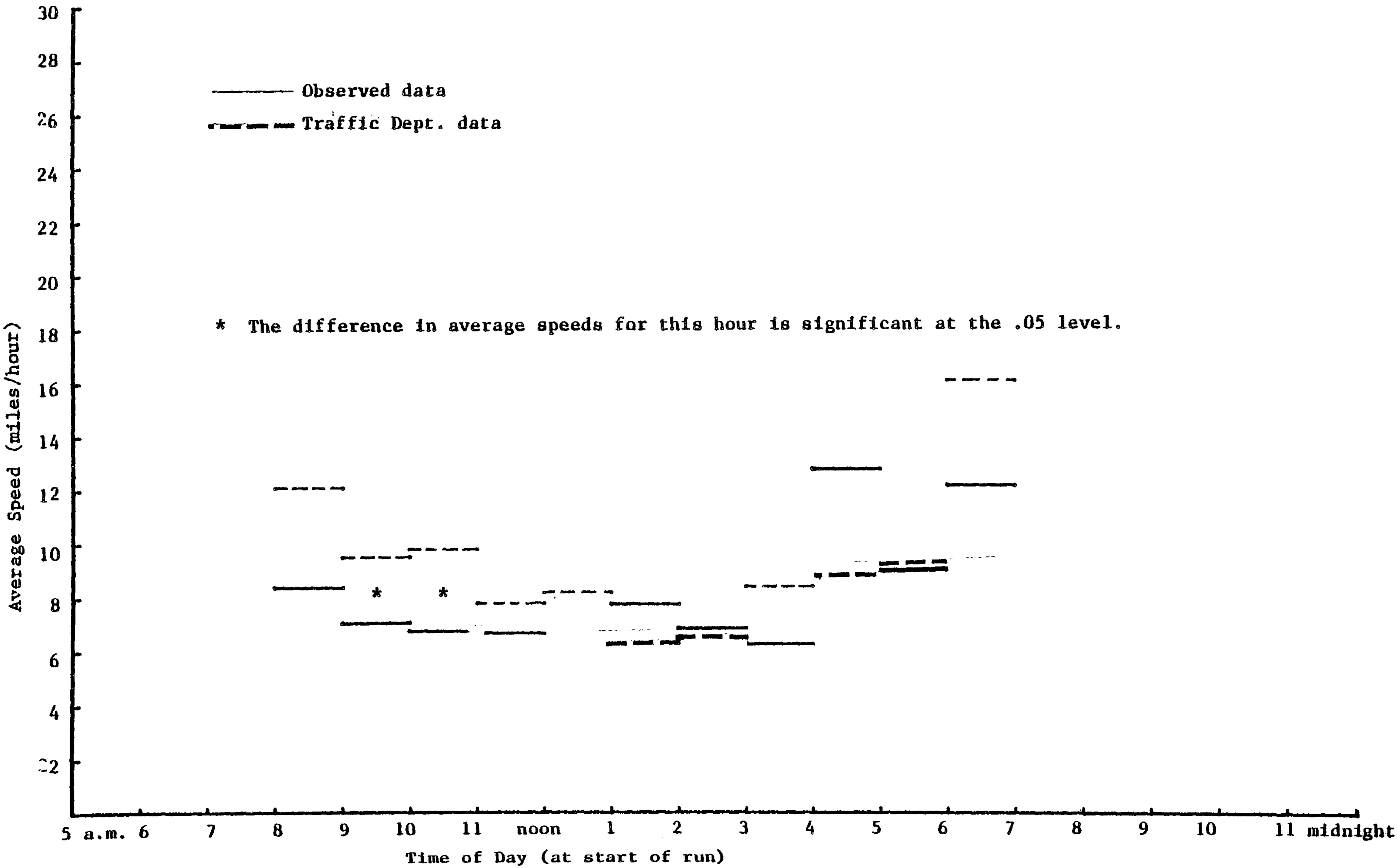


Fig. 11. COMPARISON OF TRAFFIC DEPT. DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON 57th STREET EASTBOUND BETWEEN EIGHTH AND SECOND AVENUES



Observed data
Traffic Dept. data
* The difference in average speeds for this hour is significant at the .05 level.
Average Speed (miles/hour)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
5 a.m. 6 7 8 9 10 11 noon 1 2 3 4 5 6 7 8 9 10 11 midnight
Time of Day (at start of run)

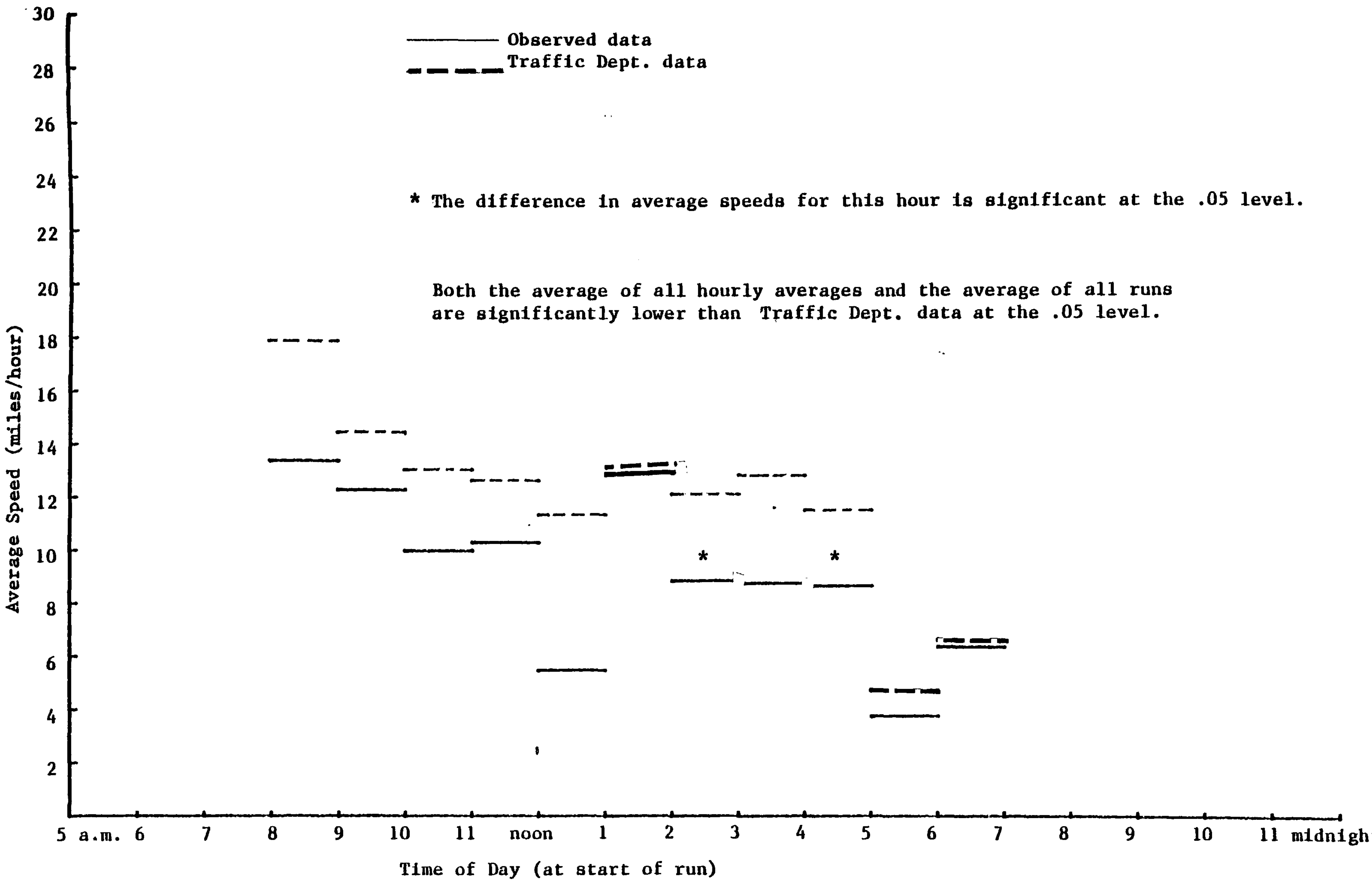
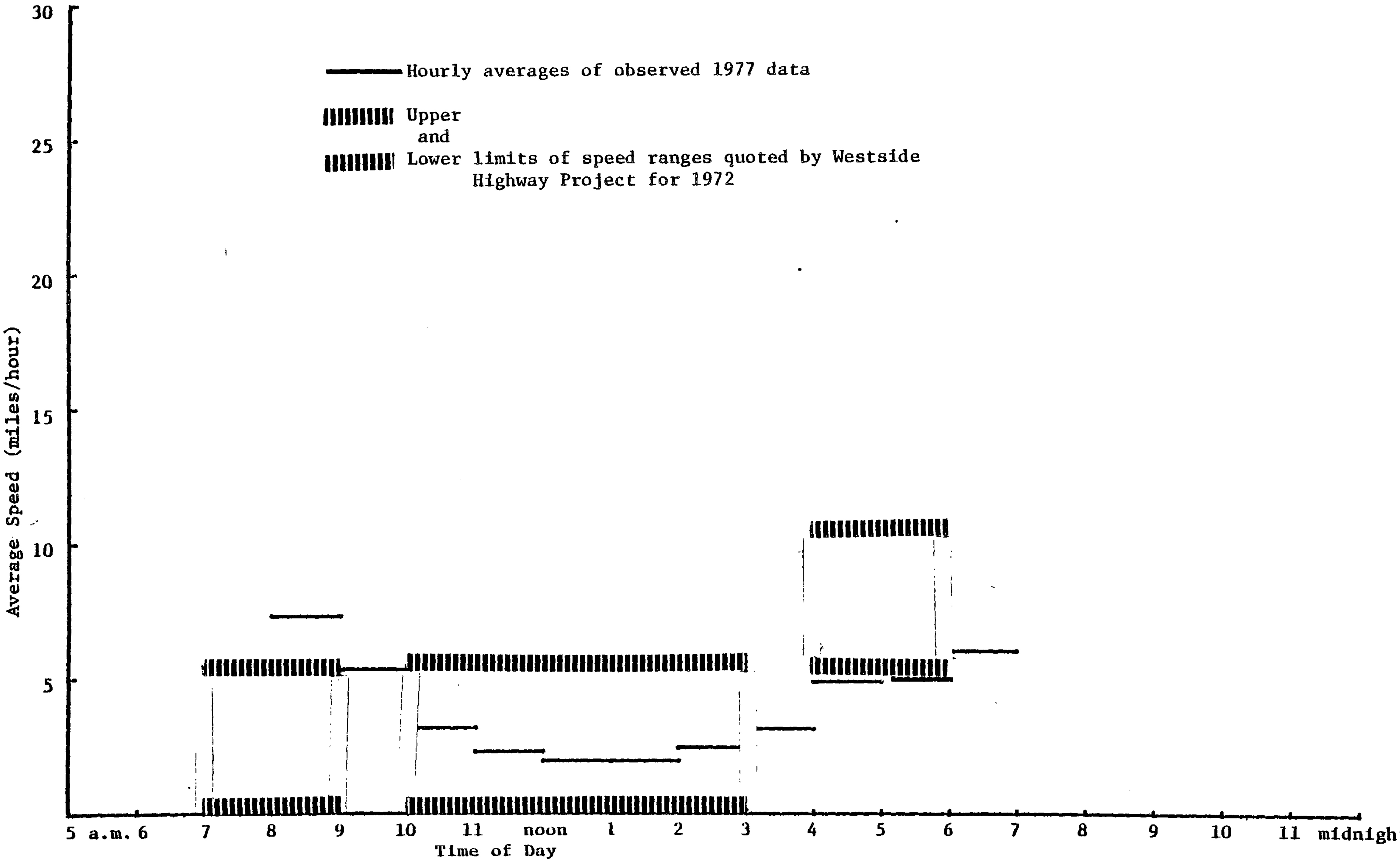


