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TRUCK TRAVEL SURVEYS: A REVIEW OF THE LITERATURE AND STATE-OF-THE-ART

by

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PREFACE AND ACKNOWLEDGEMENTS

This study was conducted for the Metropolitan Transportation Commission (MTC). The contents of this report reflect the opinions of the author who is responsible for the facts and accuracy of the information presented herein. The contents of this report do not necessarily reflect the official views or policies of MTC.

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EXECUTIVE SUMMARY

This paper presents the literature on conducting truck travel surveys in the U.S. and abroad. It includes past experiences, as well as current practices in conducting truck surveys. The primary purpose of this paper is to present compiled information on truck surveys and truck travel demand forecasting experiences to the Metropolitan Transportation Commission (MTC) to help evaluate the need for new truck/freight planning tools. The paper reports truck/freight survey experiences from Councils of Government (COGs), metropolitan planning organizations (MPOs), for which MTC is one, and other state and regional transportation planning agencies, both inside and outside of the country. The paper does not attempt to review literature on freight mode-choice surveys and/or modeling efforts (competition between rail and truck, for example).

THE NEED FOR TRUCK TRAVEL DATA

Truck travel and goods movement is essential to the economic vitality of an urban area. Trucks not only act as the "supply-line" from warehouses to points of consumption (whether they be retail stores or residences), they connect intermodal freight facilities (seaports, airports, railroad and freight terminal facilities). As important as truck travel is to a region, it also has negative effects such as traffic congestion, truck-related accidents, air pollution, noise, and pavement deterioration. In order for an urban area to undertake comprehensive truck/freight planning, accurate and reliable truck travel data is needed for analysis.

In terms of metropolitan area planning needs, improved truck travel data could be used for the following purposes:

1. Truck travel model development
   - Truck trip generation
   - Origin and destination analysis
   - Local and freeway route assignments
   - Congestion and speed simulations
   - Travel time analysis
   - Analyze impact of toll facilities
   - Spatial and temporal (time-of-day, day-of-week, and season) analyses

2. Corridor/Route analysis
   - Evaluate route/corridor traffic management proposals for freight impacts
   - Provide information on truck travel to formulate traffic management plans during roadway reconstructions
   - Assess impact of truck route reassignments or closures

3. Air quality modeling
   - Estimate truck emissions

4. Intermodal Freight Planning
   - Facilitate seaport planning
   - Facilitate airport planning
   - Understand competition and demand of different freight modes
   - Provide data to develop performance measures for Intermodal Management Systems as required under ISTEA

5. Pavement Management Planning
   - Evaluate and design road geometrics
   - Help calibrate pavement deterioration models

6. Truck restrictions and enforcement
   - Route restriction analysis
   - Dangerous goods movement regulation and enforcement analyses
   - Truck driver safety programs

7. Facilitate public-private partnership
   - Open dialog with private freight industries in gathering data
   - Provide truck travel data to public and the freight industry for research and analysis
   - Freight-economic analysis

TRUCK SURVEYS & TRUCK TRAVEL DEMAND FORECASTING LITERATURE

This literature and state-of-the-art review reveals that few urban areas in the country have had extensive experience in conducting truck surveys and truck travel demand forecasting. Most metropolitan planning organizations (MPOs) or regional transportation planning agencies continue to generate their truck trip estimates based on origin-destination surveys conducted in the 1960s and 70s. In the last ten years, only a few metropolitan areas, namely Chicago (1970 and 1986), Ontario (1978, 1983, and 1988), Vancouver (1988), Phoenix (1991), Alameda County, California (1991), New York-New Jersey (1991-94), El Paso, Texas (1994), and Houston-Galveston (1994) have undertaken significant efforts to collect truck travel data or develop new techniques in forecasting truck traffic. Out of the eight urban areas, only Chicago and Phoenix have had their truck model development and forecasting methodologies documented in detail, and only Ontario and the Port Authority of New York & New Jersey (PANYNJ) have systematically collected truck travel data. This report documents the experiences of different urban areas in the U.S. and Canada. The following is a summary of the results.

TYPES OF DATA COLLECTED

- The eight most recent truck travel surveys all collected origin-destination information (see **Table A-3**).
- With the exception of roadside surveys conducted in New York and New Jersey, most truck surveys requested land use at destination and truck odometer readings from respondents.
- Most surveys classified trucks by weight, number of axles, or by truck type.
- With the exception of roadside surveys, all other survey types included trip diaries (Chicago, Phoenix, El Paso, Houston-Galveston, and Alameda County).
- The commodity data collected ranged from a simple classification of commodity by type to detailed description of the actual commodites being carried.
- The 1988 Ontario survey is the only commercial vehicle survey that gathered information on truck driver characteristics.
- The 1994 El Paso commercial truck survey was the only survey that collected route choice information for the surveyed trip.

