Areawide Estimation of Vehicle Trip Generation Rates for Route 9A Reconstruction on Manhattan's West Side

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The Route 9A reconstruction project on the west side of Manhattan, New York City, required the projection of trip generation by land uses that would be developed by the project build year and beyond. Because new development would vary greatly in its accessibility to public transportation, socioeconomic character, size, and other attributes, it was decided that available, standard trip generation rates were inadequate to capture trip generation variations within a major land use category. In Manhattan, residential and office land uses account for 75 percent of existing developed square footage and 90 percent of the new square footage to be developed by the build year. By isolating zones of pure residential or office land use (95 percent of developed square footage in the respective land use), it was possible to analyze existing trip generation rates developed from origin-destination surveys and to infer trip generation rates. These rates were correlated with various zone characteristics such as subway access to develop formulas and trip generation rates that more accurately capture the trip-generating characteristics of developments in various locations. The trip generation rates developed are currently in use on the Route 9A project.

Trip generation factors are one of the most important elements of the traffic forecasting process. Sophisticated models for assigning vehicular traffic (to the highway network) and assessing roadway operating conditions are ultimately only as accurate as the input fed into them.

The most common usage of trip projection estimates is for facilities planning or environmental assessment. For any type of land development project, features such as parking facility size, access points, driveway size, and even project location may depend on traffic generation projections. For transportation projects, trip projections serve to size facilities and determine geometry and the potential number and characteristics of access points. Trip generation estimates in the context of growth management and environmental assessments determine where a significant impact may occur. If estimates are too low, unforeseen effects may occur that would affect a community's health, development, and general well being. When estimates are too high, projected effects may be mitigated by measures that are inappropriate, excessive, or unnecessarily expensive.

For individual land development projects, wide variations are possible in the calculation of vehicle trip generation rates. The total number of trips generated in the peak hour is dependent on the interaction of several factors: the total daily trip generation, the temporal and directional distributions, the modal split, and the vehicle occupancy rate. For each of these factors there is a range of reasonable values. When used in combination to derive a trip generation rate, the range of rates resulting from the factor's use is also broad. Typically an analyst will use factors and rates from surveys conducted by others or, when a small number of projects are being studied, the analyst may choose to do spot surveys of trip generation at existing similar developments.

Large-area or corridor studies with diverse land use, neighborhood, and transportation conditions, however, demand a different approach. Typically a single trip generation rate from a general source such as the *ITE Trip Generation Handbook* might be used for a land use under a variety of conditions. The Route 9A replacement study in the west side of Manhattan, New York City (NYC), provided a test case for deriving more appropriate trip generation rates based on the results of an origin-destination survey and on other generally available data. The Route 9A study required that trip generation rates be developed for land uses in a wide variety of neighborhoods and under a variety of conditions. Modeling to predict the potential impact of the construction of Route 9A would require determining what factors were important determinants of trip generation rates and then measuring how these factors would affect the trip generation of a specific type of land use. This paper presents the process used to derive those estimates and the results of those efforts.

BACKGROUND

Manhattan's original West Side Highway was an elevated structure running from the Battery at the southern tip of the island north to West 72nd Street. Deterioration in the highway became significant over the years and ultimately led to the collapse of a portion of the structure. In 1974, the West Side Highway was closed from the Battery to 59th Street. Subsequent efforts to identify alternatives for a replacement roadway resulted in a range of options developed by the New York State Department of Transportation (NYSDOT) in concert with the NYC departments of Transportation and City Planning. A task force appointed to look at the options also developed an alternative of its own.

Beginning in 1988, a team of consultants began preliminary design and environmental studies. The purpose of these studies was to produce the data that, among other purposes, would explore preliminary design issues, flesh out the potential al-

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ternatives, indicate the need for modifications or additions to the alternatives proposed, and assess the potential effects the proposed alternatives had on the environment. Central to each of these issues was the question of how much vehicular traffic would have to be accommodated.

The study of traffic for the Route 9A environmental impact statement required the collection of massive amounts of data. The data collection process was as follows:

1. The entire Manhattan central business district (CBD) study area was divided into just over 500 zones, generally containing two to four blocks and having approximately 1.9 million ft^2 of development on average. Origin and destinations outside the study area were also aggregated into zones.
2. Existing automobile trips generated by each zone were determined. Surveys were conducted of drivers entering the study area at its boundaries. Overall, 14.8 percent of the 484,996 drivers crossing the cordon line during the study period responded to the survey. The data were tabulated so that zone destination could be identified. The sample data were then expanded based on the sampling proportion of total trips. Internal-internal trips were obtained separately by coordinating surveys within the study area of sampled parking facilities.
3. Taxi trips were surveyed from trip sheets for medallion cab companies, reflecting 15 percent of the total daily trips. The origin and destination zone of each trip, with or without fare, was tabulated. Trips to or from each zone were expanded to reflect the sampling proportion.
4. The automobile and taxi survey data were supplemented by a survey of commercial vehicles. The survey logs had space to record a complete day's trips. The logs were distributed to and completed and returned by drivers as they crossed the cordon line into CBD locations.
5. NYC Department of City Planning records were used to compile a zone-by-zone listing of land use square footage in each of 20 general categories.
6. NYC Department of Transportation records were used to compile a listing of the parking facilities and number of spaces available in each zone.

Although census data and maps showing transit access points were also used, the data formed the core of information for determining vehicular trip generation rates.

THEORETICAL FRAMEWORK AND METHODOLOGY

Within the Manhattan CBD study area approximately 75 percent of the existing developed floor area falls into either the residential or the office category. The remaining floor area is divided between 18 other categories. Projected new development, for which the trip generation rates will be used, shows an even greater concentration (90 percent) in residential and office uses. Those two land use categories account for so much of the developed area that it is possible to identify zones in which there is virtually only one land use. For the purposes of the study, zones in which approximately 95 percent of the built floor area was office or residential were defined as "pure use zones."

Taking the trip tables developed from the survey data and the land use square footages for the pure use zones, trip generation rates were calculated for each zone. Specific zone characteristics that would explain the variation in zone trip generation rates were then sought.

CALCULATION OF PURE RESIDENTIAL ZONE TRIP RATES

Automobile Trips

Method

The Route 9A study area contains 49 pure residential zones. The relationship between the number of automobile trips generated in each zone and the square footage of development is shown in Figure 1*a*. It is evident from the figure that a given amount of development can produce a wide range of automobile trips. Among the pure use zones, for example, the p.m. peak-hour trip rate could fall in the range of from 0.024 to 0.227 trips per 1,000 ft^2. We sought to reduce the amount of unexplained variance by testing the effects of subway access, parking availability, and neighborhood type (as a proxy for income-socioeconomic factors). Various variables were tested, both singly and in combination. Where appropriate, regressions were used to seek relationships. Our testing program included the following:

Parking Availability/Density We hypothesized that parking availability should be correlated with increased trip generation rates and tested different parking conditions:

- Parking versus no parking in zone;
- High versus low parking density in zone;
- Number of spaces in the zone;
- (Number of spaces in the zone)/(developed square feet in the zone);
- (Number of spaces in the zone and adjacent zones)/(developed square feet in the zone and adjacent zones); and
- (Number of spaces in the zone and adjacent two zones)/(developed square feet in the zone and adjacent two zones).

No relationship could be established at either the zone or neighborhood level of detail between automobile trips and parking. To investigate why there might be none, we looked at the balance between parking space demand and supply. The demand-supply comparison is presented later.