Fig. 13. COMPARISON OF TRAFFIC DEPT. DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON SIXTH AVENUE NORTHBOUND BETWEEN 34th AND 57th STREETS



COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS

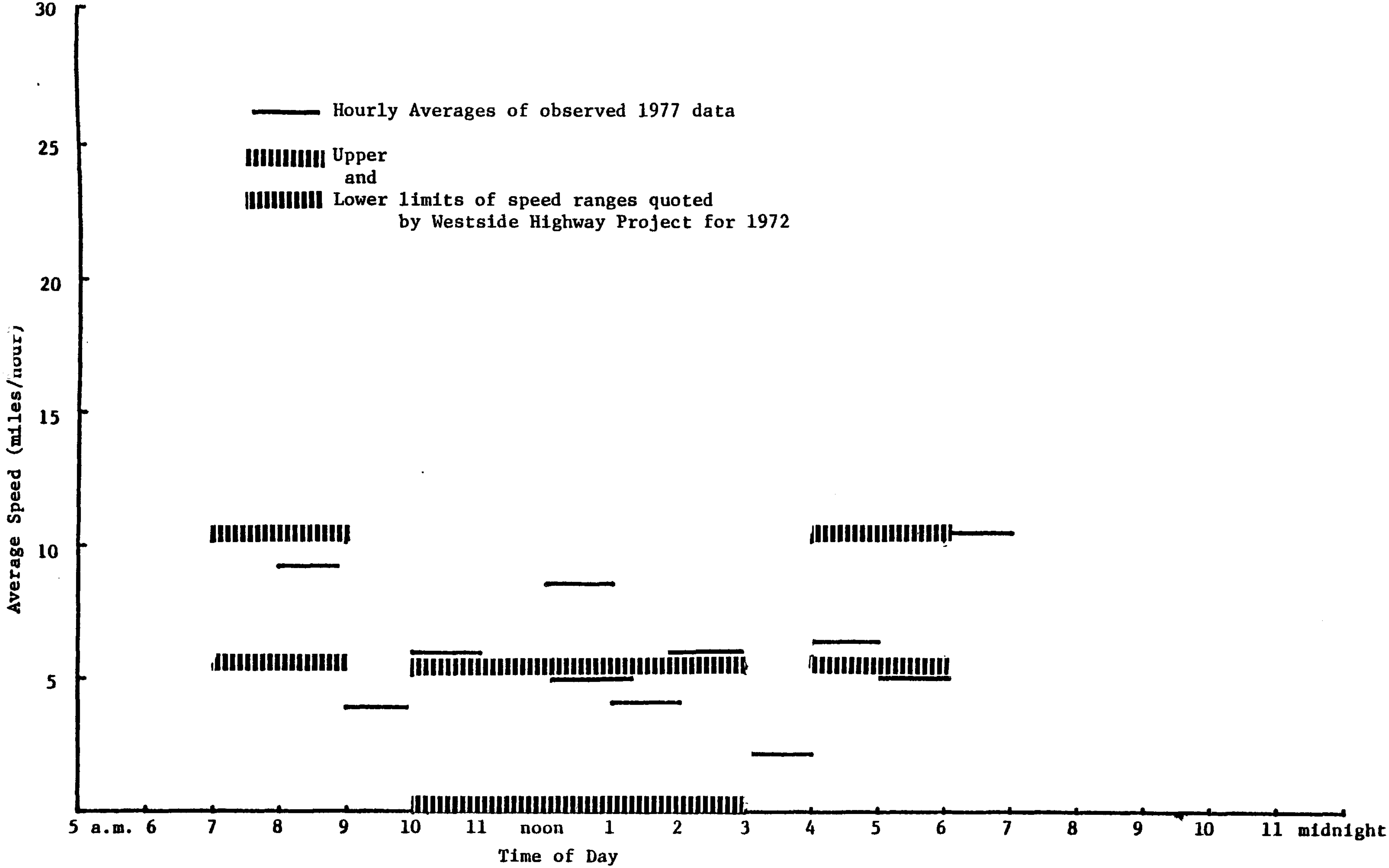


Fig. 15. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON 57th STREET WESTBOUND BETWEEN FIFTH AND SIXTH AVENUES

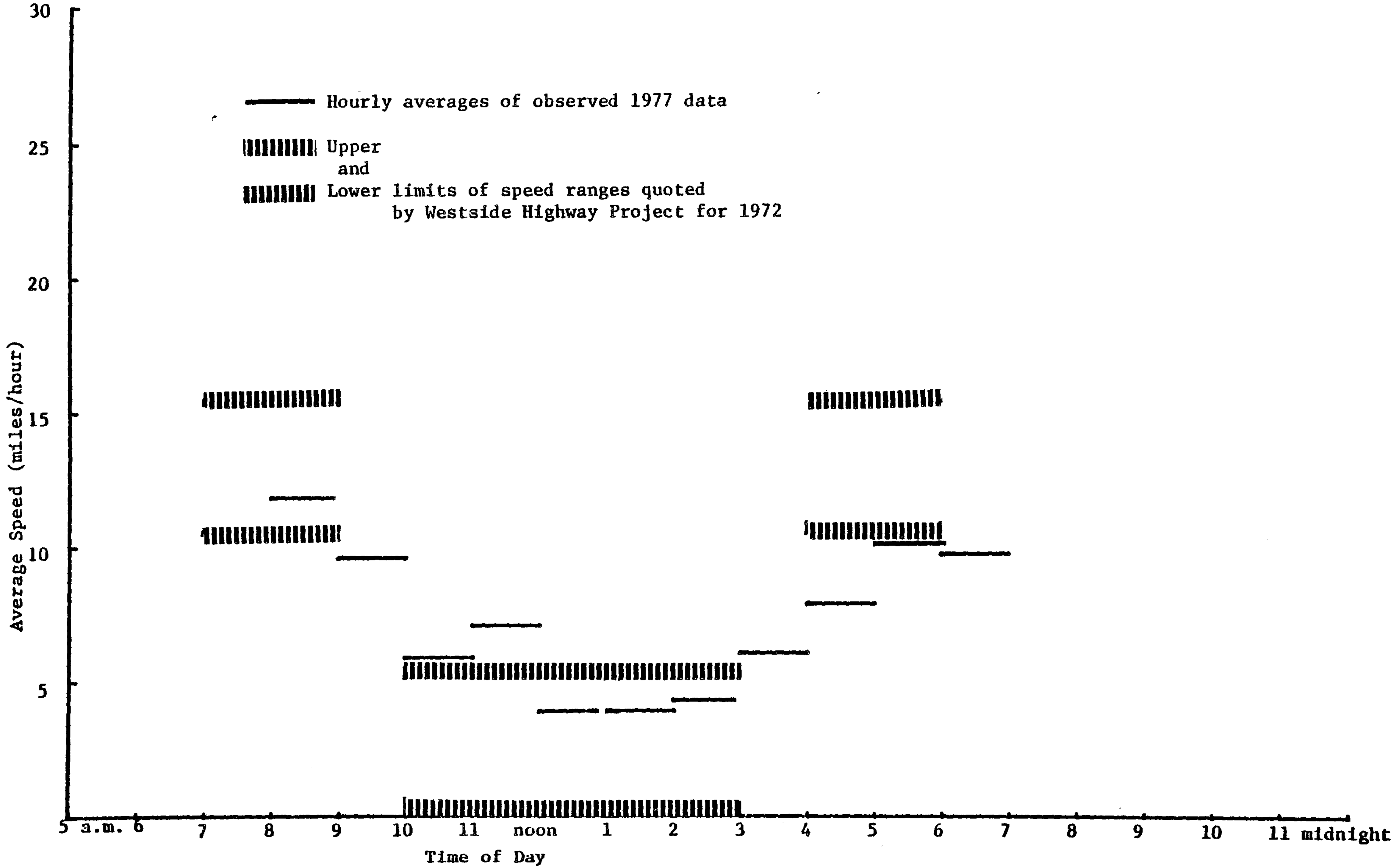


Fig. 16. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON 57th STREET WESTBOUND BETWEEN SIXTH AVENUE AND BROADWAY

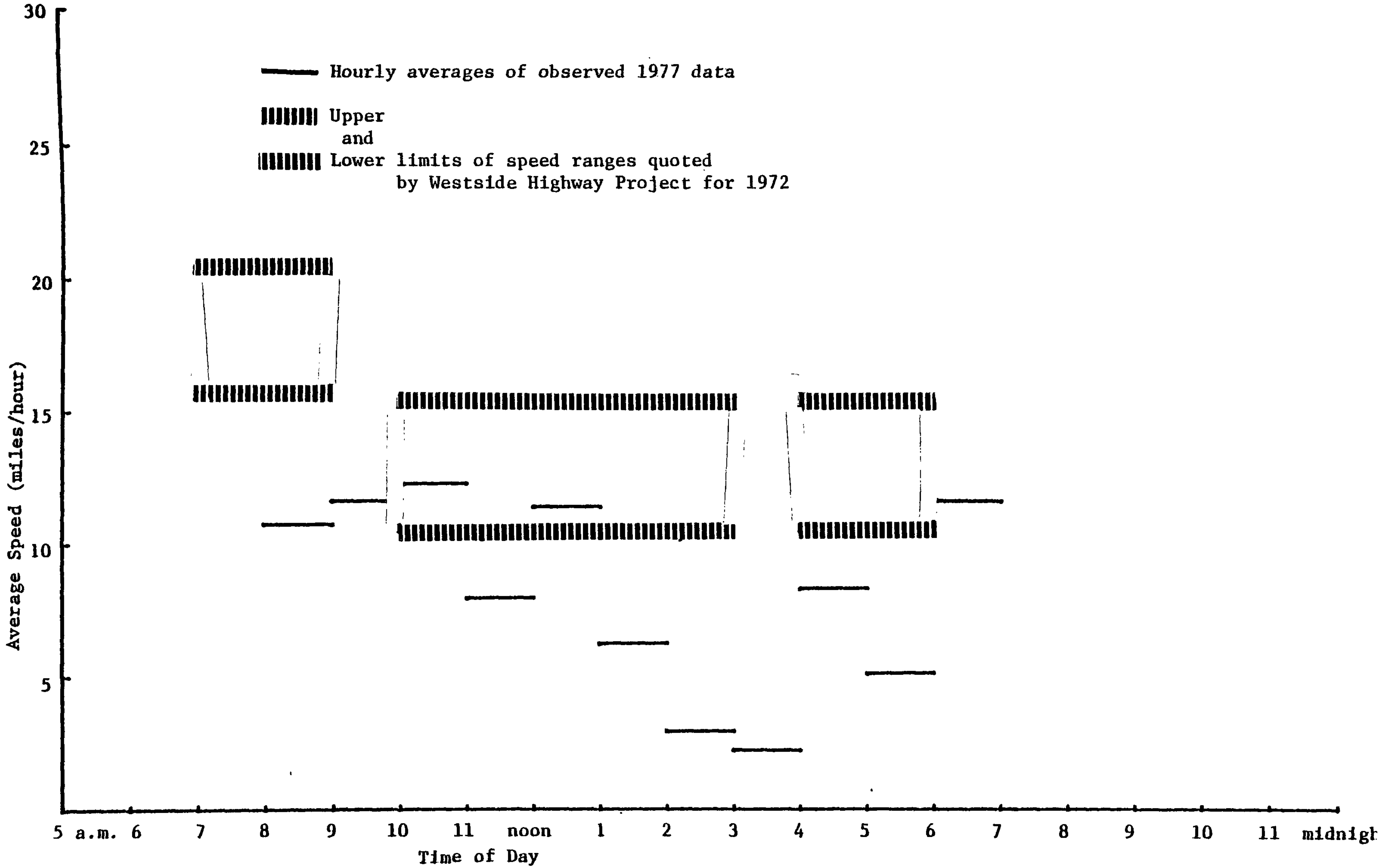


Fig. 17. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON 57th STREET EASTBOUND BETWEEN BROADWAY AND SIXTH AVENUE