USES OF TRUCK SURVEY DATA

- The most common uses of truck data are for regional truck travel model development and corridor/route analysis. Chicago, Phoenix, El Paso, and Vancouver have used their truck survey data to develop regional truck travel demand models.
- Ontario has seen the most use of its truck survey information. The truck data have been used for time series comparisons, evaluation of road design and geometrics, pavement management planning, truck-related accident analysis, dangerous goods movement regulation and enforcement, understanding truck driver characteristics and for planning truck driver education programs.
- El Paso has mainly used its truck data for regional travel and truck emissions modeling.
- The Port Authority of New York and New Jersey has used its truck data for traffic management purposes during highway and bridge/tunnel reconstructions and freight-economic analysis.
- Chicago has used its truck data to generate truck activity maps of the Greater Chicago region; truck speed simulation; and modeling the effects of toll facilities on truck route choices within the context of the Chicago regional travel model.
- The Southern California Association of Governments (SCAG) has used its truck travel data to estimate heavy truck VMT and model truck emissions in the South Coast Air Basin (SCAB) for the Los Angeles area. It has also used truck data to conduct analysis of truck traffic to the Port of Hueneme in Ventura County.

- Caltrans and Alameda County has used its truck survey data to estimate truck traffic entering and leaving the County, as well as seaport planning for the Port of Oakland.

TRUCK TRAVEL SURVEY METHODS USED

- The most common survey method for conducting truck travel surveys in urban areas was the *combined telephone-mailout-mailback* method. Three urban areas in the country - Phoenix, Arizona; Alameda County, California; and Houston-Galveston, Texas - have recently conducted truck travel surveys using the combined telephone-mailout-mailback method.
- The combined telephone-mailout-mailback survey method is more cost-effective and yields a reasonably high response rate.
- The second most used survey method was the *roadside interview* method. The Province of Ontario, Canada and the Port Authority of New York & New Jersey have conducted numerous roadside interviews.
- Roadside interviews produce very high response rates with complete information. They are ideal for cordon surveys or surveying trucks traveling in from outside the survey area.
- The most common source for drawing the survey sample is the Department of Motor Vehicle (DMV) registration files. Other sample sources include lists of truck registration files available from commercial vendors (R.L. Polk, Texas Vehicle Information and Computer Services, Inc., etc.).

A summary of different survey characteristics for eight urban truck travel surveys is found in **Table A-1**, and a summary of different truck travel survey methods (typical response rate, advantages, and disadvantages, etc.) is found in **Table A-2**.

NUMBER OF COMPLETED SURVEYS AND RESPONSE RATE

- The approximate number of completed surveys from the eight urban truck surveys varied from 188 to 19,225.
- Roadside surveys produced the highest number of completed surveys and the best response rate (nearly 100 percent).
- Mailout-mailback surveys produced the lowest overall and item response rates.
- Combined-telephone-mailout-mailback surveys produced improved response rates over mailout-mailback or telephone surveys alone (See **Table A-1** and **Table A-2**).

Table A-1: Summary of Truck Travel Surveys in Urban Areas

Survey Location	Survey Year	Survey Method	Approx. Number of Completed Surveys	Response Rate	Data Applications	Total Survey Cost	$/Survey
Chicago	1986	Mailout-Mailback	3,506	25.3%	• Truck travel model development • Corridor/Route analysis • Effects of toll on trucks • Truck speed simulation model • Truck activity mapping	$200,000	$57/survey
Ontario	1988	Roadside Interview	19,225	96.5%	• Time series comparison • Evaluate & design road geometrics • Pavement management planning • Truck accident analysis • Dangerous goods regulation & enforcement analysis • Truck driver characteristics • Driver education program	NA	NA
Phoenix	1991	Combined Telephone-Mailout-Mailback	720	30.0%	• Truck travel model development	$90,000(1)	$125/survey(1)
N.Y. & N.J.	1991	Roadside Interview	4,500	NA	• Evaluate dedicated route/corridor proposal • Traffic management for highway reconstruction • Time series freight analysis • Freight-economic analysis	NA	NA
Alameda County, Calif.	1991	Combined Telephone-Mailout-Mailback & Roadside Interview	2,200 over 8,000	79% NA	• I-880 corridor analysis • Create truck travel submodel for corridor analysis • Generate 24-hour & PM peak volumes by axle	NA	NA
N.Y. & N.J.	1992-94	Roadside Interview	14,671	37.8%(2)	NA	$312,000(3)	$21/survey
El Paso	1994	Telephone Interview	188	42.6%	• Truck travel model development • Part of regional travel study • Truck emissions analysis	$65,000(4)	$345/survey(5)
Houston-Galveston	1994	Combined Telephone-Mailout-Mailback	900	35%-40%	• Truck travel model development	$150,000	$167/survey