Subway Accessibility We correlated subway accessibility of zone with trip generation rates under various measures of subway accessibility on the assumption that with convenient subways, automobile use would drop. The subway accessibility measures examined included

- Average number of subway stations within ¼ mi of each zone in a neighborhood. Each separate subway station is counted, although some may serve more than one line, whereas others may serve lines that can be accessed at multiple locations within the ¼-mi radius.

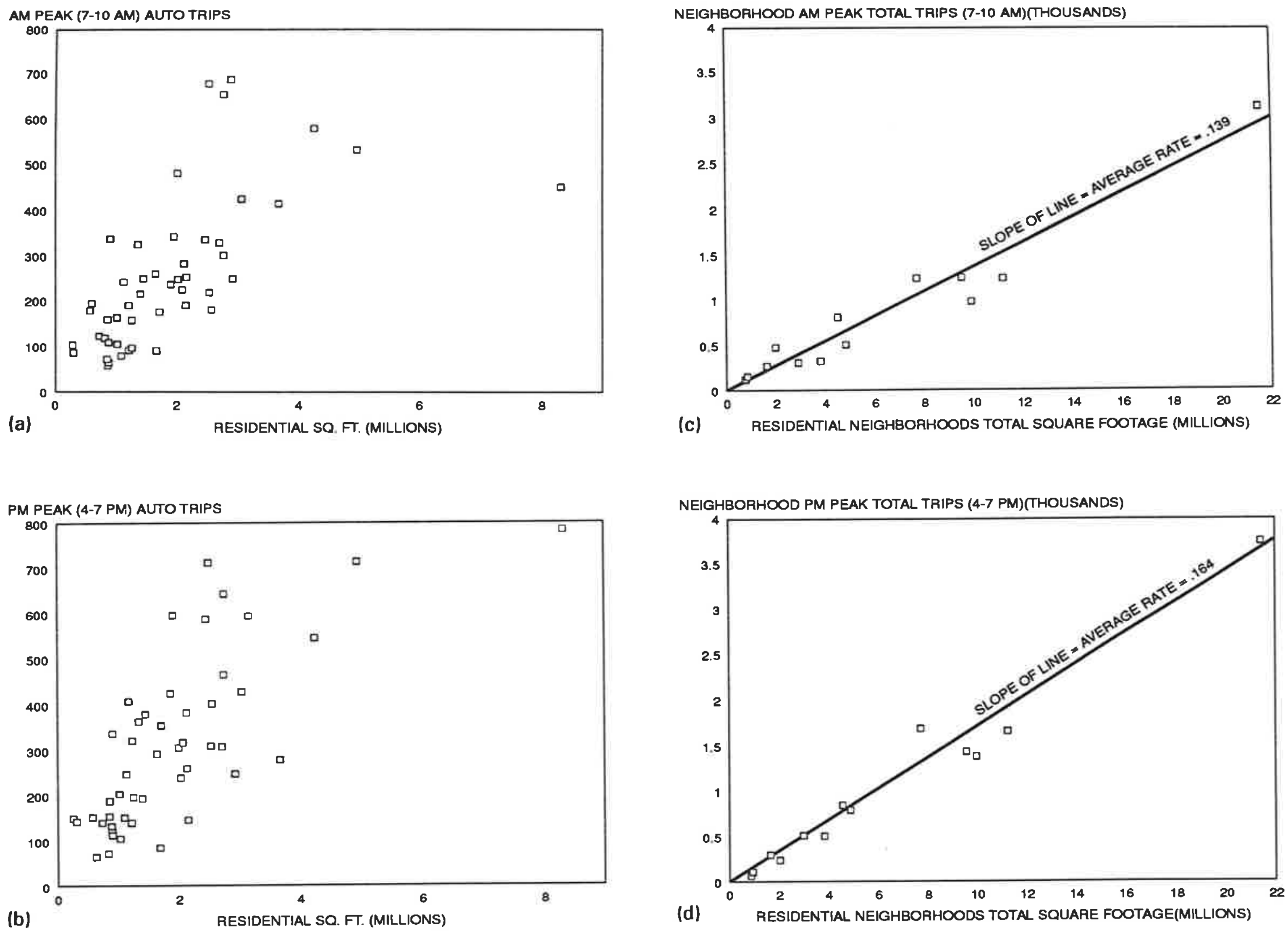


FIGURE 1 Relationship between number of automobile trips generated in each zone and square footage of development; (*a*) pure residential zones, a.m. peak automobile trips; (*b*) pure residential zones, p.m. peak automobile trips; (*c*) residential neighborhoods, a.m. peak trips; (*d*) residential neighborhoods, p.m. peak trips.

- Average number of subway lines accessible within ¼ mi of each zone in a neighborhood.
- Subway station access versus no subway station access within ¼ mi of zone.

It was found that those zones without subway access had a markedly higher average trip generation rate than those with subway access.

Neighborhood Groupings Neighborhood groupings were established as proxy for income and socioeconomic factors. The tests described earlier were performed for various groupings:

- 18 neighborhood areas centered around clusters of pure use office or residential zones.
- Uptown (north of 14th Street) versus downtown (south of 14th Street).

The neighborhood groupings of zones resulted in less variability in trip rates and more easily discernable patterns (compare Figures 1*a* and 1*b* to 1*c* and 1*d*).

Results

A.M. Peak Hour For zones with subway access, the most accurate estimates of existing trip ends were derived by using an average trip generation rate of 0.070 trips/1,000 ft^2 for zones without subway and a rate of 0.053 trips/1,000 ft^2 for zones with subway (see Figures 2*a* and 2*b*).

P.M. Peak Period Because the p.m. regression against subway station density yielded weak results, we used average trip generation rates for the 1-hr peak period shown in Figures 2*c* and 2*d*. Scatter patterns fit the average with moderate success when neighborhoods are stratified by subway versus no subway. For zones with subway, we used the average rate of 0.060 from Figure 2*c*. For zones without subway we used 0.069 (also from Figure 2*d*) as the average rate.

Taxi Trips

Method

Taxi trip rates were thought to be related to three factors that we had the ability to measure. These factors are subway accessibility, location of zone on a major taxi cruising corridor (e.g., a midtown avenue), and zone income. As with automobile trips, we tried to reduce the amount of unexplained variation by addressing the following factors:

Subway Accessibility The effect of subway accessibility was tested for various measures of accessibility in combination with various neighborhood groupings. The distribution of trip rates for uptown zones with and without subway access is shown in Figure 3. When trips are aggregated according to uptown and downtown, there appears to be a relationship between taxi trip rate and subway accessibility. Uptown zones with subway access have lower average taxi trip generation rates than uptown zones without subway access. Downtown zones, however, display the opposite pattern: zones with subway access have higher taxi trip generation rates than zones without. Although superficially counterintuitive, the pattern is most likely reflective of taxi cruising habits. South of 14th Street, the residential zones without subway access are either in lower-income areas or away from avenues with heavy taxi cruising. Hence, in these zones, lower demand for and lower availability of taxis combine to produce lower taxi use.

Neighborhood Groupings Variances in zonal trip generation rate were reduced by grouping zones into neighborhood aggregations. These aggregations, in conjunction with subway access, were a significant explanatory factor. The uptown-downtown dichotomy in taxi use is most likely attributable to income differences.

Results

A.M. Peak Hour (7:00–8:00 a.m.) Based on our findings, we used average rates for various conditions to project taxi trip generation. Four separate rates were used, as appropriate:

Route	*Trip/1,000 ft^2*
Uptown with subway	0.039
Uptown without subway	0.063
Downtown with subway	0.034
Downtown without subway	0.017

P.M. Peak Hour (5:00–6:00 p.m.) Four separate rates were used, as appropriate:

Route	*Trip/1,000 ft^2*
Uptown with subway	0.043
Uptown without subway	0.047
Downtown with subway	0.027
Downtown without subway	0.015

Truck Trips

Focus

When the O-D surveys were conducted, commercial vans were included as trucks and are therefore included in our analysis as well. The traffic survey counts indicate that the ratio of vans to trucks is approximately 0.8 to 1.0.