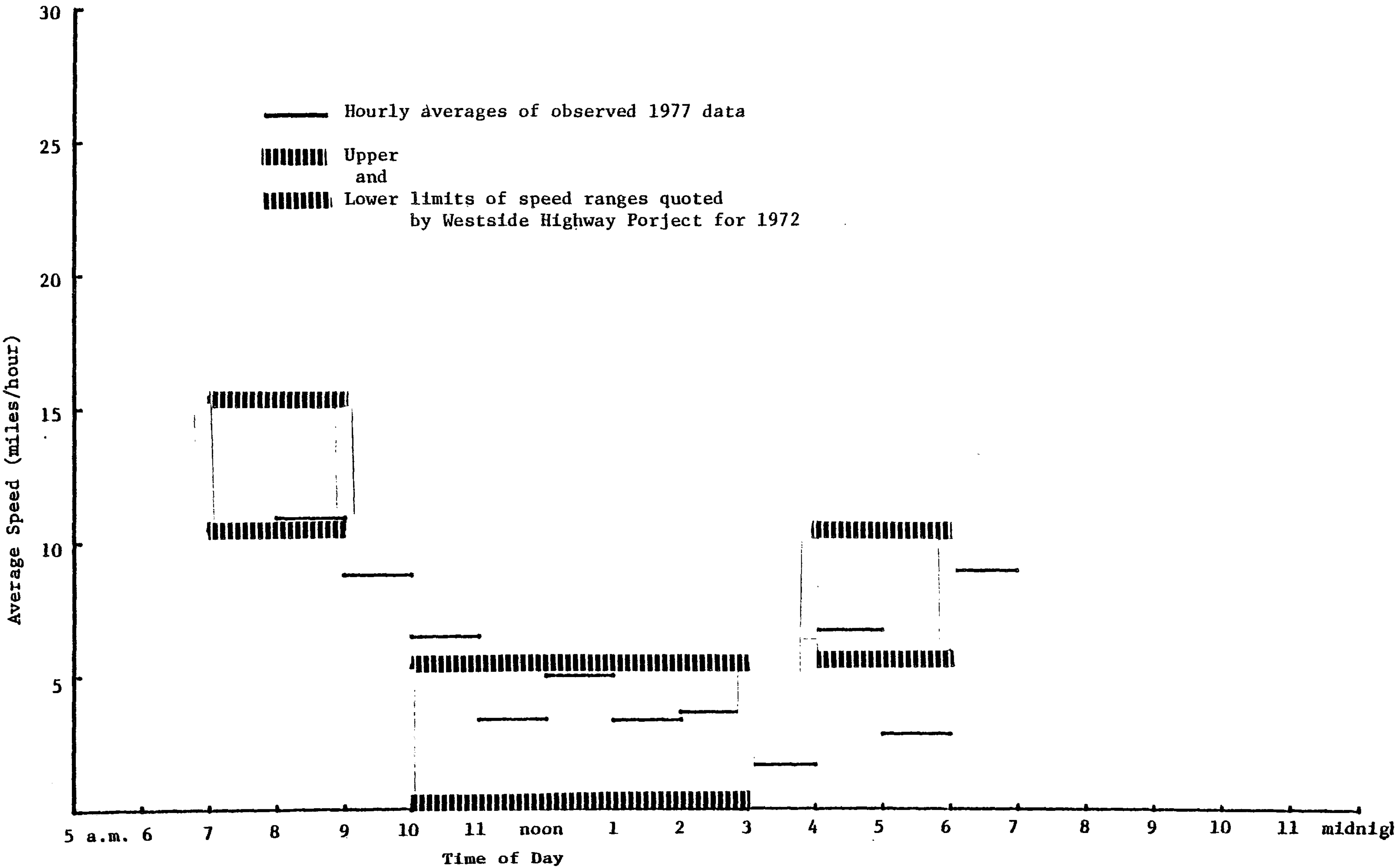


Fig. 18. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS

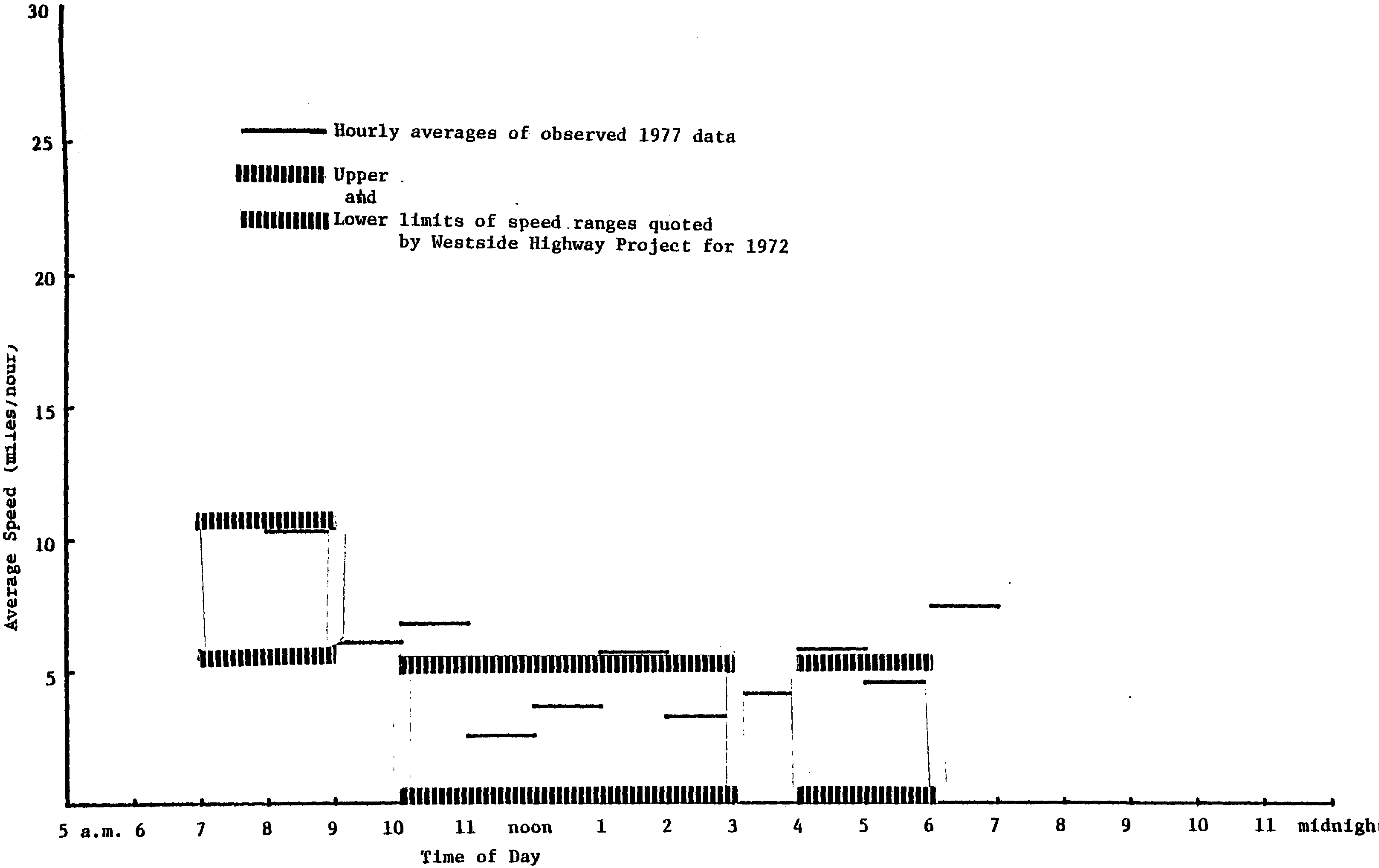


Fig. 19. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON 57th STREET EASTBOUND BETWEEN FIFTH AND SECOND AVENUES