(1) Cost included data collection, data coding, and model development.
(2) This was the sampling rate. No response rate was given.
(3) This was a multi-agency effort, with partnership from the New Jersey Department of Transportation (NJDOT), the New York Metropolitan Transportation Council (NYMTC), and the Port Authority of New York and New Jersey. The survey was conducted at 18 locations with 3 interviewers per toll plaza for 24 hours.
(4) Cost included sample design, survey design, data collection, coding, reporting, survey analysis, and model development.
(5) The higher cost was due to a high number of incomplete surveys.

Table A-2: Summary of Truck Travel Survey Methods

Survey Methods	Place (year) of Surveys	Typical Completed Surveys (% of Total Pop.)	Typical Response Rate	Advantages	Disadvantages
Telephone Interview	N.Y.(1964) Calgary(71) El Paso(94)	4%-15%	40%-50%	• High response rate • Easy to follow-up	• Can only call during business hours • "Phone-tagging" problem • Limited time on phone if respondent is busy • Requires access to vehicle registration file
Mailout-Mailback	Chicago(86)	1%-5%	10%-45%(1)	• Less costly • Good response rate w/ certified mail • Only follow-up of non-responses is necessary	• Low overall & item response rate • Possible bias due to better response from some drivers/owners • Low response from small truck owners • Low response from out-of-state trucks • Need to follow-up on non-responses • Difficult to ensure that the driver will fill out the form, instead of the owner or fleet manager who receives the survey forms • Requires access to registration file
Combined Telephone -Mailout-Mailback	Phoenix(91) Houston(94) Alameda, CA(91)	3%-10%	30%-80%(2)	• Improved response rate over mailout-mailback alone • Early identification of owners who agree to participate & potential non-responses through phone contact • Phone contact may help adjust sample size for mailout-mailback	• Same disadvantages as telephone survey method above • High cost of telephone follow-ups • Need phone reminders for trip diary • More costly than above methods
Roadside Intercept/ Interview	Calgary(71) Ontario(78, 83, 88) N.Y. & N.J. (74, 82, 85, 91-94) Alameda County, CA (91)	8%-35%(3)	95%-100%	• Complete information • High response rate • Better sampling control • Good representative sample of trucks entering or leaving a cordon line • Easy comparison with mainstream traffic through field counts at survey location	• Potential disruption to traffic • Quality and conduct of survey affected by weather, lighting • Hazardous to survey crew • Time constraint • No follow-up possible • Enforcement problems • Drivers avoiding the survey station • Only represent trucks traveling on road along survey station, not entire region

(1) The higher response rate was due to better survey participation from large truck fleet operators.
(2) The higher response rate was due to an employer survey conducted in California (1991 Caltrans-Alameda County Survey).
(3) The higher percentage is from the 1988 Ontario survey which surveyed 57 locations over a 1,855-hour period throughout the Ontario Province.

Table A-3: Types of Data Collected

Survey Location	Survey Year	Survey Method	Sample Source	Weight	Axle	Truck Type	O-D	Odometer	Commodity	Land Use	Driver Info	Route Info	Develop Model
Chicago	1986	Mailout-Mailback	DMV	•		•	•	•		•			Yes
Ontario	1988	Roadside Interview	Road-side(1)	•	•	•	•	•	•		•		
Phoenix	1991	Combined Telephone -Mailout-Mailback	DMV	•	•	•	•	•		•			Yes
N.Y. & N.J.	1991	Roadside Interview	Toll Plaza		•	•	•		•				
Alameda County, Calif.	1991	Combined Telephone -Mailout-Mailback & Roadside Interview	DMV, Port of Oakland Road-side(1)		• •		• •	• •	• •	• •			Yes
N.Y. & N.J.	1992-1994	Roadside Interview	Road-side(1)		•	•	•		•				
El Paso, Texas	1994	Telephone Interview	TVICS(2)		•	•	•	•	•	•		•	Yes
Houston-Galveston	1994	Combined Telephone -Mailout-Mailback	DMV			•	•	•	•	•			

(1) Sample taken at roadside intercept surveys.
(2) Sample drawn from the Texas Vehicle Information and Computer Services, Inc. (TVICS) database.

SURVEY COST

- Telephone interviews are the most costly to conduct. They require a large number of staff and time for data collection.
- Combined telephone-mailout-mailback surveys are the most cost-effective to conduct. They yield reasonably high response rates over mailout-mailbacks alone. The phone contact portion of the survey can help assess non-response biases when analyzing and weighting the mailback survey samples.