We did not anticipate a relationship between truck trips and parking or subway availability because trucks typically do not park in commercial lots or garages. Also, if costs of truck transportation rise, a business cannot shift to moving bulk goods by subway. Parking costs are also not relevant to trip generation because truck trips generally will be for the purpose of loading or unloading goods and will not require parking for extended periods in commercial lots. Our efforts were therefore focused on reducing the amount of variation

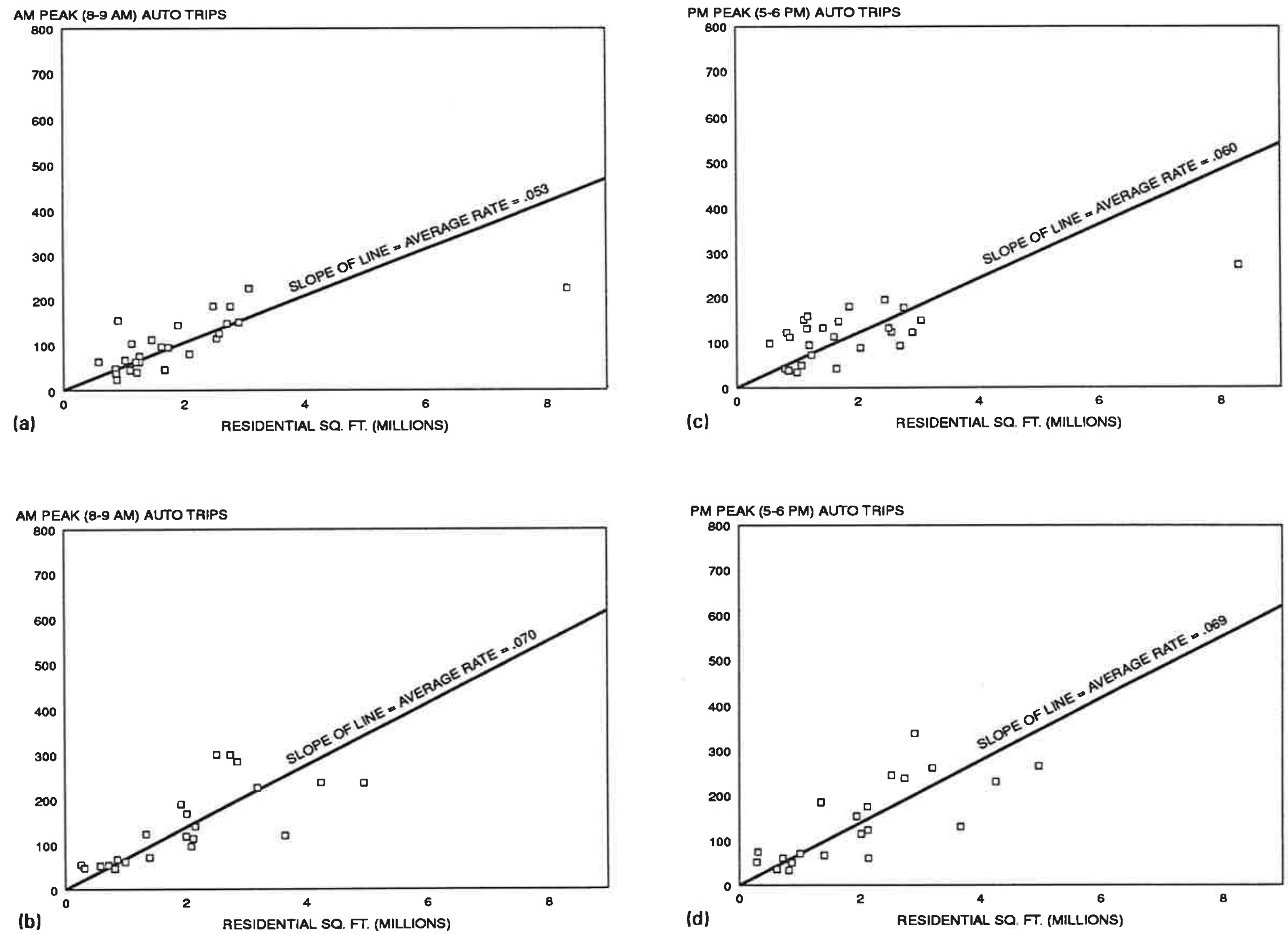


FIGURE 2 Comparison of residential zones with and without subway accessibility: (*a*) with subway, a.m. automobile trips; (*b*) without subway, a.m. automobile trips; (*c*) with subway, p.m. automobile trips; (*d*) without subway, p.m. automobile trips.