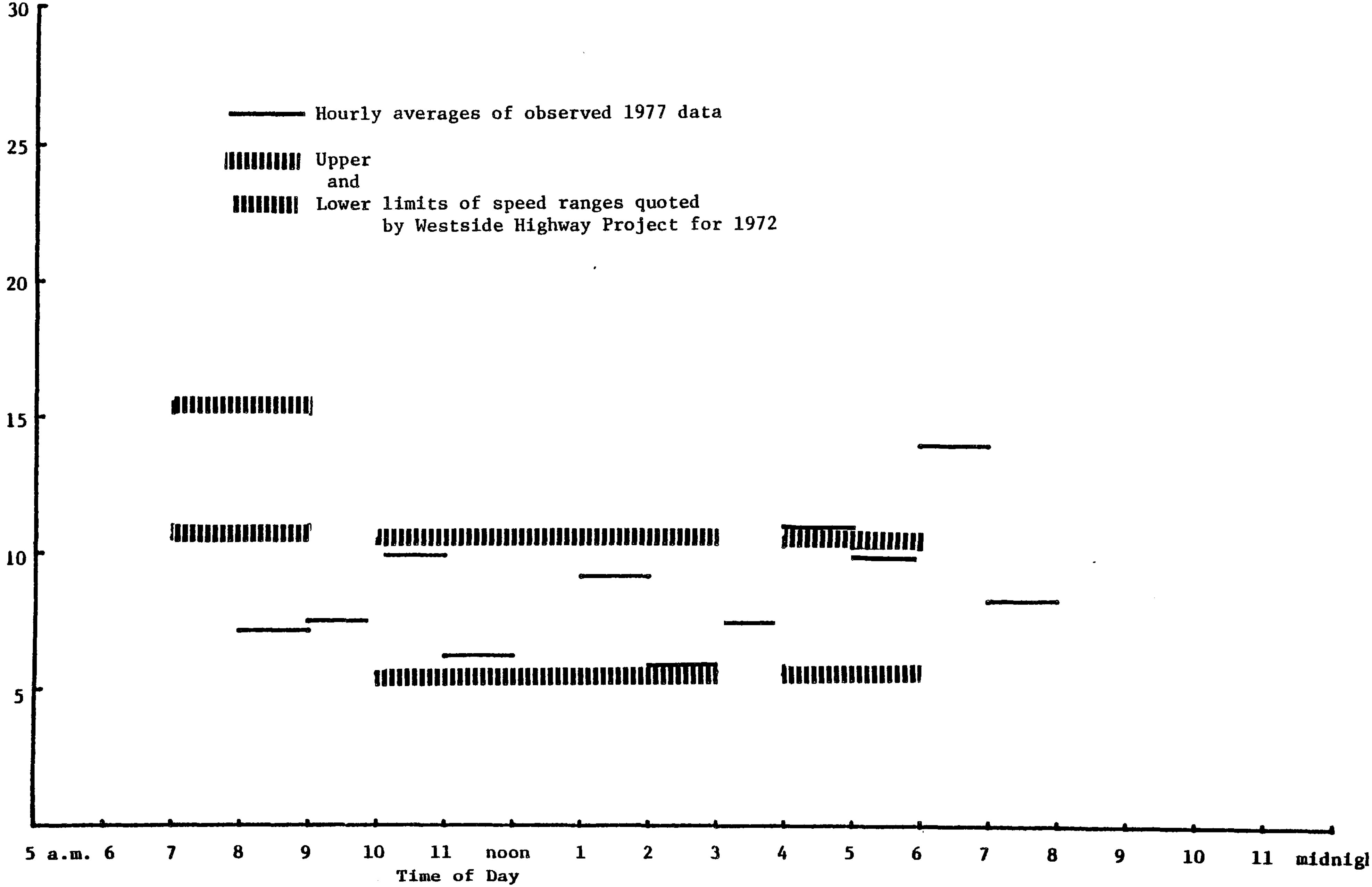


Fig. 20. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS

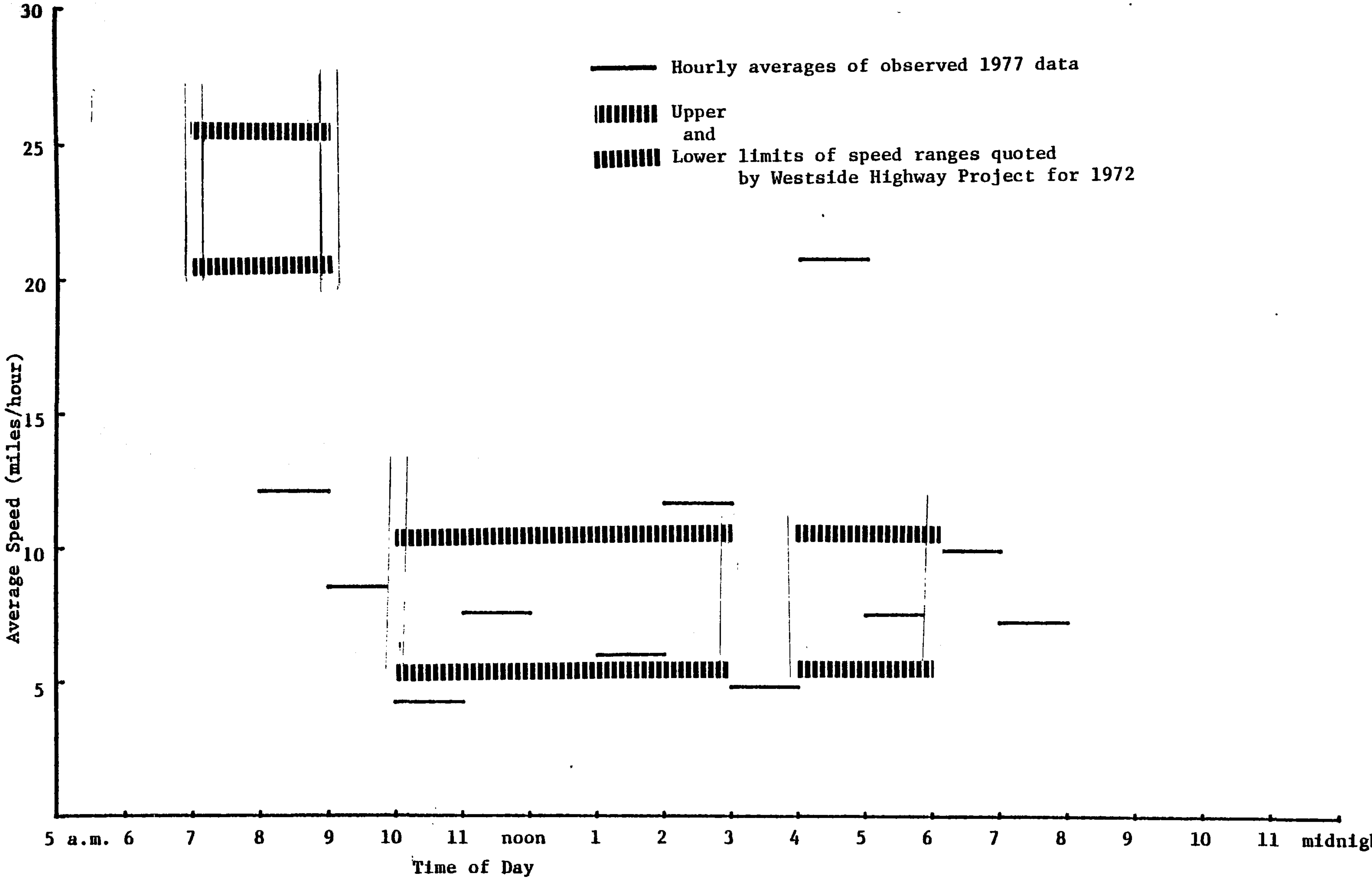
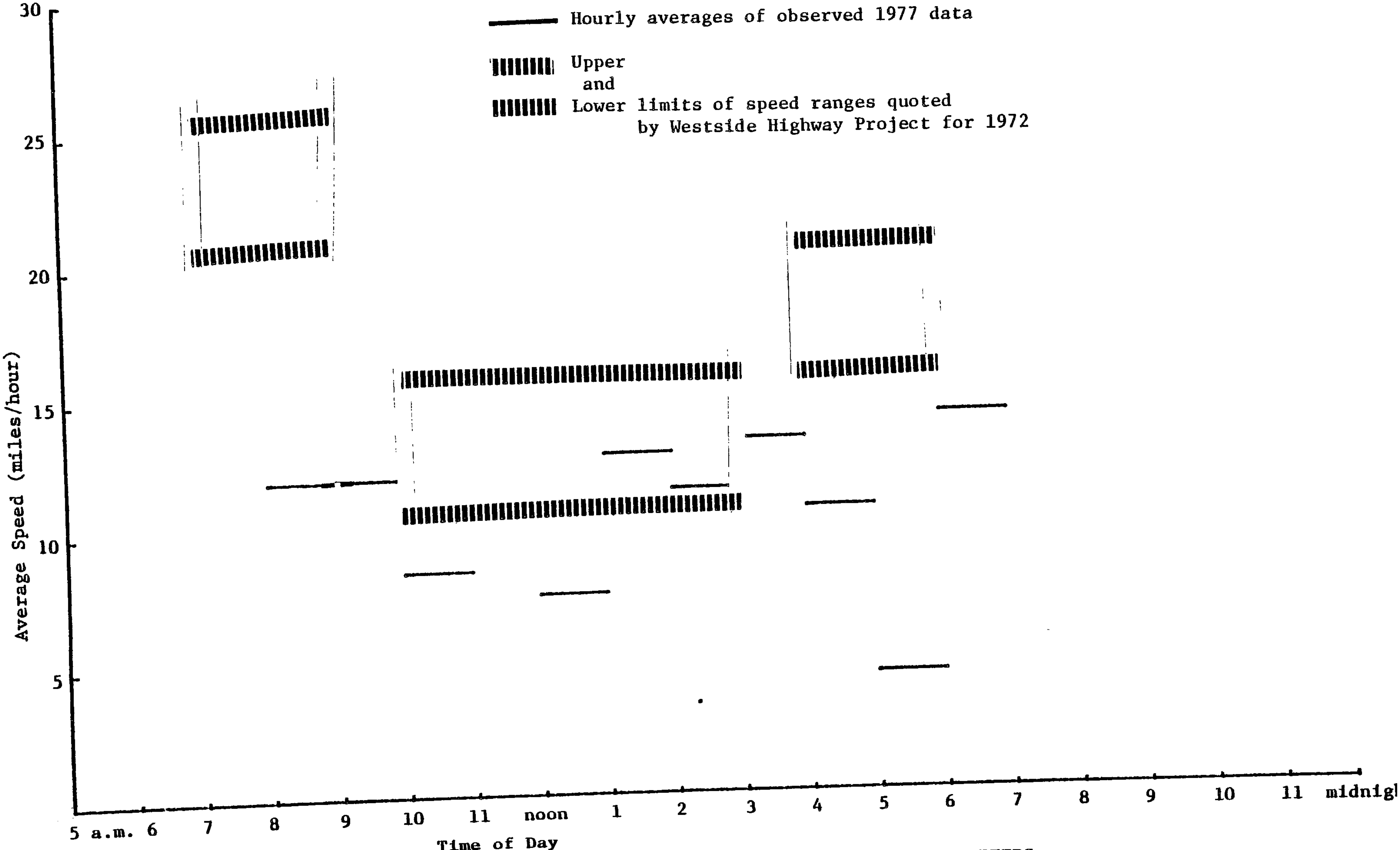


Fig. 21. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON FIFTH AVENUE SOUTHBOUND BETWEEN 42nd AND 34th STREETS



ARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS

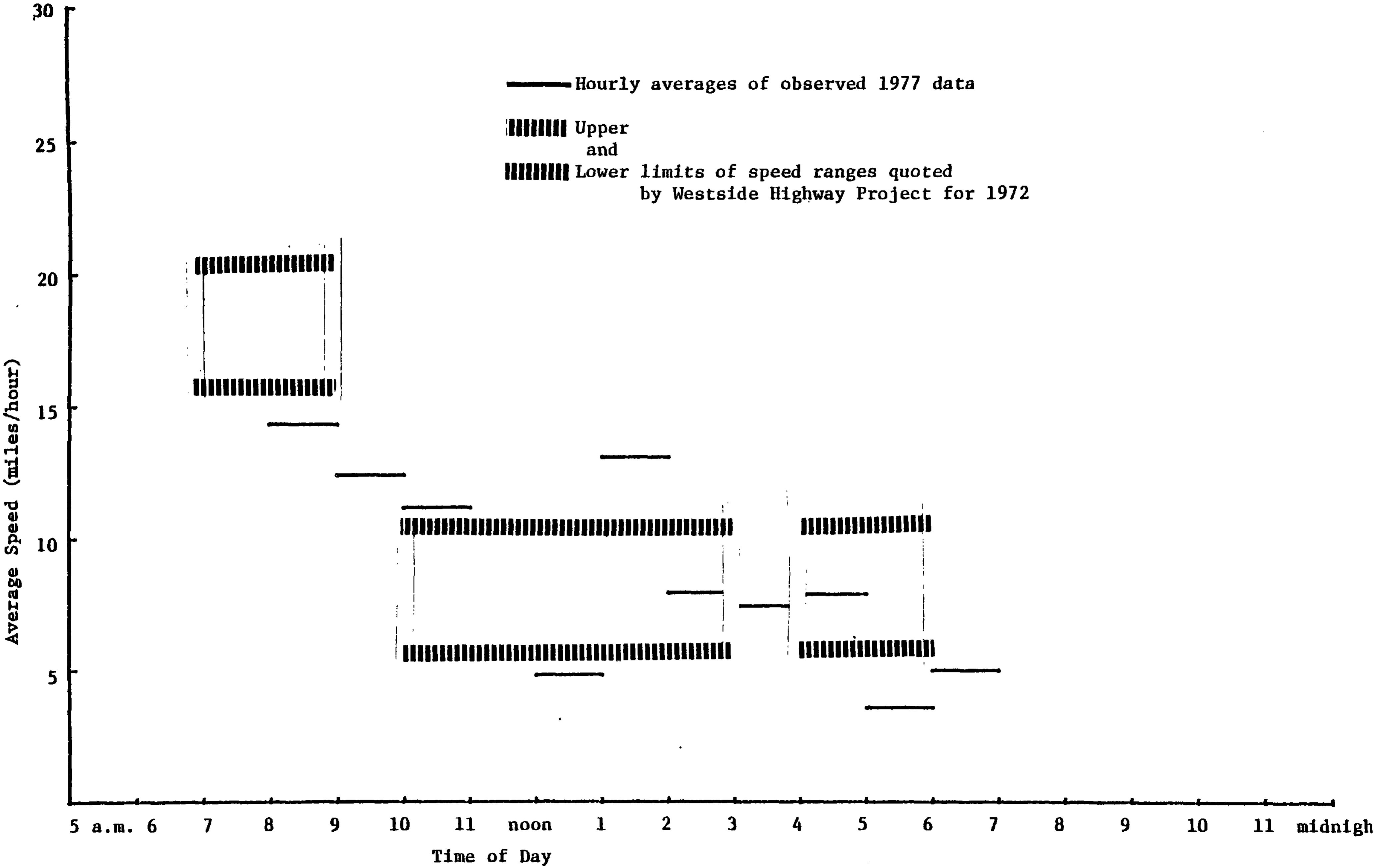


Fig. 23. COMPARISON OF WSHP DATA WITH OBSERVED HOURLY AVERAGE SPEEDS ON SIXTH AVENUE NORTHBOUND BETWEEN 42nd AND 57th STREETS

THE SOCIETAL COSTS OF CONGESTION IN NEW YORK CITY

APPENDIX 3

AN ANNOTATED BIBLIOGRAPHY

December 1979

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Discusses short range, labor intensive transportation strategies for urban areas to help reduce energy consumption, congestion and air pollution; and to improve transportation, safety and other environme amenities. Strategies include traffic flow improvements, car poolin pricing, and energy restrictions.

Bergamasco, B., M. Gilli and Giovanni Rossi. "Changes in cortical responsivity to multisensorial stimuli during exposure to urban traffic noise," Acta Oto-Laryngologica, Suppl. 339, 1976, pp. 24-2

Preliminary study on the effects of traffic noise on cortical respon sivity (EEG) to acoustic and visual stimuli. The findings from 20 normal 18-35 year old subjects exposed to a 10 minute road noise tape recording show a striking decrease in evoked auditory but not visual potentials.

Better Towns With Less Traffic. Wash., D.C.: Organization for Economic Cooperation and Development Publications Center, 1975.

Proceedings of the Better Towns with Less Traffic Conference in Paris in April 1975. Includes case studies of seven towns which limit motor traffic to improve the environment: Uppsala, Bologna, Singapore, Nagoka, Munich, Besancon and Nottingham. Also summarizes specialized sessions dealing with parking, traffic limitation, cyclists and pedestrians, para-transit planning, financing and implementing urban transport policies, and economic and energy implications.

Bhatt, Kiran U. What Can We Do About Urban Traffic Congestion? A Pricing Approach. Wash., D.C.: The Urban Institute, April 1976.

Study of various congestion pricing techniques and their feasibility, in both practical and political terms. Considers toll booths, supplementary licenses, self-cancelling stickers, automatic vehicle identification systems, and vehicle meters.

Bhatt, Kiran, Ronald Kirby and Michael Beesley. A Transportation Improvement Program for Congested Areas. Wash., D.C.: The Urban Institute, Feb. 1976.

An examination of congestion pricing as a means of reducing congestion. Includes look at legal aspects, previous efforts and equity. Proposes demonstration program for urban areas that would combine charges for using congested streets with incentives for using high occupancy modes.

"Britain is Missing the Bus," The Economist, Vol. 258, No. 6914, Feb. 28, 1976.

Describes decline in use of British bus services from 1964-74 and corresponding rise in auto travel; also, the measures undertaken to reverse these trends and their failure.

Brown, Gerald R. "Influence of Park-and-Ride Factors in Modal Shif Planning," Transportation Research Board Transportation Research Record, No. 557, 1975, pp. 15-20.

Investigates park-and-ride facilities and municipal parking policie as means of controlling the modal split in urban areas. Concludes that a park-and-ride facility can be a useful planning tool if properly designed.

Brugger, Robert L. "Taxi Cruising in Midtown Manhattan," Traffic Engineering, Vol. 45, No. 5, May 1975, p. 26.

A study of the effects of carbon monoxide pollution by cruising ta Found that taxis in midtown contribute about 8 tons of CO (or 25% the total found in the air) from 7 a.m. to 7 p.m. with about 8% attributable to unoccupied cabs. Recommends additional taxi stand

"Capacity and Quality of Service," Transportation Research Record, No. 538. Wash., D.C.

Collection of seven papers covering: comfort and flow characteristics for pedestrian facilities such as walkways, escalators and moving walks; weaving section design; the application of computer analysis to interchange design; methods for determining intersection capacities; off-line signal optimization techniques; a photooptic system to record vehicle position; and the impact of lower national speed limits.

Caprio, Raphael J., Harry L. Margulis and Morris M. Joselow. "Lead Absorption in Children and Its Relationship to Urban Traffic Densities," Arch. Environ. Health, Vol. 28, April 1974, pp. 195-197.

Examines the relationship between blood/lead levels in children and household location with respect to distance from major arterials and traffic density in newark, N.J. Found that the proportion of children with levels suggesting lead poisoning more than doubled in the sample living in areas exposed to vehicle densities above 24,000 vehicles per average weekday.

California State Transportation Board. California Transportation Plan - Recommended Statewide Transportation Goals, Policies and Objectives. Sacremento, CA: March 1977.

The policy element of the California State Transportation Plan. Deals with goals, policies and objectives, including implementation strategies.

Carnegie Mellon University Transportation Research Center. The Pittsburgh Parking Strike. Springfield, VA: National Technical Information Service, Dec. 1972.

Examines impact of 1972 strike by parking lot employees which close 80% of the area's parking capacity. Concludes that large numbers o auto commuters were able to continue commuting through public trans and car pooling. Notes low absenteeism rates and looks at effects retail sales, entertainment, and civic attitudes.

Caro, Robert. The Power Broker. Robert Moses and the Fall of New York. New York: Random House, Vintage Books, 1975.

Extensive information throughout on congestion by both private and public modes but most particularly in Chapters 39 and 40. Includes historical, institutional and financial analyses of its causes; alsc very useful index.

Cesario, Frank J. "Emissions Implications of Traffic Reductions," APCA Journal, Vol. 25, No. 9, Sept. 1975, p. 957.

Technical report on the indirect reduction of vehicle emissions whi results from alleviating traffic congestion. Uses carbon monoxide emissions as a case in point.

Christiansen, Dennis L. and Ronald W. Holder. "Off-Street Loading Space for Downtown Buildings," Texas Transp. Res., Vol. 10, No. 1, Jan. 1974, pp. 5-7.

Argues that off-street loadings for downtown buildings can reduce traffic congestion and enhance commerce, that space must be adequate for needs and allow good accessibility, and that design is important. Agrees with space requirements proposed by E.M. Whitlock and J.G. Schoon for Dallas' Central Business District: 1.4 loading spaces per 100,000 sq. ft. for major office complexes.

Citizens Traffic Safety Board. The Cost of Traffic Congestion and Traffic Accidents in the City of New York. New York: Sept. 1953.

Early attempt to quantify the cost of congestion to New York City through a survey of its business community. Concluded the cost was $1 billion per year exclusive of environment-related factors.

City Club of New York. "Manhattan Auto Study," Hearing Before the Subcommittee on Environmental Pollution of the Committee on Public Works, United States Senate. Ninety-Third Congress, Second Session, Part 3, Wash., D.C., May 1-2, 1974, pp. 821-1060.

Analysis and quantification of the cost of New York City's congestion, which it concluded was $1 billion per year, including air pollution related expenses. Recommends a series of remedies based on traffic management reforms, new highways and parking lots.

Cohen, Sheldon, David C. Glass and Jerome E. Singer. "Apartment Noise, Auditory Discrimination, and Reading Ability in Children," Journal of Experimental Social Psychology, Vol. 9, No. 5, Sept. 1973, pp. 407-422.

Examines the relationship between the auditory and verbal skills of 73 children in Grades 2-5 and the noise level of their homes, with expressway traffic as the principal source of noise. Results suggest long-term behavioral effects in auditory responsiveness despite noise adaptation.

Collins, M.S. "Efficient and Economic Use of Existing Urban Road Networks Having Regard to Consideration of the Environment," Journal of the Institute for Municipal Engineering, Vol. 101, No. 10, Oct. 19 pp. 262-268.

Examines possible methods of achieving planned traffic restraint and concludes that unplanned restraint or restraint by congestion is the most likely outcome.

Colt, Rosanne J. Problems in Implementing Roadway Pricing. Wash., D.C. Transportation Research Board, 1974, Report No. TRB/TRR-74/494.

Examines problems related to roadway pricing, including legal issues, methods of price restraint, the collection problems of congestion pricing and automatic vehicle identification; also, analyzes the effects of a 25% parking tax imposed in San Francisco from 1970 to 1972.

Crain, John L., and Sydwell D. Flynn. Southern California Rapid Transit District 1974 Strike Impact Study. Menlo Park, CA: Bigelow-Crain Associates, Jan. 1975, Report No. BHT-004.

Describes the effect of a labor strike on the Los Angeles area public transportation system from Aug. 12 to Oct. 18, 1974. Concludes that although the system only carries 2 to 3% of the area's weekday person trips, there were impacts on traffic congestion, mobility and commerce. Evaluates in detail nine particular areas including business and auto traffic.

Crowell, William H., Michael Gerrard and Granville Sewall. Social, Economic, and Environmental Impacts of Selected Transportation Strategies. New York: Council on the Environment of New York City, 1975.

Examination of the probable impacts of five typical transportation control plan strategies: reducing parking by banning or pricing mechanisms, the creation of exclusive lanes for buses or carpools with fringe parking facilities, carpooling, traffic management improvements, and a ban on taxi cruising. Focus is on major east coast cities.

Die Volkswirtschaftlichen Kosten des Strassenverkehrs. "Den Buergern 45 Milliarden DM Wert. (The Costs for Passenger Car Traffic. Worth 45 Million DM to the Citizens.)," Umwelt, Duesseldorf, W. Germany, Vol. 3, No. 2, 1973, pp. 30-31.