COMPARISON OF SURVEY FINDINGS

A summary of the general findings from various truck travel surveys are as follows:

Characteristics of Commercial Vehicles

- ***Average Vehicle Weight***: The only survey that reported average vehicle weight was the 1991 Phoenix Commercial Vehicle Survey. The average vehicle weight per commercial trip was 11,870 lbs.

- ***Truck Size***: The share of different truck sizes used varied from urban area to urban area.

Characteristics of Commercial Vehicle Trips

- ***Average Trip per Commercial Vehicle***: Light trucks have a higher average trip frequency than for heavy trucks.
- ***Regional vs. Through Trips***: Most truck trips serve local regional needs. Of the few through trips (usually less than 10 percent), most are made by heavy trucks.
- ***Average Trip Length***: Heavy trucks make longer trips than lighter trucks.
- ***Vehicle Miles Traveled***: Heavy trucks log a higher VMT per day than light trucks.
- ***Time of First Commercial Vehicle Trip***: Most "first" truck trips occur early in the morning (between 6:00 a.m. to 9:00 a.m.). This pattern, however, varies by weight category. Light trucks were more likely to start their first trip between 6:00 a.m. and 9:00 a.m. Heavy trucks, however, started their first trip before 6:00 a.m.
- ***Time-of-Day Distribution***: Most truck trips seem to occur during the midday period between 9:00 a.m. and 3:00 p.m. Truck "through" traffic seems to avoid peak periods and tend to travel at night.
- ***Truck Travel During Peak Periods***: The results vary by urban area and by individual locations. In New York and New Jersey, over 35 percent of trucks made trips during the morning peak period (6:00 a.m. to 10:00 a.m.). In comparison with AM and PM peaks for private vehicle travel, the results found that the AM peak period travel was as important for commercial vehicles as for private vehicles.
- ***Truck Travel During Peak Periods as Percent of Total Vehicular Volume***: Truck traffic range from less than 9 percent to as high as 17 percent of the total vehicular volume during peak periods.
- ***Day-of-Week Distribution***: Truck traffic typically occurs on weekdays and decreases significantly on the weekends.
- ***Average Trip Duration***: Trip time generally increases with vehicle weight. The 1991 Phoenix survey recorded that the overall average trip time for truck travel was 28.1 minutes.
- ***Truck Travel by Facility Type***: Few surveys or studies have attempted to analyze truck trips based on facility types used. Only the Canadians used facility types to classify their truck trips. A 1991 Barton Aschman Study of Alameda County truck trips found that many of the approximately 5,000 daily truck trips in the Port of Oakland area are local trips that never access a freeway.
- ***Route Choice for Return Trips***: The only survey that analyzed route choice for return trips was the 1991 New York and New Jersey Truck Commodity Survey. It found that 73 percent of the truck drivers interviewed in the toll direction indicated that they would use the same route for the reverse trip.

- ***On-Street Stops***: The 1991 Phoenix survey was the only to report the number of on-street stops made by trucks. The results found that over one-third of all commercial vehicles stops were made on-street. Light vehicles made half of their stops on-street.

Commercial Vehicle Trips and Land Use

- ***Trips by Land Use***: Light trucks make more residential trips than any other truck category. Retail attracted many more light and medium truck trips. Heavy trucks dominated terminal/warehouse land uses.
- ***Activities at Trip Ends***: Light trucks are heavily used for service delivery and personal business. Heavy trucks are most used for loading and unloading cargo at their trip ends.

Other Truck-Related Findings

- ***Truck Travel and Dangerous Goods Movement***: The Ontario survey (1988) was the only survey that obtained information on dangerous goods movement. It found that a total of about 5 to 6 percent of all truck trips surveyed involved the carrying of dangerous goods. Flammable liquids (47 percent) were the most frequently transported dangerous goods, followed by compressed gases (24 percent), and corrosive substances (20 percent).
- ***Truck-Related Accidents***: The 1988 Caltrans Urban Freeway Gridlock Study found that 5 to 10 percent of all truck-related incidents were found to cause major incidents which closed two or more freeway lanes for at least two hours.

RECOMMENDATIONS

This report recommends the following for conducting a regional truck travel survey and truck travel demand forecasting model if MTC should be interested in developing new truck data and tools:

Survey Conduct

- For internal-to-internal or internal-to-external truck trips, draw the survey sample from the DMV registration file or regional truck registration files (PUC, or private truck registration databases). Conduct either a telephone or mailout-mailback survey, or a combination of both to obtain a better response rate.
- For external-to-internal or external-to-external truck trips, conduct roadside intercept surveys at various roadway facilities and links in the network. The best places to conduct them are "weigh-in-motion" stations. This would minimize traffic delay for the mainline and would be safer for the survey crews compared to conducting the survey at the roadside.