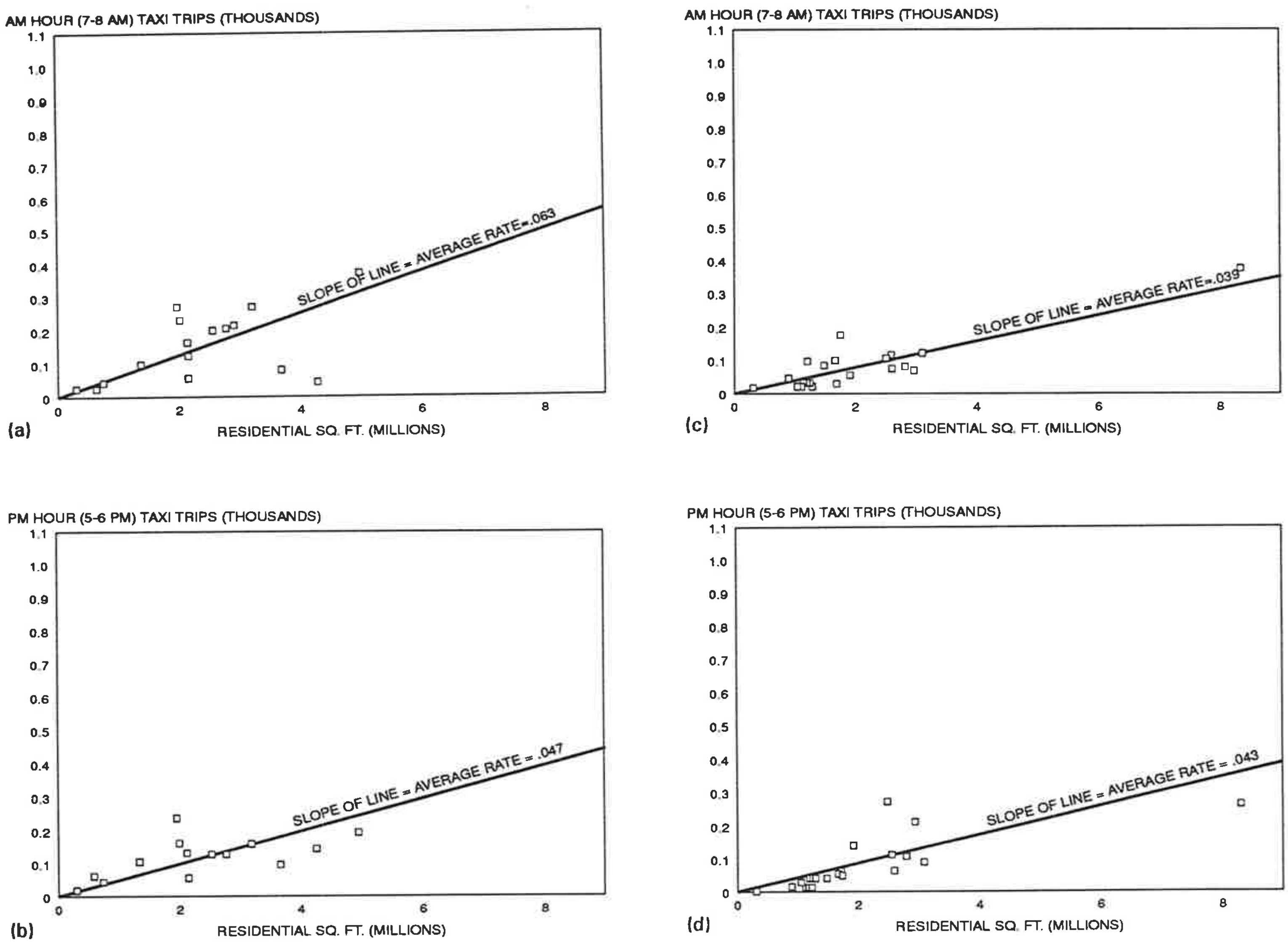


FIGURE 3 **Distribution of trip rates for uptown residential zones with and without subway accessibility: (*a*) with subway, a.m. taxi; (*b*) without subway, a.m. taxi; (*c*) with subway, p.m. taxi; (*d*) without subway, p.m. taxi.**

in trip generation rates by grouping into neighborhoods and by looking at 3-hr peak periods, as well as 1-hr peak periods.

Our findings indicate that when trips are aggregated at the zone level of detail, there is a large variability in trip rates between zones that may be reduced by aggregating into neighborhoods. Trip rates are also less variable when studied at the 3-hr instead of the 1-hr interval.

Results

Considering our findings, we used simple averages for trip generation (see Figure 4).

A.M. Peak Period We used a 3-hr trip rate of 0.046 trips per 1,000 ft^2 of development and converted it to a 1-hr rate

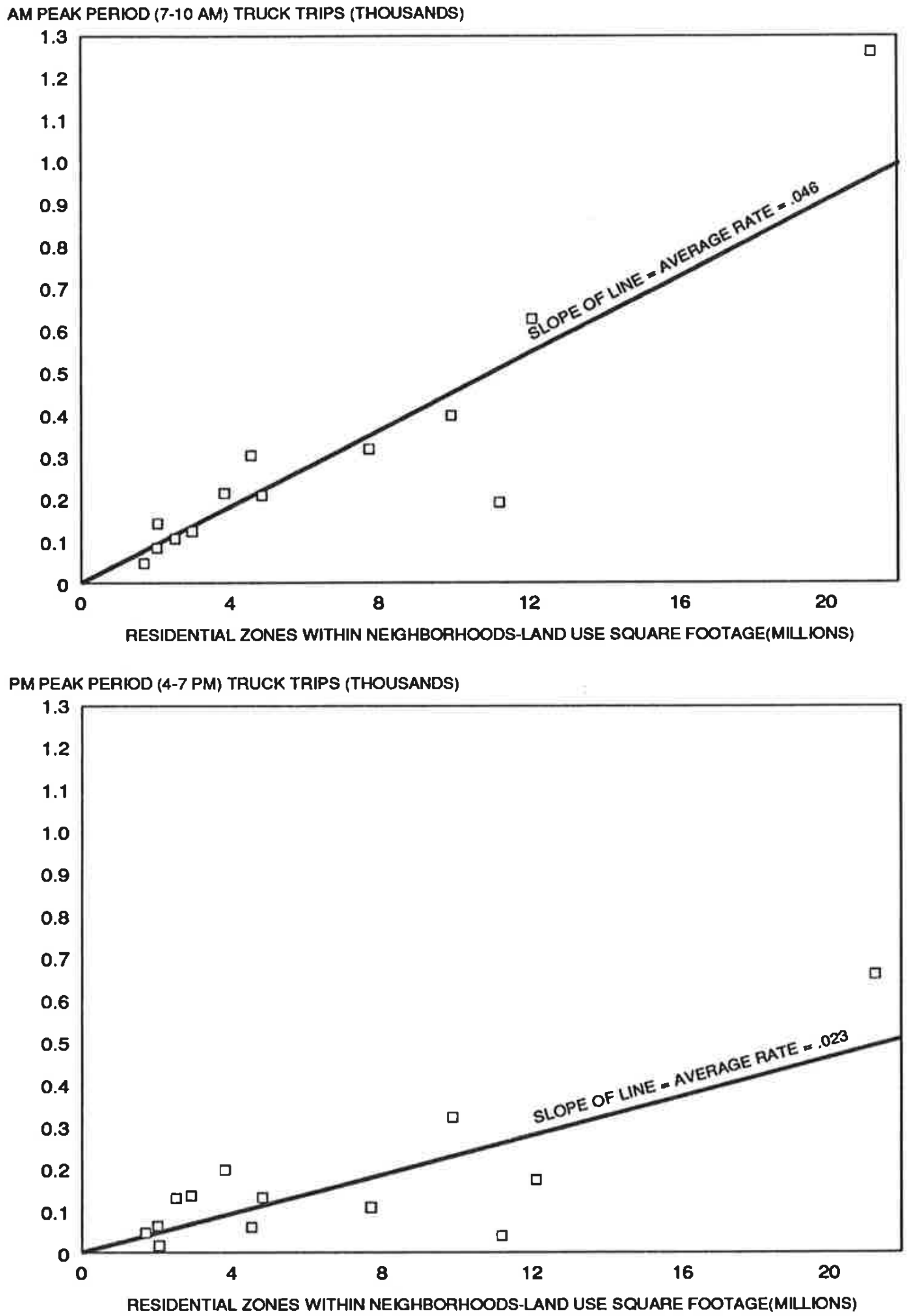


FIGURE 4 Comparison of a.m. (*top*) and p.m. (*bottom*) truck trips in residential neighborhoods.

by multiplying it by the factor 0.35 (total truck trips in peak hour per total 3-hr peak period trips).

P.M. Peak Period We used a 3-hr trip rate of 0.023 trips per 1,000 ft^2 of development and converted it to a 1-hr rate by multiplying it by the factor 0.31.

CALCULATION OF PURE OFFICE ZONE TRIP RATES

Automobile Trips

Focus

The relationship between automobile trips generated in each of the 35 zones defined as pure office and the square footage of development is shown in Figure 5. Zones containing City Hall and the World Trade Center were omitted because their trip generation patterns were different from most zones. Evening peak-hour automobile trip generation rates for pure office zones ranged from 0.013 to 0.104, whereas a.m. peak-hour rates ranged from 0.017 to 0.091 trips per 1,000 ft^2. Our program to reduce the amount of unexplained variation was based on the same premises as those for the residential zone analyses. The findings for pure office zones follow.

Parking Availability/Density When zones are aggregated at the neighborhood level, we find that most neighborhoods have the same parking density. As with residential zones, no relationship could be established at the zone level between automobile trips and parking. Parking availability was examined when defined both as the number of spaces per square foot in an area consisting of the individual zone and a single zone-width band around it and as an area consisting of an individual zone and a double zone-width band around it. Neither measure provided good results. A more detailed discussion is provided later.

Subway Accessibility Virtually all office zones are served by subway. When trips are aggregated at the neighborhood level, the relationship between subway accessibility and trip rates can be established. The relationship is stronger when subway accessibility is measured as the average number of stations within ¼ mi of a zone than when it is measured as the average number of different lines within the ¼-mi radius.

Neighborhood Groupings In general, variability of trip rates is reduced when trips are aggregated to the neighborhood level of detail.