Estimates that the social costs of passenger car traffic (for cleaning devices, for reducing lead pollution, for road construction for noise and exhaust pollution damages, for congestion time loss, and for accident injuries) amounts to $15 billion in West Germany. Also compares air pollution problems of W. Germany with southern California. In German.

Delaware Valley Regional Planning Commission. Philadelphia Central Business District Parking Rate Experiment. Springfield, VA: National Technical Information Service.

Report of experiment involving two downtown garages at which rates were changed to favor short term, non-commuter parking at the expense of all day, commuter parking. Findings indicated success. Business and turnover at both garages increased. Performed as part of DOT's Urban Corridor Demonstration Program.

Dienemann, Paul F., and Armando M. Lago. External Costs and Benefits Analyses, Northeast Corridor Transportation Project (NECTP). Bethesda, MD: Resource Management Corp., Dec. 1969.

Quantifies the costs and benefits of alternative Northeast Corridor transportation system impacts on noise, air pollution, aesthetics, air and highway congestion, safety, and employment.

DeLeuw, Cather & Co. and the Urban Institute. Characteristics of Urban Transportation Systems. A Handbook for Transportation Planners. Springfield, VA: National Technical Information Service, May 1975.

Reference source for the performance characteristics or urban transportation systems: commuter, rapid and light rail; local and rapid bus transit; the auto-highway system; and pedestrian assistance and people mover systems. Studies their speed, capacity, operating costs, energy consumption, pollution, capital costs, and accident frequencies.

Edholm, S., and B. Kolsrud. "Travel-Actuated Charging: A New Technique for Road Pricing," Traffic Engineering Control, Vol. 14, No. 16-17, Aug./Sept. 1974, pp. 739-743.

Proposes charging drivers according to the social costs they produce as a way of reducing congestion. The author's system is based on the features of a journey's time-distance relationship in congested traffic.

Energy and Environmental Analysis, Inc. Development of a Prototype Parking Management Plan. Wash., D.C.: EPA Office of Transportation and Land Use Policy, Nov. 1975.

A parking management plan for the Washington metropolitan area. Includes impact analysis on air quality, mass transit, energy use and urban amenities. The D.C. Core, Rosslyn, Silver Spring and Centreville were studied in detail.

European Economic Community Report. "Study of Environmental Pollut and Environmental Injuries by Traffic in Urban Areas - Noise and Exhaust Gases - Summarizing Overview." Verein Deutcher Ingenieure, Dusseldorf, W. Germany, March 1974.

Part of an extensive study by nations of the European Community on the theoretical and practical problems of urban street use. The purpose is to develop a methodology to calculate the costs of reducing noise and exhaust pollution in urban areas to desired levels. In German.

Faigin, Barbara Moyer. Societal Costs of Motor Vehicle Accidents - 1975. Wash., D.C.: National Highway Traffic Safety Administration, Dec. 1976.

Revision of a similar study in 1972. Quantification of the various societal costs imposed by motor vehicle accidents. Considers production losses, medical care, and the costs of funerals, lawyers, courts, accident investigations, insurance, vehicle damage, traffic delays, property damage, and non-quantifiable factors such as pain and suffering.

Federal Highway Administration. Improving Urban Mobility - Through Better Transportation Management. Wash., D.C.: FHWA, May 1975.

Discusses low cost traffic engineering and public transit techniques which can improve urban mobility. Techniques include better managem of existing systems, bus lanes, bus streets, intersection priorities fringe parking, and ride sharing.

Federally Coordinated Program of Research and Development in Highway Transportation. Volume 2: Reduction of Traffic Congestion and Improved Operational Efficiency. Wash., D.C.: Federal Highway Administration, Jan. 1975, Report No. FHWA/RD-FCP-003.

Research concerned with improving the design of new highway facilities and improving the efficiency of existing ones by encouraging more people to travel per vehicle and by improving the demand/capacity relationship through signal timing and traffic routing techniques. Argues that one cause of congestion is motorists' lack of knowledge of alternative routes.

Ford, Frank R. "Traffic Conditions of New York City," Street Railway Journal, Vol. 18, No. 4, Oct. 1901, pp. 225-248.

Statistical Report on New York City traffic, particularly the public transit modes, and the extensive congestion which existed even in 1901. Includes maps and illustrations.

Geehan, Randall. "Landing Delay Costs at Airports: A Simulation of First-Come-First-Served and Two Priority Classes," Information Journal, Vol. 3, No. 1, Feb. 1975, pp. 88-98.

A computer simulation technique for calculating average delay costs, marginal delay costs, and taxes - along with the results for typical daily cycles with different peak hour traffic intensities. Presents the case for rationing capacity through pricing and provides a method of performing the necessary calculations.

Handbook for Pedestrian Action. Wash., D.C.: U.S. Govt. Printing Office, 1977.

Rationale economics and techniques for pedestrian zoning policies.

Hartmann, H.F. "Carbon Monoxide - Occurence, Concentration, Effects on Man: A Review," Clean Air, Vol. 6, No. 2, Feb. 1972, pp. 2-7.

Reviews effects of CO on people: threshold levels, ambient air leve in cities, poisoning symptoms, CO levels in traffic, safety standard etc.

Harris, Hillary. Organism. New York: Phoenix Films, Inc., 1975. 16mm film.

Twenty minute film examining the relationship between living tissue and urban structures. Extensive time lapse photography visually demonstrates repeated 24-hour congestion patterns, pedestrian and vehicle.

Hazeman, R.H. "Gigantism and pollutions: The Impact of Environmenta Pollution on the Internal Milieu-Psychology," Revue de Medecine Psychosomatique et de Psychologie Medicale, Vol. 13, No. 4, Winter 19 pp. 373-389.

Suggests pollution is a natural brake on the excessive growth of well-fed populations, that pollution is proportional to the populatio density, and that the present situation requires a population policy that will seek quality rather than quantity. Also that: gigantism, mechanization, bureaucracy, noise, growing conformity and lack of imagination combine to undermine emotional defenses, interfere with circulatory systems (human and social), and disrupt interpersonal communication.

Highway Research Board. Citizen Participation in Transportation Planning. Wash., D.C.: HRB, 1973, Special Report 142.

Report of a conference on transportation planning and citizen participation organized by the Highway Research Board, plus papers and a conference report on both topics as applied in Boston.

Hirst, Eric. Pollution Control Energy Costs. Detroit: American Society of Mechanical Engineers, Winter Annual Meeting, 1973. Paper 73-WA/Ener.-7.

Examines the energy needed for or saved by several environmental protection strategies. Areas considered include urban passenger traffic and air pollution control. Concludes that relatively little is required to meet the environmental needs he assumes. Analyzed scenarios include (1) a 10% shift from urban auto traffic to public transit, (2) adoption of automobile pollution control devices which meet clean air standards, and (3) the redesign of automobiles to improve fuel economy.

Hoover, A. and Walter and Robert M. Albrecht. The Use of Panelists as Substitutes for Taxicab Drivers in Carbon Monoxide Exposure (Final Report). New York: Columbia University Division of Environmental Health Sciences, Environmental Protection Agency and Coordinating Research Council, Inc., July 1973. Report EPA-650/1-74-001.

Analyses of breath and blood samples from 30 pairs of taxi drivers and panelists who drove in New York City traffic for 8 hours on two consecutive days. Findings indicate that both drivers and panelists attained similar carboxyhemoglobin levels - both smokers and non-smokers.

International Trade Commission. The Fuel Efficiency Incentive Tax Proposal: Its Impact Upon the Future of the U.S. Passenger Automob Industry. Wash., D.C.: U.S. Govt. Printing Office, 1977.

Prediction of the impact of President Carter's proposed Fuel Effici incentive tax on the domestic auto industry.

Interplan Corporation. Joint Strategies for Urban Transportation, Air Quality and Energy Conservation. Wash., D.C.: Urban Mass Transportation Administration, Jan. 1975.

Report of a joint effort by the Urban Mass Transportation Administr the Environmental Protection Agency and the Federal Energy Administ tion to develop an approach to resolve the problems of traffic congestion, air pollution and petroleum shortages. Includes princi strategies and their relationships to each other; also, evaluation of 54 specific actions and two proposed joint action programs.

Jordan, D., and others. Effective Citizen Participation in Transportation Planning. Volume 1: Community Involvement Processes. Volume II: A Catalog of Techniques. Wash., D.C.: Federal Highway Administration, 1976.

Guide for organizing or monitoring citizen participation in transportation planning. Describes 37 citizen participation techniques and how they relate to the transportation planning process, itself divided into 19 sequential steps. Techniques include: advocacy planning, charrette, hotlines, surveys, workshops, and advisory committees; also, eight case studies of their application.

Kenton, Edith. Car Pools (A Bibliography with Abstracts). Springfield, VA: National Technical Information Service, Dec. 1977.

Studies of the feasibility, methodology and benefits of urban car pooling. Contains 71 entries, including items on congestion, pollution, energy conservation, community hitchhiking, and exclusive lanes.

Keyani, Barbara Ibarra, and Evelyn S. Putnam. Transportation System Management: State-of-the-Art. Wash., D.C.: U.S. Govt. Printing Office, Sept. 1976.

State-of-the-art information on 31 actions in seven categories: improving vehicle flow, preferential treatment of high-occupancy vehicles, reducing peak period travel, parking management, promoting non-auto or high-occupancy auto use, transit and paratransit service improvements, and transit management improvements. Summaries of actions include advantages and disadvantages, implementation guidelines, costs, and inter-relationships.

Kulash, Damian. Parking Taxes for Congestion Relief: A Survey of Related Experience. Urban Institute, Wash., D.C.: Urban Institute, 1974.

Examines the impacts of several changes in areawide parking prices and looks at additional areas where sharp parking price differentials already existed.

Lane, R. and D.H. Hodgkinson. "Permit System for Traffic Restraint," Traffic Engineering Control, Vol. 17, No. 3, Mar. 1976, pp. 94-97.

Discusses the need for and the objectives of traffic restraint in the centers of large cities as well as alternative methods of contro[illegible] Concludes that parking controls cannot achieve its stated objectives. Also describes a control system suitable for midtown which relies on the distribution of permits to selected users and the purchase of permits by occasional users.

Levinsohn, David M., and James T. McQueen. A Procedure for Estimatin[illegible] Automobile Fuel Consumption on Congested Urban Roads. Final Report. Wash., D.C.: National Bureau of Standards, Technical Analysis Divisi[illegible] Aug. 1974.

Proposes a procedure based on vehicle characteristics and roadway operating conditions, with an example application.

Fisch, Oscar, and Donald A. Hanson. Optimal Inner City Redevelopment With Congestion Costs. New York: Institute of Electrical and Electr[illegible] Engineers, Nov. 1974, Pap. FP3.6, pp. 827-828.

Report of IEEE Conference on Decisions and Control. Offers optimal housing and traffic desities for the fixed inner ring of a city. Includes costs of congestion. Argues that the optimal plan differs from a free market redevelopment plan.

Maher, M.J., and R. Akcelik. "Route Control - Simulation Experiments," Transportation Research, Vol. 11, No. 1, Feb. 1977, pp. 25-31.