- Consider conducting intercept surveys at bridge toll plazas. For a better explanation of how to conduct roadside surveys at toll plazas, review the experiences in New York and New Jersey.
- For roadside interviews or cordon surveys, conduct vehicle classification counts at the same time and at the same location where the actual survey/interview is conducted. This will provide the basic information for sample expansion and analysis.
- For obtaining trip diaries, using a combination of fleet-employer samples and truck unit samples is desirable. Sub-sampling fleet employers will provide better sample control and reduce the problem of oversampling large fleet operators.
- Oversample smaller or individual truck operators. The 1986 CATS survey has shown that large fleet operators tend to respond better (more manpower, time, or incentive to reply to surveys) and smaller operators tend to yield higher non-responses.
- To reduce the cost of conducting a full-scale truck survey, consider making the survey a multi-agency effort.
- Consider soliciting the help of private freight/trucking agencies or organizations. Open a dialog with interested parties to facilitate cooperation and to request assistance, especially in the design of the survey.

Truck Travel Analysis

- Time-of-day (24-hour), day-of-week, and seasonal variations in truck travel should be examined.
- Analyze trips by facility types used (include questions that obtain facility type information for each trip).
- Conduct further analysis on the impact trucks have on peak period congestion. Several surveys (New York, New Jersey, and Ontario) have found that in comparison with AM and PM peaks for private vehicle travel, AM peak period travel was as important for commercial vehicles as for private vehicles.
- Estimate total truck hours of delay by facility to help reduce truck operating cost.
- Conduct further analysis on the impact of truck traffic on pavement, especially the impact of waste-refuse trucks and buses (considered as "passenger-carrying trucks") on residential arterials and streets.
- The origins and destinations of trips that begin and end within the study area should be geocoded to the transportation analysis zones (TAZs) rather than at the city or zip code level. This would improve the accuracy of truck trip generation models based on zonal socioeconomic attributes.
- Exercise extreme caution when using or applying vehicle equivalency factors (VEQs) in truck travel analysis.

Chapter One
INTRODUCTION

TRUCK SURVEYS & TRUCK TRAVEL DEMAND FORECASTING LITERATURE

To date, there has been limited experience in truck surveys and truck travel demand forecasting in urban areas. In most states and metropolitan areas, the collection of truck traffic data and development of truck travel demand forecasts are treated as an appendage to similar data collection and modeling efforts being done for passenger vehicles. There have been few efforts in treating truck data collection and forecasting as a separate issue. Moreover, a survey conducted by the Indian Nation Council of Governments (INCOG) has found that many MPOs continue to generate their truck trip estimates based on origin-destination surveys conducted in the 1960s and 70s (INCOG, 1990). Only a few metropolitan areas, namely Chicago (1970 and 1986), Ontario (1978, 1983, and 1988), Phoenix (1991), Vancouver (1988), Alameda County, California (1991), New York-New Jersey (1991-94), El Paso, Texas (1994), and Houston-Galveston (1994) have recently undertaken Herculean efforts to collect truck travel data or develop new techniques in forecasting truck travel. Moreover, recent technological advances, such as Weigh-in-Motion (WIM) count machines, Automated Vehicle Classification (AVC) devices, and Automated Vehicle Identification (AVI) systems, have made gathering truck data more accurate and less costly and cumbersome (National Cooperative Highway Research Program, 1988). Truck activity mapping, using geographic information systems (GIS), has also enhanced the ability to analyze truck and goods movement spatially. The cited studies varied in context, methodology and results. They reflect a limited but sizable literature from which to draw some lessons and conclusions.

This paper presents the literature on conducting truck travel surveys in the U.S. and abroad. It includes past experiences, as well as current practices in conducting truck surveys. The primary purpose of this paper is to present compiled information on truck surveys and truck travel demand forecasting experiences to the Metropolitan Transportation Commission (MTC). The objective of this paper is to present truck/freight survey experiences from Councils of Government (COGs), metropolitan planning organizations (MPOs), for which MTC is one, and other state and regional transportation planning agencies, both inside and outside of the country. The purpose, however, is not to present literature on freight mode-choice surveys and modeling efforts (competition between rail and truck, for example).

This report is organized into seven chapters. The following is a brief description of each chapter:

Chapter One is the introduction to the report. It presents a background and context to which the report is based.

Chapter Two gives a brief description of four recent national truck travel surveys and data collection efforts.

Chapter Three presents truck travel survey experiences in urban areas. It includes a description of truck manuals produced in the 1960s and early 70s. Truck travel survey experiences from Chicago, Phoenix, New York and New Jersey, Texas, North Carolina, Calgary, Ontario, and Vancouver are presented.