Results

A.M. Peak Period For zones with subway access, the most accurate estimates were derived from the regression for the 3-hr peak period displayed in Figures 5*c* and 5*d*. The formula for this regression is

$$\text{trip generation rate} = 0.249 - 0.028X$$

where X is the number of subway stations within ¼ mi. For zones without subway access we used 0.24 as a "cap" on the trip rate. For zones with subway access, we used 0.083 (the right-hand intercept) as a minimum rate. The factor for deriving 1-hr trip rates was calculated as the ratio of automobiles in the peak hour (6,198) to total automobiles in the peak 3-hr period (19,460). The resulting conversion factor would be 0.32.

P.M. Peak Period For zones with subway access, we used the regression for the 3-hr peak period displayed in Figures 5*c* and 5*d*. The formula for this regression is

$$\text{trip generation rate} = 0.208 - 0.024X$$

For zones without subway access, at the left-hand side of the graph, we used 0.21 as a cap on the trip rate. This cap is an extrapolation from the regression line back to the vertical axis. For zones with subway access, we used 0.070 (the right-hand intercept) as a minimum rate. The p.m. residential automobile conversion factor (from the 3-hr to the 1-hr rates) would be 0.45.

Taxi Trips

Focus

Our program of actions to reduce observed variations in trip generation rates included grouping zonal data into neighborhoods to service as proxies for socioeconomic and locational factors as well as subway accessibility. We found that there appears to be a difference in trip generation rates for uptown and downtown zones. However, no distinction can be made between those areas with and without subway access, since virtually all pure office zones are in areas close to subways. As in the other analyses, grouping zones into neighborhoods reduced the amount of variance between the trip generation rates.

Results

As noted previously, offices are seldom located in zones not served by subways. Therefore, no with/without subway distinction is possible. Figure 6 shows the average rates for uptown and downtown taxi trips.

A.M. Peak Hour We used two separate rates as appropriate:

Zone	*Trip/1,000 ft^2*
Uptown	0.042
Downtown	0.019

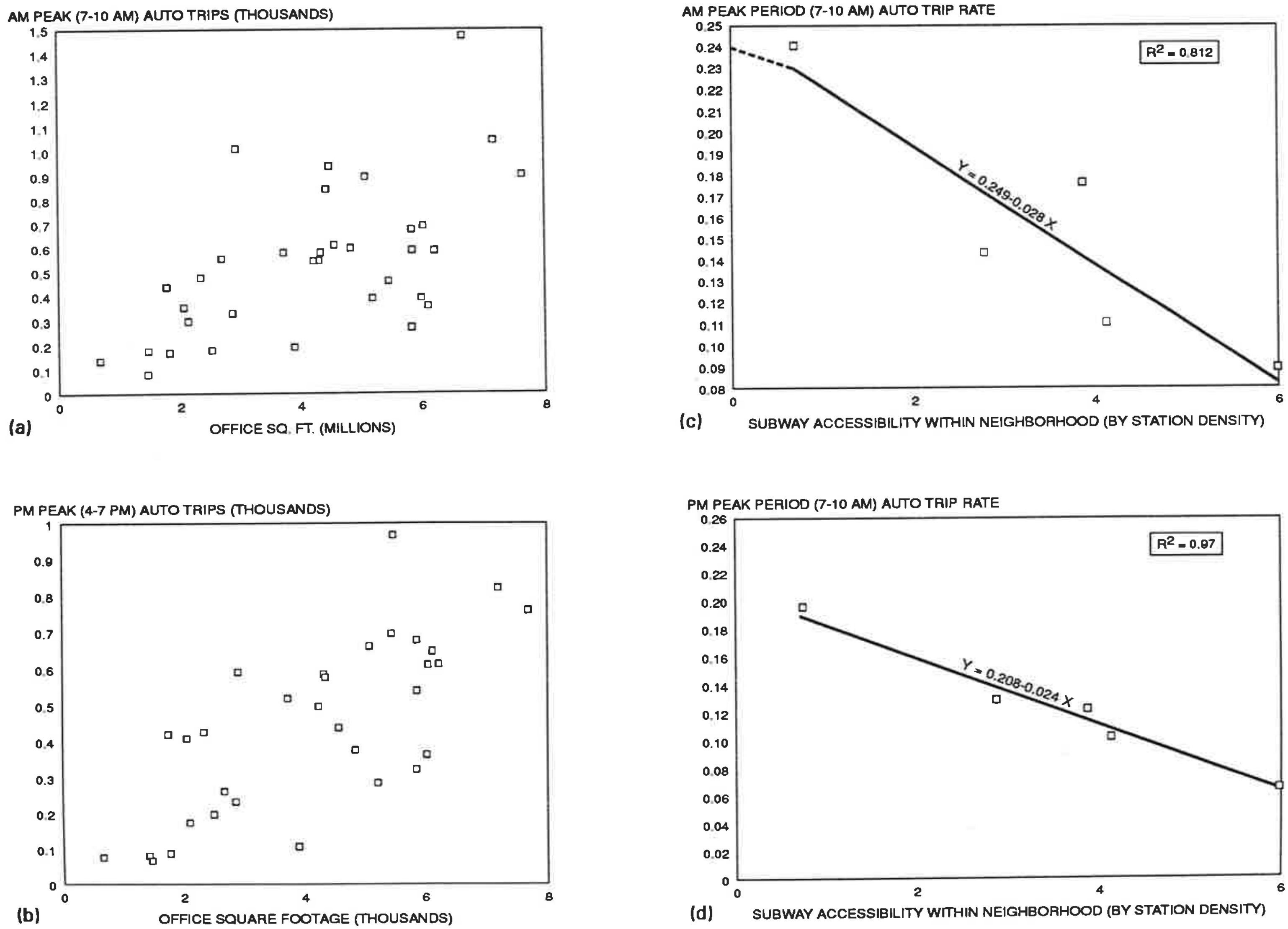


FIGURE 5 **Relationship between automobile trips generated in each of 35 zones defined as pure office and square footage of development: (*a*) all office zones, a.m. automobile trips; (*b*) all office zones, p.m. automobile trips; (*c*) office neighborhood, a.m. automobile trips (r^2 = .812); (*d*) office neighborhood, p.m. automobile trips (r^2 = .97).**