Investigates the potential time savings of using route control techniques in an urban network of streets where the dominant control mechanism is the traffic signal. Distinguishes between user and system optimizing solutions. Uses three networks and five origin-destination flow patterns in simulation experiments with a stochastic, semi-macroscopic traffic model, a partial loading assignment model, and a tree-building signal optimization algorithm.

Manos, N.E., and G.F. Fisher. "An Index of Air Pollution and Its Relation to Health," Journal of the Air Pollution Control Association, Vol. 9, No. 1, May 1959, pp. 5-11.

An index of cities ranked according to air pollution based on general sources including automobiles. The index is correlated with mortality by several causes and using several age/race/sex breakdowns and other socio-economic and urban characteristics. Findings indicate that four causes of death produce a large number of high positive correlations with various air pollution indices. They are (1) malignant esophagus and stomach neoplasms; (2) malignant neoplasms of the trachea, bronchus and lung; (3) arteriosclerotic heart disease, including coronary disease; and (4) chronic endocarditis and other myocardial degeneration.

May, A.D. "Traffic Management and Restraint by Parking Control in Greater London," Highway Research Record, No. 474, 1973, pp. 19-30.

Describes parking control systems for traffic restraint in Greater London and recommends that control be attempted predominently by pricing. Suggests a 15% reduction can be achieved in auto commuting to Central London.

Metropolitan Washington Council of Governments. Parking Management Policies and Auto Controls. Springfield, VA: National Technical Information Service, Feb. 1976.

Examines parking management programs as a way of meeting air quality standards in Washington. Includes legal, administrative and institutional perspectives on four particular programs. Concludes rate regulation and supply-restraint policies pose serious implementation problems; looks toward downtown auto control zone as a more successf approach.

Mitchell, Roger S. Effects of Air Pollution on Human Lungs. Boulde Colo.: Air-Water Pollution Proceeding, Summer Workshop, Aug. 1970, pp. 505-512.

Describes the sources and effects of air pollution on human lungs.

Mitre Corporation. Simplified Estimators for Benefit Assessment of Bus Priority Systems (Traffic Signal Preemption). Springfield, VA: National Technical Information Service, Aug. 1975.

Study of simplified estimators for simulation studies of bus priority systems; in particular, bus travel time and intersection capacity estimators. States that such estimators increase insight into bus priority systems and aid in their application to other situations.

Mitre Corporation. Unconditionally Preemptive Bus Priority System: Summary of Simulation Results. Sprinfield, VA: National Technical Information Service, July 1975.

Report on simulation runs of an urban network traffic model used to elevate a bus priority system algorithm that automatically gives a green signal to buses approaching an intersection. System was found to substantially improve travel time for a variety of buses with minimal disruption of other traffic.

Mitre Corporation. Overview of Experimental Bus Priority Systems. Springfield, VA: National Technical Information Service, Mar. 1975.

Report on the results of bus priority strategies tested in eight different cities, including: Leicester, Eng.; Bern, Switz.; Washington, D.C.; and Derby, Eng. Discussion of different techniques and approaches, and comparison of results.

Morrall, John, and Nicholas Finn. "Transit Policy and Operations ir Europe and Canada," Traffic Quarterly, Vol. 29, No. 3, July 1975, p

Compares Canadian and European city transit systems to determine relationships between city planning policy, city structure, and suck transit variables as parking, traffic, land use, zoning, transit fir restraints, ridership, vehicle mileage, transit priorities, access t transit facilities, fare systems, communications and marketing. Concludes that Europe's larger transit riderships are the result of more innovative attitudes by the responsible transportation authorit

National Technical Information Service. Joint Strategies for Urban Transportation, Air Quality and Energy Conservation: Joint Action Programs. Springfield, VA: NTIS Report PB-244 473, Dec. 1974 (378)

An integrated approach for solving the problems created by traffic congestion, air pollution, and gasoline shortages. Strategies and actions are summarized and ranked to assess their impact on six short and long range sub-goals: better auto alternatives, better vehicle flow, less auto use, lower travel demand, lower vehicle emissions, and lower petroleum consumption. Also describes two synergistic joint action programs.

New Jersey Department of Transportation. Manhattan CBD - North Jers Corridor Joint Use Park-and-Ride. Springfield, VA: National Techni Information Service, Feb. 1975.

Summarizes work performed for the Urban Corridor Demonstration Progr Includes methodology for developing park-and-ride facilities using parking lots at shopping centers, drive-in theaters and factories.

New York State Department of Environmental Conservation. New York City Metropolitan Area Air Quality Implementation Plan Transportation Controls. New York: April 1973.

New York's official response to the requirements of the 1970 Clean Air Act and subsequent EPA ambient air quality standards. Describes a series of traffic and transit strategies to improve air quality by reducing vehicle congestion. Plan was approved but never implemented.

Oram, Richard L. Transportation System Management: Bibliography of Technical Reports. Wash., D.C.: UMTA, Office of Policy and Program Development, May 1976.

Bibliography of more than 150 reports divided into nine sections dealing with low capital, short range, and policy oriented improvements. Categories include Preferential Treatment for High Occupancy Vehicles, Transit Improvements and Management, Pooling and Paratransit, Pedestrians and Bicycles, Traffic Operations, Parking Management, and Demand Management.

Organisation for Economic Co-Operation and Development. Interim Synthesis Report, Traffic Policies to Improve the Urban Environment. Phase I Case Studies: Besancon, Gothenburn, London, Nagoya, Nottingham, Singapore. Paris: OECD, May 1977.

Summary and comparison of the transportation policy approaches of the six cities of the title. Includes city by city evaluation of results, costs and financing problems, implementation processes, and institutional contexts.

Organisation for Economic Co-Operation and Development. Urban Traff Noise. Strategy for an Improved Environment. Paris: OECD, 1971.

Assessment of traffic noise control methods. Includes characterizat of varieties of urban traffic noise, costs of abatement, effects on human bodies and activities, control methods, and survey of European control practices.

Ostfeld, Adrian M., and David D'Atri. "Psychophysiological Respons to the Urban Environment." International Journal of Psychiatry in Medicine, Vol. 6, 1975.

Examines the relationship of urbanization to bodily changes and chronic diseases; in particular, stress as defined by crowding. Includes discussion of the psychophysiological effects of driving in traffic.

Parsonson, Peter S. A Feasibility Study of a System for Monitoring the Road-User Cost of Urban Traffic Congestion. Technical Memorandu Georgia Institute of Technology. School of Civil Engineering, Sept. 1 Project: HPR-PR-15, GHD-7004.

Describes a method of measuring road-user cost due to congestion utilizing a Marbelite Traffic Data Compiler, Robert Winfrey's road-user costs tables, and a computer program developed by the Federal Highway Administration.

Patrassi, Angelo. "I Problemi Della Congestione Del Traffico E Dei Pendolari Nella Pianificazione Dei Servizi Metropolitani E Ferroviari" ("Problems of Traffic Congestion and of Commuters in the Planning of Metropolitan and Railroad Services"), Ing. Ferrov., Vol. 29, No. 5, pp. 17-22.

Views individual autos as the main cause of traffic congestion in urban areas and considers remedies, particularly the system adopted by the British Transport Commission for London which separates urban transit from suburban and regional systems. Also compares short distance and inter-city commuter services. In Italian.

Peat, Marwick, Mitchell, and Co. A Guide to Parking Systems Analysis. Wash., D.C.: Federal Highway Administration, Oct. 1972.

Describes procedures for systems analysis of parking facility planning. Includes case study and appendices describing component programs.

Pinnell-Anderson-Wilshire & Associates, Inc. Traffic Control Systems Handbook. Wash., D.C.: Federal Highway Administration, Office of Development, Implementation Division, Dec. 1975.

Basic principles of planning, designing and implementing traffic surveillance and control systems for urban streets and freeways. Includes a compendium of the existing technology and separate chapters on computers and communication techniques.

Proven Ways to Reduce Congestion. Society of Automotive Engineers, Pap. 700190 for meeting Jan. 12-16, 1970.

Describes traffic engineering techniques and methods used by Detroi to reduce congestion and speed traffic flow. Finds best results ar obtained by using several methods on a single street and that lack of funds to apply remedies is a major cause of the congestion still remaining.

Public Technology, Inc. Center City Environment and Transportation: Local Government Solutions. Wash., D.C.: Urban Consortium for Tech Initiatives, Dec. 1977.

Description of how seven cities - Buffalo, Detroit, Houston, Los Ange New York, San Francisco, and Seattle - use innovations in transportat and pedestrian movement in downtown revitalization efforts. Highligh techniques include: preferential parking, protected residential area pedestrian malls, free transit within limited areas, and people mover

R. H. Pratt Associates, Inc. A Study of Low Cost Alternatives to Increase the Effectiveness of Existing Transportation Facilities - Results of Case Studies and Analysis of Busway Applications. Wash., Federal Highway Administration, Jan. 1973.

Report on seven operating exclusive bus lane projects. Three operate as contraflow freeway facilities, three as contraflow lanes on arteri streets, and one as a specially constructed lane. Concludes that exclusive bus lanes can move more people faster than competing modes. Discusses technical, institutional and operational aspects; federal funding; and the potential for bus lanes in five diverse urban enviro ments.

R.H. Pratt Associates, Inc. A Study of Low Cost Alternatives to Increase the Effectiveness of Existing Transportation Facilities - Results of Survey and Analysis of Twenty-one Low Cost Techniques. Wash., D.C.: Federal Highway Administration, Jan. 1973.

The techniques evaluated are rated according to their potential effectiveness. Includes evaluation of costs, effects on the disadvantaged, environmental and safety factors, viability and traveler response; also, case studies.

Regional Plan Association. Urban Densities for Public Transportation. New York: RPA, May 1976.

Study of the relationships between land use and transportation. Provides a framework for evaluating a variety of public transit modes as they apply to a variety of land use arrangements, including cost of service factors.

Remak, Roberta, and Sandra Rosenbloom. Solutions to Peak Period Traffic Congestion. Volume 1: State-of-the-Art Survey. Wash., D.C.: Transportation Research Board, Dec. 1974.

Interim report of a study to identify solutions to urban area traffic congestion. Vol. 1 discusses 11 major categories of techniques, including: staggered and flexible work hours, shortened work weeks, pricing and regulatory mechanisms, access restrictions, land-use planning, marketing, carpooling and ride sharing, communications in lieu of travel, and vehicle design. Extensive annotated bibliography.

Remak, Roberta, and Sandra Rosenbloom. Solutions to Peak Period Traffic Congestion. Volume II: Options for Current Programs. Wash., D.C.: Transportation Research Board, Aug. 1975.

Interim report of a study to identify solutions to urban area traffi congestion. Vol. II consists of eight packages of mutually supporti techniques with limited cost/benefit analyses. Includes recommendat for applying them to central business districts, urban freeways, corridors, and a variety of other roadway situations. Concludes tha state-of-the-art impact assessment methodology is crude, ill-defined and in need of serious investigation.

Robertson, Dennis I., and others. Traffic Control and Transportati Systems. Proceedings, Second International Symposium on Traffic Co and Transporation Systems, Monte Carlo, Monaco, Sept. 1974. New Yo American Elsevier Publishing, 1974.

Fifty-seven papers on the most recent advances in automation and control as applied to transportation with emphasis on systems aspec Includes papers on: urban traffic control, bus control systems, an urban transportation systems on segregated tracks. Some papers in French with English abstracts.