Chapter Four discusses truck travel data collection experiences in California. It includes a detail discussion of experiences from Los Angeles and the San Francisco Bay Area.

Chapter Five presents other research and studies of truck travel characteristcs. It includes topics such as hourly distribution of internal truck trips in urban areas, truck trip generation by land use, passenger vehicle equivalencies (VEQs), and truck travel demand forecasting and pavement management issues.

Chapter Six gives a brief discussion of computerized data collection techniques for gathering truck travel data. It presents the results of evaluating handheld computers for truck travel data collection.

Chapter Seven presents the conclusions from the analysis of the various surveys and studies mentioned in this report. It includes a list of recommendations for conducting future regional truck travel surveys.

Chapter Two
NATIONAL TRUCK TRAVEL SURVEYS

There are various national efforts to collect large truck data. The purpose is to estimate truck miles traveled mainly for accident risk assessment and energy consumption estimations. Currently, there are four main national truck travel data sources available: the Truck Inventory and Use Survey (TIUS) conducted by the U.S. Bureau of the Census; the 1990 Nationwide Truck Activity and Commodity Survey (NTACS) conducted by the Bureau of the Census for the U.S. Department of Transportation; the National Truck Trip Information Survey (NTTIS) conducted by the University of Michigan Transportation Research Institute (UMTRI); and annual estimates published in *Highway Statistics* by the Federal Highway Administration (FHWA).

Truck Inventory and Use Survey (TIUS)

The Bureau of Census conducts the TIUS every 5 years as part of the Census of Transportation. The samples for the survey are drawn from the R.L. Polk vehicle registration files. The survey is conducted via questionaires mailed to a random sample of truck owners (Massie, Campbell, and Blower, 1993). The questionaires solicits information on the "typical" configuration and operation of all trucks over a 1-year period. Owners are asked to estimate the number of miles traveled with respect to the sampled vehicle, as well as information on the number of trailers usually hauled, type of cargo usually carried, typical weight of a load, etc. As a result, TIUS produces aggregate (state and national level) truck travel estimates and cannot be broken down to reflect operating environments or specific truck configurations. For the 1987 TIUS, a total of 104,606 trucks, including all truck weights[2-1], were sampled. Massie compared the 1982 and 1987 TIUS results with the NTTIS data (Massie *et al*, 1993). The comparisons covered power unit type, gross vehicle weight rating (GVWR) class, cab style, carrier type, and owner-reported annual mileage. Overall, Massie found that there was a good overall agreement between the two sets of survey data.

1990 Nationwide Truck Activity and Commodity Survey (NTACS)

The NTACS was a detailed annual and daily truck activity database for a sample of trucks covered in the 1987 TIUS. The data was collected at randomly selected days over a 12-month period ending in October 1990. The results of the survey were presented in a summary report (Oak Ridge National Laboratory, 1993). Unlike the TIUS which reported only annual data, the 1990 NTACS asked truck operators to report daily, as well as annual data. The purpose was to capture temporal and geographic variations in truck travel and other trucking characteristics beyond the scope of the TIUS. The 1990

[2-1] TIUS and NTTIS excludes ambulances, open utility vehicles, motor homes, buses, farm tractors, and government-owned vehicles.

NTACS sampled 44,002 trucks, a subsample of the approximately 105,000 trucks from the 1987 TIUS. The trucks were stratified by geographic division, types of haul, and truck classification. The survey was a mailout-mailback type survey (the survey instrument can be found in **Appendix I**). Respondents were asked to report trip activities for 2 selected days in a 4-week period. The survey response rate was around 77.9 percent, with 104,601 trucks responded, representing 9,794 operators. Because of initial low item response rate, two mail and one telephone follow-ups were conducted. Due to the high cost of telephone follow-ups, the use of certified mail responses was implemented. Certified mail proved to be the most cost effective method and improved not only response rate, but item non-response as well. The survey analysis included the estimated population of four year and older trucks, with an adjusted estimate which included trucks under four years old. It also included estimated annual miles traveled, daily miles traveled, and distribution by truck type. The survey excluded vehicles owned by Federal, State, or local governments, ambulances, buses, mobile homes, farm tractors, unpowered trailers, and trucks sold prior to 1987 and disposed of prior to July 1, 1986. The NTACS, however, suffered from high item nonresponse and data inconsistency problems. The report warns that it should be used with caution.