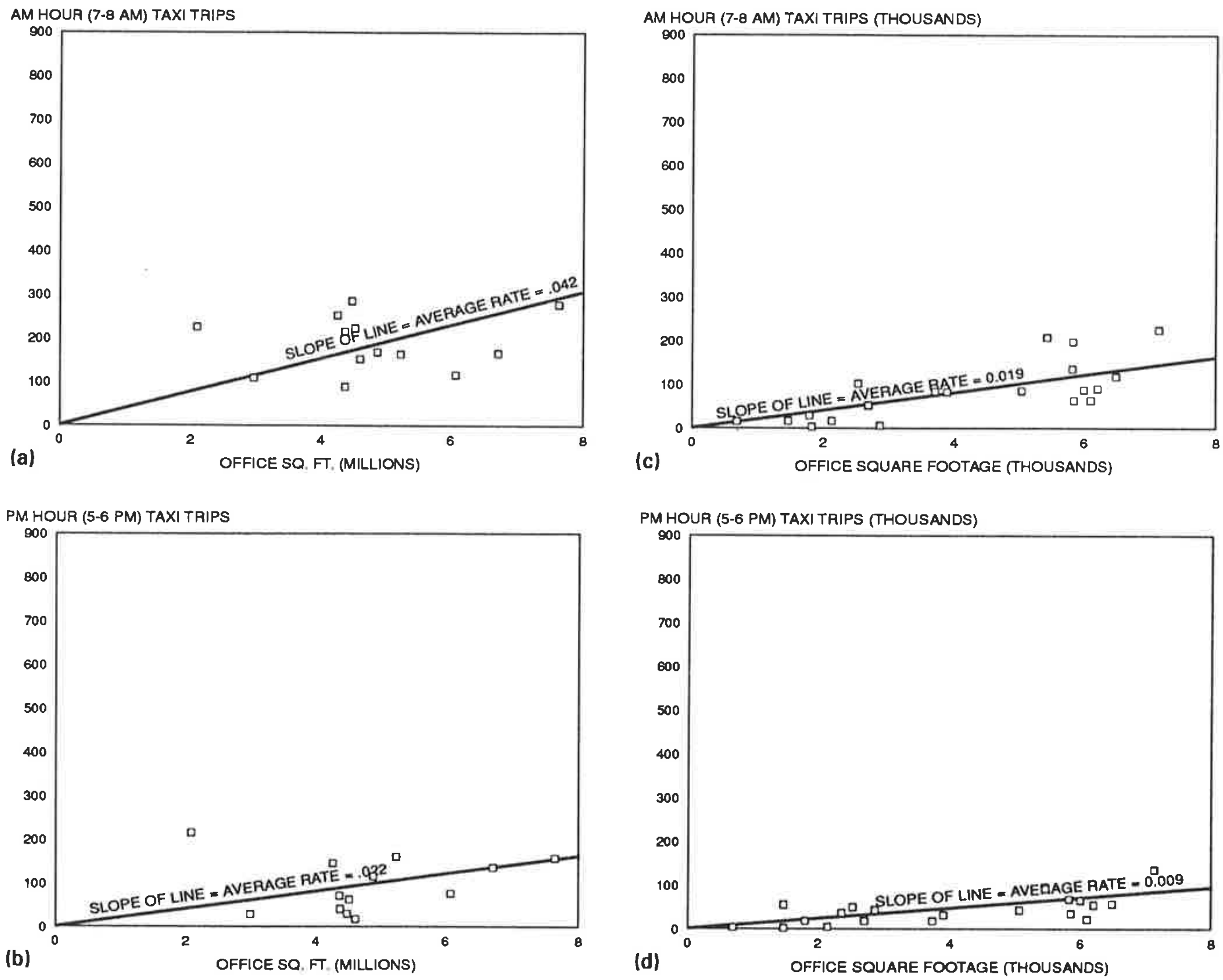


FIGURE 6 Average rates for taxi trips: (*a*) uptown, a.m.; (*b*) uptown, p.m.; (*c*) downtown, a.m.; (*d*) downtown, p.m.

P.M. Peak Hour We used two separate rates as appropriate:

Zone	*Trip/1,000 ft²*
Uptown	0.022
Downtown	0.009

Truck Trips

Discussion

Truck trip generation for office uses followed the same pattern as for residential land use. We did not, therefore, anticipate a relationship with parking or subway availability. Our analysis findings were also similar, to the extent that when trips are aggregated at the zone level of detail, a large variability in trip rates between zones is reduced by aggregation into neighborhoods and the 3-hr trip rates show less variability than the 1-hr rates.

Results

We used simple averages for trip generation (see Figure 7).

A.M. Peak Period We used a 3-hr trip rate of 0.088 trips per 1,000 ft² of development and converted it to a 1-hr rate by multiplying it times the factor 0.37 (total peak hour trips/total 3-hr peak period trips).

P.M. Peak Period We used a 3-hr trip rate of 0.034 trips per 1,000 ft² of development and converted it to a 1-hr rate by multiplying it times the factor 0.34.

PARKING DEMAND/SUPPLY CALCULATION

The research into automobile trip generation for residential and office uses yielded results that, in some cases, had run

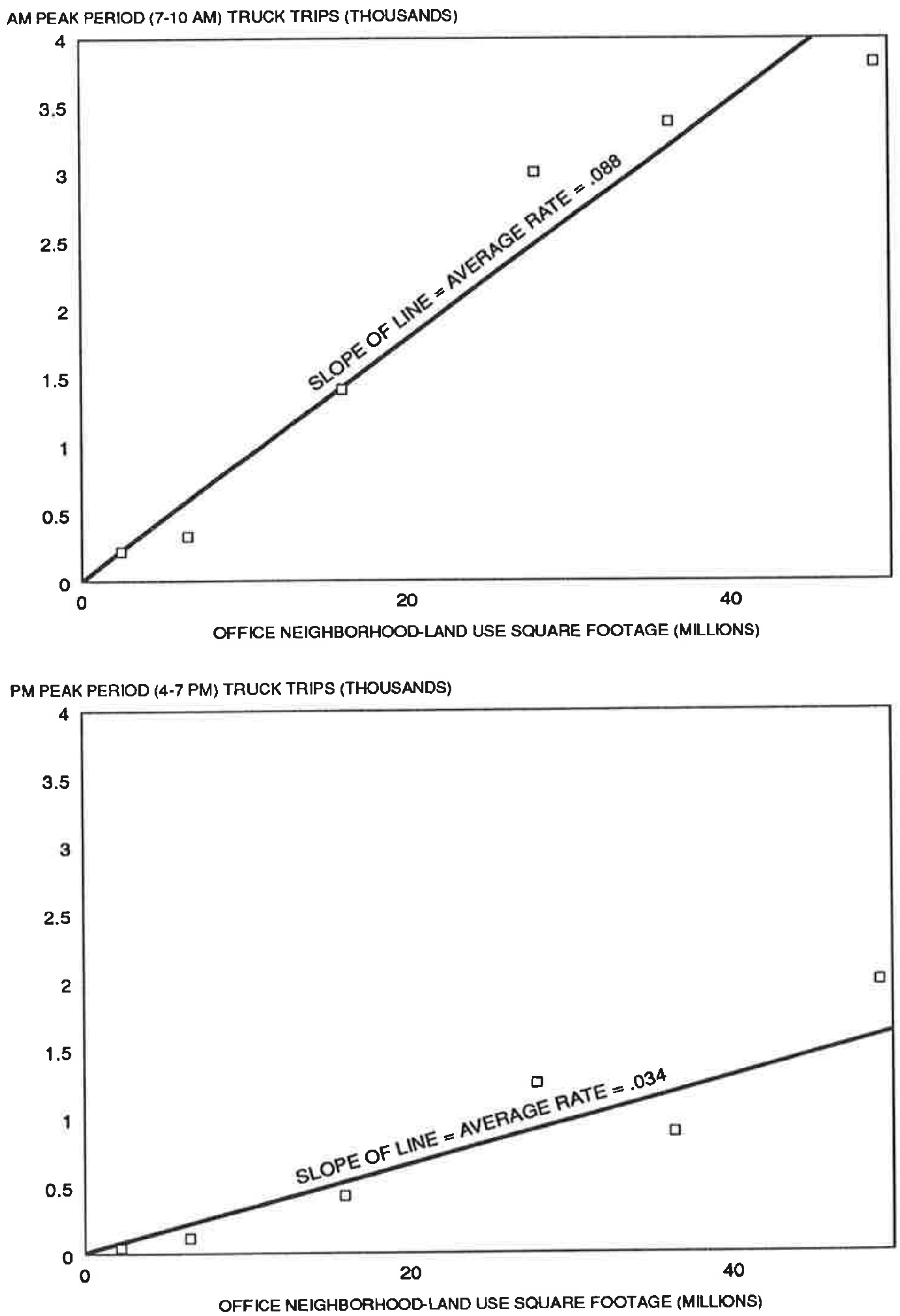


FIGURE 7 Comparison of a.m. (*top*) and p.m. (*bottom*) truck trips in office neighborhoods.

counter to our expectations. New York City has a policy of discouraging the construction of new public parking facilities in the Manhattan CBD. The intent is to limit the number of parking spaces in an area in which there is already perceived to be a shortage and thereby further discourage people from driving into the city. It was our expectation, and that of policy makers, that there would be a correlation between the supply of parking and an area's peak-hour vehicular trip generation rate. The analysis of pure residential- and office-use zones did not find a clear correlation between the density of parking spaces and trip generation rates.