Samimi, Behzad, and Hassan Nanbakhsh. Human Exposure to Excessive Levels of Carbon Monoxide Due to Traffic Congestion in the City of Tehran. International Conference on Environmental Sensing and Assessment, Joint Conference Comprising the International Symposium on Environmental Monitoring and the Third Joint Conference on Sensing Environmental Pollution, Las Vegas, Nev., Sept. 1975. New York: Institute of Electrical and Electronics Engineers, 1976, Pap. 35-37.

Finds significant negative correlations between average CO concentration and the average speed of motor vehicles on cross-city trips, between CO concentration and wind speed, and between CO concentration and visibility reduction.

Scardino, Charles A., and G. Scott Rutherford. The Energy Crisis - Observed Gasoline Price Elasticities in Three American Cities. Presented at the Air Pollution Control Association Annual Meeting, 68th, Boston, MA, June 1975, Pap. 75-11.3.

Analysis of gasoline price elasticities in Boston, Denver and Washington, D.C. in the face of proposed gasoline taxes to reduce auto exhaust pollution and save energy. Monitored vehicle miles traveled, public transit, auto occupancy, air quality and gasoline sales, availability and price in each city. Variables found adequate for describing short-term reactions to increased gasoline taxes were found inadequate for formulating programs for achieving and maintaining air quality.

Shanks, Scott G., Robert R. Hippler and P.N. Formica. Urban Transpor tation Strategies Model. Winter Simulation Conference, Annual Procee Wash., D.C., Jan. 1974, Vol. 1, pp. 338-348.

Simulation model for evaluating the effects of urban transportation strategies on vehicle use. The interaction of factors such as parki and public transit availability, and the degree of roadway congestio are evaluated by simulated runs which estimate citizen reaction to various mixes and the degree of change in choice of transit mode. Results can be quantified in terms of pollution levels.

Schoon, John G., and Herbert S. Levinson. "New Concepts in Urban Parking," ASCE Transportation Engineering Journal, Vol. 100, No. T pp. 611-623.

Reviews parking policy options for major metropolitan areas as they relate to demand, transit-service extensions, and community prefere also, a public participation process which involves continuous revi of alternatives and programs.

Silence, Steiner M. "Procedures for Measuring the Activity Level and the Parking Demand of the CBD," Highway Research Record, No. 4 1973, pp. 9-18.

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Assessments of programs and projects to improve commodity transportation within urban areas. Considers high costs, traffic congestion, pollution, land use, and institutional arrangements in terms of their effects on shippers, carriers, consignees, and the general public.

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Survey of a neighborhood near a recently completed segment of London's Ringway 1 to assess how much motorway pollution was worth to people actually suffering from it. Concludes the cash value of the nuisance caused by this particular east London motorway is minute compared with its estimated traffic benefits.

Sterman, Brian P., and Joseph L. Schofer. "Factors Affecting the Reliability of Urban Bus Services," ASCE Transportation Engineering Journal, Vol. 102, No. 1, Feb. 1976, pp. 147-159.

Tests the inverse of the standard deviation of point-to-point travel time as a measure of the reliability of bus service in the Chicago area. Reliability was found to be significantly decreased by increasing route length, increasing intensity of intersection control (particularly traffic signal density), increasing traffic volume, and - less certainly - increasing passenger loadings. Suggests strategies for improving reliability.

Techniques of Improving Urban Conditions by Restraint of Road Traff Wash., D.C.: Office of Economic Cooperation and Development Public tions Center.

Proceedings of a symposium held in Cologne, Germany in Oct. 1971. Papers cover objectives of traffic restraint, traffic flow and netw planning, parking controls and bus priority techniques, road pricin and methods of evaluating and comparing traffic restraint technique

Todorovic, Pavle. "Air Pollution and Traffic Safety," Experientia Supplement, Vol. 20, 1974, pp. 55-60.

Studies on the influence of carbon monoxide and nitrogen oxide concentrations along city streets and inside motor vehicles on driving abilities. Reports extremely high levels of pollution and evidence that they exert a strong effect; also, that concentrat inside vehicles in some cases exceeded the maximum allowed values for safe working conditions. Performed in Belgrade.

Transportation and Traffic Engineering Handbook. 1975. Arlington, VA: Institute of Traffic Engineers, 1975.

A revision of the 1965 Third Edition emphasizing total and balanced transportation planning. Updates essential facts about vehicles, highways and drivers; discusses other transportation modes and innovations such as computer applications and traffic surveillance techniques. Stresses need for traffic engineers to improve street efficiency by increasing street capacity while actively working to decrease auto travel demand by aiding alternative modes. Individua chapters on such areas as urban traffic characteristics, travel flo theory, parking, regional transportation planning, and environmenta considerations.

Transportation Research Board. Better Use of Existing Transportation Facilities. Wash., D.C.: TRB, Special Report 153.

Reports results of an Aug. 1974 conference in Jacksonville, Fla. Papers discuss applying management techniques to transportation, freeway metering and control, park-and-ride facilities, bus strategies, traffic signal improvements, facility improvements and maintenance, highway safety, and pricing and work schedule changes to reduce peak period demand.

U.S. Department of Transportation. Priority Techniques for High Occupancy Vehicles. State-of-the-Art Overview. Cambridge, MA: U.S. DOT, Transportations Systems Center, Technology Sharing Program Office, Nov. 1975.

An overview of available techniques including implementation guidelines, decision making criteria, discussion of impacts, and characteristics of freeway and arterial/street priority applications.

U.S. Environmental Protection Agency. Transportation Controls to Reduce Automobile Use and Improve Air Quality in Cities. The Need, the Options, and Effects on Urban Activity. Wash., D.C.: EPA Office of Policy Analysis, Nov. 1974.

Discusses methods of reducing auto use (parking management, transit improvements, carpooling, bicycling, etc.), their effectiveness, the background and status of transportation control regulations, the economic and social effects of reduced auto use, and the relationship of transportation controls to other aspects of transportation planning and decision making.

Urban Institute. Parking Taxes as Roadway Prices: A Case Study of the San Francisco Experience. Wash., D.C.: The Urban Institute, March 1974, Pap. 1212-9.

Examines imposition of a 25% parking tax in San Francisco from 1970 to 1972. Finds tax had little impact on congestion, air pollution and energy use but reduced parking lot profits.

Urban Institute. Parking Taxes for Congestion Relief: A Survey of Related Experience. Wash., D.C.: The Urban Institute, Mar. 1974, Pap. 1212-1.

Examines the likely impacts of parking taxes on travel patterns. Finds that past efforts have had little effect and that work-trip parking demand is inelastic. Concludes that such a policy, by itsel: will not effectively reduce congestion, air pollution or energy use.

Urban Mass Transportation Administration. Transit Marketing Manageme: Handbook. Wash., D.C.: UMTA, Office of Transit Management, Nov. 197: April 1976.

Study and guide based on survey of more than 100 transit systems in several countries with personal visits to many. Objectives are to assist transit professionals in developing a marketing approach and structure, and to examine transit marketing as it already exists. Includes separately available chapters on Marketing Organization, User Information Aids, Marketing Plan, and Pricing.

Urban Mass Transportation Administration and Federal Highway Administration. Transportation System Management. Supplementary Information on Development and Implementation of TSM Plans. Wash., D.C.: UMTA, Dec. 1975

Question and Answer discussion of the Transportation System Management requirement: federal intent, local response, available planning and technical assistance, and the relationship of the TSM Plan to other transportation planning activities.

Ury, Hans K., Norman M. Perkins and John R. Goldsmith. "Motor Vehicle Accidents and Vehicular Pollution in Los Angeles," Arch. Environ. Health, Vol. 25, No. 5, Nov. 1972, pp. 314-322.

Compares Los Angeles motor vehicle accident (MVA) frequencies with ambient air levels of oxidents (OX) and carbon monoxide. Finds a statistically significant association for OX and MVA but not between CO and MVA.

Voorhees, Alan M. & Associates, Inc. An Analysis of the Economic Impact of Motor Vehicle Use Restrictions in Relation to Federal Ambient Air Quality Standards. Springfield, VA: National Technical Information Service, Sept. 1973.

A cost-effectiveness methodology for evaluating transportation contr strategies to achieve ambient air quality objectives using Baltimore and Boston as case studies. Requires explicit identification of the air pollution reduction potentials of alternate control strategies as well as the costs incurred by public agencies, users, and other interest groups. Results indicate the relative average cost per uni of emission reduction for each alternative. Vehicle use restaints discussed include vehicle-free zones, parking bans, gasoline rationi pricing policies, better transit service and lower fares, staggered work hours, taxes, improvements in traffic flow, and increased parking costs.

Voorhees, Alan M. & Associates, Inc. Guidelines to Reduce Energy Consumption Through Transportation Actions. Springfield, VA: National Technical Information Service, May 1974.

Summarizes low-cost, short-term transportation actions and estimate their potential for reducing energy consumption. Includes institut legal, socio-economic and environmental considerations; also, packa actions in groups and presents guidelines for applying them to urba areas of differing sizes. Concludes such actions may reduce energy consumption by improving vehicle efficiency, causing modal shifts, and reducing travel demand.

Wilbur Smith & Associates, and others. Bus Rapid Transit Options for Densely Developed Areas. Wash., D.C.: U.S. Govt. Printing Office, Feb. 1975.

Describes and evaluates bus rapid transit systems in dense urban areas. Assesses options, costs, services, community impacts, and available technology.

Winett, Richard A. "Behavior Modification and Social Change," Journal of Professional Psychology, Vol. 5, No. 3, Aug. 1974, pp. 244-250.

Describes behavior modification techniques such as contingency systems, token economies, and behavioral analyses that can effectively prompt social change. Practical applications are proposed for regulating natural resources, traffic problems, school integration, and environmental design as well as a methodology for studying programs on the community level. Cautions that such programs must be under citizen control to avoid the possibility of coercion.

Yabroff, I., and others. The Role of Atmospheric Carbon Monoxide in Vehicle Accidents (Final Report). Menlo Park, CA: Standard Research Institute, Feb. 1974.

Authors find that attempts to relate high levels of atmospheric CO or blood carboxyhemoglobin to accidents suggest that driver fatalities have higher levels of COHb than drivers not involved in accidents; the degree to which this is due to smoking rather than atmospheric CO absorption is not known. Describes a plan using correlation analysis to more fully establish the degree to which atmospheric CO contributes to vehicle accidents and includes a literature search in this regard.

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16. ABSTRACT

This is a study of the problem of vehicular congestion on the island of Manhattan with emphasis on its Central Business District. It defines the nature of Manhattan's congestion, traces its growth over the past century, assesses its costs, and evaluates various abatement strategies. The approach is in the manner of a case study of the impact of street congestion on the economic, social and environmental health of the city's residents. Abatement strategies considered include several dealing with traffic management and goods movement, uniform bridge tolls, free transit fare zones, and the development of extensive pedestrian areas.

17. KEY WORDS AND DOCUMENT ANALYSIS

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accident data, air pollution, automotive emissions, cost analysis, environmental impact, environmental policy, pedestrian malls, toll bridges, traffic engineering, traffic flow, transportation.	air pollution control, central business district, Manhattan, New York City, traffic control transportation alternatives, transportation costs.	fields 5,6, & 13.

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