UMTRI National Truck Trip Information Survey (NTTIS)

From November 1985 to February 1987, the Center for National Truck Statistics of the University of Michigan Transportation Research Center (UMTRI) conducted a 15-month National Truck Trip Information Survey (NTTIS) of medium and large trucks. The results were summarized in three separate TRB articles (Campbell, 1986; Massie *et al.*, 1993; Massie *et al.*, 1993). Like TIUS, the NTTIS drew its sample from the R.L. Polk vehicle registration files and obtained most of its information through telephone interviews with truck owners. Mail versions of the interview forms were used only if the interview could not be completed by phone (see **Appendix II** for sample of questionnaire). In contrast, however, NTTIS was based on actual trips made by truck drivers, not a characteristic of "typical" trips as in the case of TIUS. Only commercial vehicles with a gross vehicle weight rating (GVWR) greater than 10,000 lb. were sampled.[2-2] The sampling frame was stratified by state, and within each state, straight trucks were sampled separately from tractors. A total of 8,144 trucks were selected from the R.L. Polk registration list to form the survey sample. Out of the 8,144 trucks, 564 of the samples were determined to be unusabled. Of the resulting 7,580 cases, 6,305 interviews were completed, with a response rate of 83.2 percent and a refusal rate of 3 percent. NTTIS included truck information by road type, area type, and time-of-day. Moreover, information on truck configuration, number of trailers, carrier type, cab style, fuel type, cargo body style, cargo type and weight, number of truck axles, power unit, driver age and experience were all obtained from the survey. The data were organized into three separate data files: a truck file, a truck-tractor trip file, and a straight truck trip file (Blower and Pettis, 1988). The truck file contains information on the vehicle,

[2-2] TIUS and NTTIS excludes ambulances, open utility vehicles, motor homes, buses, farm tractors, and government-owned vehicles.

company (owner), and annual mileage, with one record per vehicle. The tractor and straight truck files contain trip information, one record per trip for each trip taken by the surveyed vehicle.

A sub-sample of 2,511 straight trucks and 2,501 tractors were drawn to collect detailed 24-hour truck travel information for a designated day. Phone calls were made, typically the day after the survey day, to the drivers or owners to obtain detailed trip information. The trips were traced on specially prepared maps based on the Rand McNally *Road Atlas* maps, and mileage was broken down by road type, rural/urban, and day/night. The overall response rate for the 24-hour truck trip survey was 93.7 percent (4,789 out of 5,112 truck surveyed, including vehicles not in-use). The response rate for vehicles in-use, however, were 88.2 percent for straight trucks and 84.6 percent for tractors.

The NTTIS data found that straight trucks outnumbered tractors in the national large-truck population by about 70 percent to 30 percent. The annual miles of travel, however, was nearly the reverse. Tractors logged in 68 percent of the total miles traveled and straight trucks only 32 percent. The survey also found that the average annual mileage of a tractor was 5 times that of a straight truck (41,176 miles compared to 8,231 miles). Trucks by configuration found that single tractors logged in 63 percent of the total annual mileage, straight trucks with no trailers 30 percent, and bobtails, doubles, and straight trucks pulling trailers together accounted for only 7 percent of the total large-truck travel. Truck travel by road type revealed that less than 20 percent of straight trucks to more than 72 percent of doubles traveled on limited access roads. Conversely, travel on arterials dropped from 42 percent for straight trucks to 20 percent for doubles. Truck travel by time-of-day showed that all truck configurations log in far more miles during the day than at night. The distribution, however, varied. Straight trucks made less than 3 percent of their trips at night, and doubles made less than 40 percent for the same period.

In summary, Massie concludes that truck travel varies by truck configuration, road class, time-of-day, and population area. Secondly, large trucks vary widely in their physical configuration, which in turn affects their risk of accident involvement. The authors state that the diversity of trucking operations underscores the importance of reliable truck travel data in any analysis that seeks to determine the relative safety of one class type versus another.

FHWA *Highway Statistics* Reports

Each year, the Federal Highway Administration (FHWA) compiles all state transportation statistics and publishes an annual national *Highway Statistics* report. The report categorizes truck travel by vehicle class and road type. The *Highway Statistics* report includes data on government-owned vehicles and commercial vehicles registered in Alaska and Hawaii. The data are provided by state DOTs and are mainly aggregate data. Mileage data submitted by the states are based on traffic counts of 13 vehicle classes on 12 selected types of road. Counts are often conducted manually or by

automated vehicle counters. Massie cited that manual and automated counts are both problematic due to human counting error and defective automated detectors (Massie *et al*, 1993). Because trucks represent a small portion of overall traffic, counting errors can lead to large percentage errors in vehicle classification estimates. Second, in a recent discussion of *Highway Statistics* estimates for large trucks, Mingo cited several indications that the estimates are too high (Mingo, 1991). Third, state classification systems tend to vary. This makes it especially difficult for cross-referencing and comparisons. Fourth, state counts are conducted only on weekdays. They do not take into account day-of-week variations in truck travel. Overall, Massie concluded that the FHWA *Highway Statistics* systematically overestimates truck travel. Moreover, it is plagued by data collection and reporting errors.