We set out to investigate a possible explanation for the lack of correlation. We compared parking demand and supply to determine if there was an excess supply of spaces in most of the study area zones. If this were the case, then parking availability would not be a strong factor in a commuter's decision to drive or not.

We measured parking demand as the net of the trips into a zone minus the trips out during the morning peak period. Parking supply was simply the number of parking spaces in a study zone. We acknowledge that this gives only an imperfect view of the supply/demand balance because it does not

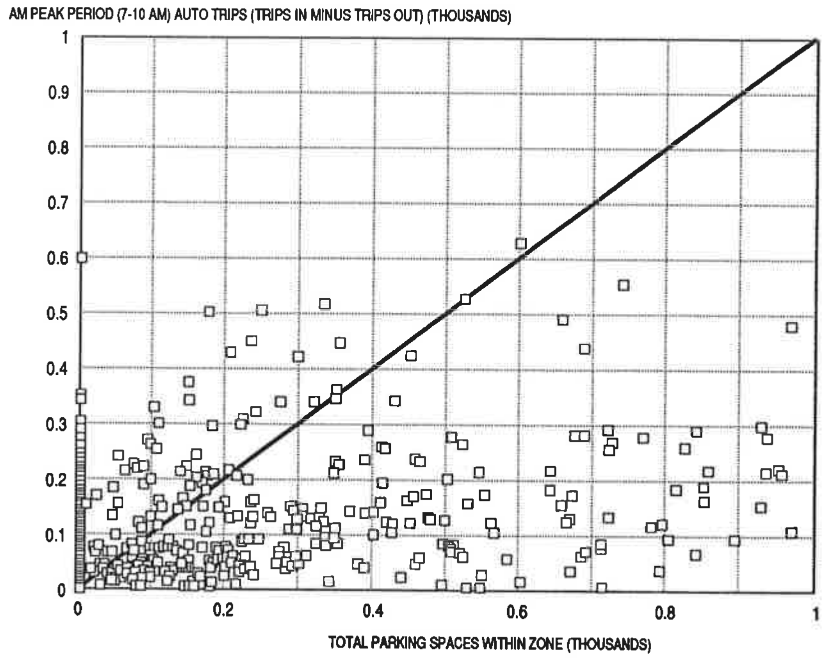


FIGURE 8 Automobile trips for all zones, a.m. peak.

TABLE 1 Final Trip Generation Rates for All Land Uses with Areawide Adjustments (trip ends per 1,000 ft² unless otherwise noted)

Land Use	Auto Trip Ends AM Peak Hour	Generation Rates PM Peak Hour	Taxi Trip Ends AM Peak Hour	Generation Rates PM Peak Hour	Truck Trip Ends AM Peak Hour	Generation Rates PM Peak Hour
Retail:						
Specialty	.0	.200	.0	.122	.03	.0
Dept. Store	.0	.078	.0	.051	.09	.0
Convenience	.081	.233	.163	.500	.02	.0
Hotel	.029	.022	.054	.051	.013/room	.006/room
Hospital	.135	.177	.056	.086	.004	.003
Museum	.0	1.532	.0	1.449	.0	.0
Health Club	.0	.133	.054	.122	.016	.009
Cinema	.0	.017/seat	.0	.026/seat	.0	.0
Theater	.0	.0	.0	.004	.0	.0
Schools	.046	.004	.043	.004	.007	.0
Colleges	.148	.249	.034	.063	.007	.0
Manufacturing/						
Automotive	.059	.021	.055	.019	.05	.05
Warehouse	.066	.173	.012	.065	.0	.0
Churches	.013	.071	.012	.065	.0	.0
Library	.113	.546	.121	.502	.007	.0
Community Ctr	.261	.317	.243	.292	0.015	0.007
Residential						
with Subway	.055	.058	0.038[b]	0.039[b]		
			0.034[c]	0.024[c]		
without Subway	.072	.067	0.062[b]	0.042[b]		
			0.017[c]	0.013[c]		
Office						
with Subway	0.081-0.009X[a]	0.096-0.011X[a]	0.045[b]	0.018[b]	0.029	0.010
			0.020[c]	0.007[c]		
without Subway	0.081	0.096	----	----	----	----

[a] Independent variable X = Number of subway stations within ¼ mile of a zone. Each separate subway is counted, although some stations may serve more than one line, while others may serve lines which can be accessed at multiple locations within the ¼ mile radius.

[b] North of 14th Street

[c] South of 14th Street

account for such factors as on-street spaces or long-term parking in garages. Figure 8 does, however, give a strong indication that in most zones the demand for parking is less than the supply of spaces (those zones to the right of the diagonal line). Hence most commuters, if they are willing to pay the cost of parking, would not be influenced in their decision to drive by concern over availability of spaces. Since the analysis was limited to a 3-hr peak period in the morning, it does not have implications for noncommutation trips. Available parking supply continues to diminish as the midday approaches, and drivers arriving later may have much more trouble finding parking spaces.

TRIP GENERATION RATES FOR MISCELLANEOUS LAND USES

Miscellaneous land uses that are present in the study area and that are called out in the land use data base are divided into 16 categories, including, for example, department stores, hotels, schools, churches, hospitals, theaters, and factories.

We obtained peak-hour vehicular trip generation rates for these land uses by two methods. First, where possible, we calculated trip generation rates that would typically be used in NYC environmental impact assessment work. This was accomplished by assembling common vehicle occupancy rates, modal splits, temporal distributions, and person trip generation rates. Second, for more unusual land uses, we resorted to trip generation rates assembled by ITE, with modifications we thought were appropriate for New York City. The ITE trip generation rates are derived from studies of communities that are smaller and generally less congested than New York. All miscellaneous land use trip generation rates and their sources are summarized in Table 1.

TRIP GENERATION RATES FOR SPECIAL LAND USE ZONES

Special use zones are those zones that are so unique that we thought they should be handled individually. Either the use in the zone did not fall into one of the broad categories for which trip generation rates were available (such as courthouses), or the use was large enough or unique in some other way that would preclude the use of standard rates. Trips resulting from growth in the unique uses of these zones would be estimated by using the trip rate of that particular zone.

ADJUSTMENTS TO PURE USE ZONE TRIP GENERATION RATES

It was necessary to adjust the trip generation rates calculated for the pure use zones downward to account for the 5 percent, on average, of land use square footage that was categorized as miscellaneous. Using the trip generation rates compiled for miscellaneous land uses and the derived residential and office trip rates, a new trip total was calculated for all land uses. This new trip total was divided into the trip total for the office and land uses alone to obtain an adjustment factor.

TABLE 2 Comparison of Original and Adjusted Trip Generation Rates

	Original Trip Generation Rate		Adjusted Trip Generation Rate	
	AM	PM	AM	PM
Residential Auto				
W/Subway	.053	.060	.047	.052
W/out Subway	.070	.069	.062	.060
Residential Taxi				
Uptown W/Subway	.039	.043	.035	.038
Dwntwn W/Subway	.063	.047	.057	.042
Uptown W/out	.034	.027	.031	.024
Downtown W/out	.017	.015	.015	.013
Residential Truck	.016	.007	.015	.007
Office Auto				
W/Subway	.080-.009X	.094-.011X	.070-.008X	.086-.010X
W/out Subway	.080	.095	.070	.086
Office Taxi				
Uptown	.042	.022	.042	.018
Downtown	.019	.009	.019	.007
Office Truck	.033	.012	.029	.009

The office/residential trip generation rates were then multiplied by the factor. Table 2 shows the results of the adjustment.

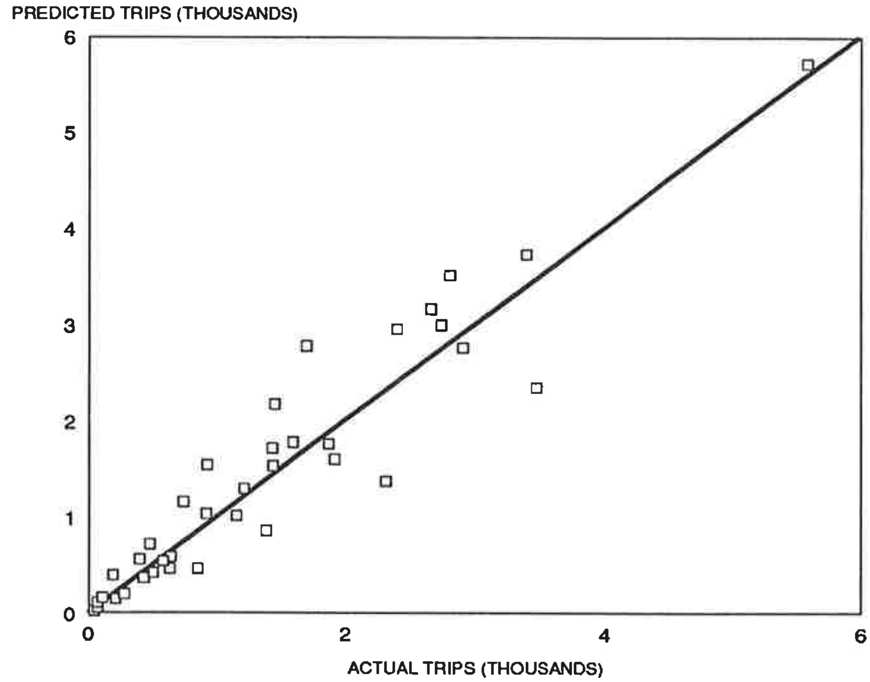
VALIDATION/CALIBRATION RESULTS

Using the process described in the methodology section, trip generation was projected for each zone in the study area. The ratios of actual trips to predicted trips when totaled across all zones for automobiles, taxis, and trucks were then calculated separately. The ratios determined were as follows:

	Ratio of actual to predicted trips	
	a.m.	*p.m.*
Automobiles	1.16	1.11
Taxis	1.09	1.02
Trucks	.92	1.08

These ratios were in turn used as a final adjustment factor for trip generation rates of all land uses. The final trip generation rates are given in Table 1.

Actual trips, by zone, were compared against predicted trips (using the rates in Table 1) at the zone level and at the neighborhood level. Figure 9 shows predicted versus actual trips for each zone. The diagonal line indicates where predicted and actual trips are equal. The figure demonstrates that the predicted trip generation rates are relatively good approximations of actual trip generation at the aggregate level.



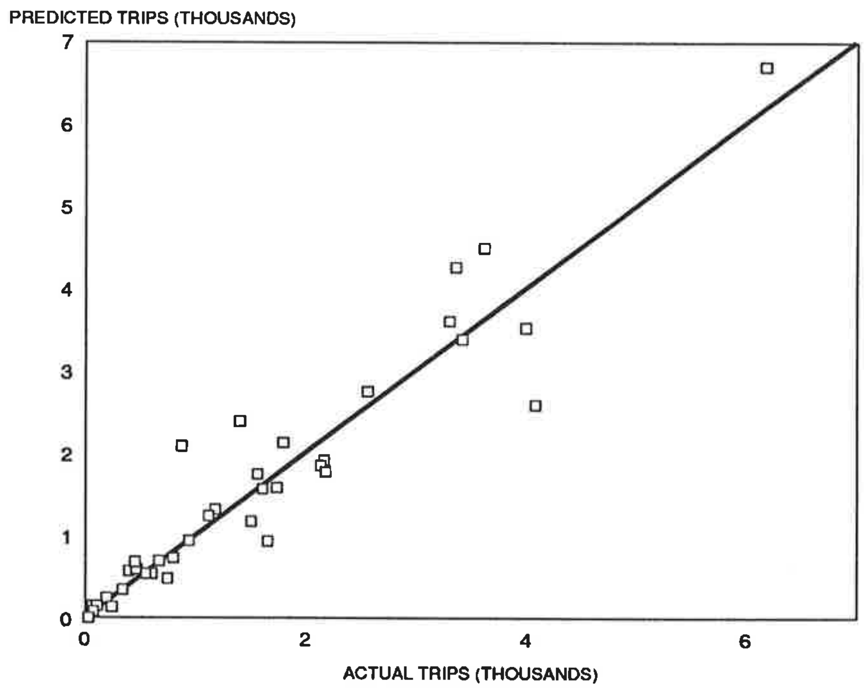


FIGURE 9 Comparison of actual and predicted trips for each zone: a.m. (*top*); p.m. (*bottom*).

CONCLUSIONS

The Route 9A project for the replacement of Manhattan's West Side Highway necessitated development of an alternative methodology for the calculation of trip generation rates. For the 9A project, it was not as important for trips from each new building or land use to be projected accurately as it was for the overall estimate of future trips to be as true as possible. The approach taken, however, provides greater accuracy than total reliance on secondary sources. The *ITE Trip Generation Handbook* provides little guidance on which rates to use when transit is a viable alternative to most vehicular trips. The handbook, for example, states that for the a.m. peak hour, office trip generation rates range from 0.03 to 0.56 trips per 1,000 ft^2 (depending on the modal split assumptions) and provides no rule for which rate to apply and where. For the Manhattan CBD, the expected automobile trip generation rates range from 0.027 to 0.081 trips per 1,000 ft^2 and are explicitly related to transit services. For residential apartments, the ITE handbook provides a.m. peak hour rates that typically range from 0.06 to 1.64 trips per 1,000 ft^2 (again depending on the modal split). In contrast, the Manhattan

CBD rates range from 0.055 to 0.076 trips per 1,000 ft^2 and are explicitly related to transit service.

The approach is one that (a) focuses on the dominant land uses, thereby avoiding wasted effort to estimate more accurate trip generation rates for land uses that will only slightly affect the margin of error; (b) allows the use of available data without extension field work beyond the establishment of the trip table; and (c) through the use of small zones, allows for subarea summaries that serve as proxies for income, transportation access, and other characteristics of zones.

ACKNOWLEDGMENTS

This study was one in a series sponsored by NYSDOT as part of the Route 9A replacement study. The authors wish to thank the NYC departments of Transportation and City Planning and NYSDOT for their help on this project and, in particular, the members of the technical review committee: Gerard J. Cioffi and Lee Maynus of NYSDOT, Michael Graham of NYC Department of Transportation, Dick Chudd of the NYC Department of City Planning, and Daniel Greenbaum and Jerry Nielsten of Vollmer Associates. Their input and commentary were invaluable in the analysis of results and in development of the trip generation methodology.

The authors assume all responsibility for any errors or omissions in the product of this work.

Publication of this paper sponsored by Committee on Transportation and Land Development.