Chapter Three
TRUCK SURVEYS AND TRUCK TRAVEL DEMAND FORECASTING EXPERIENCES IN METROPOLITAN AREAS

During the 1960s, there was a major national effort to collect truck travel data through Federal sponsorship of roadside surveys. In the past two decades, however, Federal support has waned because of high data collection costs and safety problems associated with protecting survey crews during the data collection process. Consequently, commercial vehicle trip data have been downplayed in many metropolitan areas and have become less important and more difficult to obtain. Recent estimates, however, reveal that commercial vehicle trips account for 10 to 30 percent of the total trips, with many of the trips originating from or destined to outside the metropolitan areas (INCOG, 1990; Schlappi, Marshall, and Itamura, 1993). Furthermore, many of the heavier trucks have been found to account for over 30 percent of the total vehicle miles traveled (VMT) in metropolitan areas (Schlappi *et al*, 1993). Very little is known about the 10 to 30 percent of commercial trips traveling within a metropolitan area. Traditionally, truck trip estimations were merged with total vehicle trip estimations and simply represented as a certain percentage of the total trip estimates. The percent of truck trip estimates used for forecasting may be based on a rate derived from vehicle classification counts, or a percentage selected and based on a planner's best judgment or intuition. Only recently has there been a national trend to collect new truck trip data and develop new techniques for forecasting truck travel in metropolitan areas.

There are numerous papers and studies on urban goods and freight movement. Most are related to specific problems or issues, such as cost, congestion in downtown, inter-city or inter-state goods movement, etc. Few, however, deal with developing regional travel models to forecast truck traffic in metropolitan areas. During the 1960s and 70s, several truck surveys were conducted, and survey procedure manuals were produced with funding from the U.S. Department of Transportation, Bureau of Public Roads. The metropolitan areas that have conducted truck surveys in the 1960s and 70s were the Tri-State Transportation Committee of Connecticut (1964), New Jersey, and New York, the Upstate New York Transportation Studies (1964), the Indiana State Highway Commission (1970), the Chicago Area Transportation Study (1970), and the Bay Area Transportation Study Commission (1965). Unfortunately, few of the survey results have been published. Chicago and Phoenix seem to be in the forefront of metropolitan areas that have published their survey results and developed models and methodologies in forecasting truck travel. Outside of the U.S., Canada - Calgary (1971), Vancouver (1988), and Ontario (1978, 1983, and 1988) - and Australia (1977-78) has also conducted numerous commercial vehicle surveys.

TRUCK SURVEY MANUALS

FHWA Urban Origin-Destination Survey Guide

In 1944, the Bureau of Public Roads (now Federal Highway Administration) published the first procedural guide for conducting origin-destination surveys. Revised editions were published in 1946, 1954, and 1973. The latest revision *Urban Origin-Destination Surveys* was reprinted in 1975 (FHWA, 1975). Chapter 5 of the 1975 survey guide included guidelines on conducting internal truck and taxi surveys. It discussed sampling frame, sampling procedures, interviewing techniques, and some survey management issues. The guide included a sample of typical survey questionnaire. A sample set of instructions is included in the appendix. This document is merely a guide and is not intended to serve as a manual.

Tri-State Transportation Committee

The Tri-State Transportation Committee, in cooperation with the three States of New York, New Jersey and Connecticut, conducted a goods movement - external truck survey in 1963-64. The study involved studying the movement of people and goods within the 8,000 square mile Tri-State area. A truck survey procedure manual was produced (Tri-State Transportation Committee, 1964). The manual documented the data collection procedures for the survey interviewers. The truck survey involved conducting roadside interviews of trucks registered within the region, as well as commercial vehicles crossing the cordon line. Interview stations were selected at 22 routes. The types of information collected from the survey include commodity, weight, length-of-haul, and origin-destination information. Approximately 480 interview hours and at least 3,000 interviews were planned. During the roadside interview, a separate vehicle classification count was also conducted at the location of the interview station.

Upstate New York Transportation Studies

In 1964, the Upstate New York Transportation Studies produced a truck and taxi survey manual (Upstate New York Transportation Studies, 1964). The manual was written for telephone interviewers. The vehicle owners, drivers, or fleet dispatchers were contacted by phone and asked to participate in the survey. The interviewers were encouraged to directly survey the driver of the vehicle being sampled. The survey was conducted to collect trip information on origin and destination, beginning and ending times, trip purpose, land use at trip ends, volume and description of the cargo hauled, whether expressways were used, whether the vehicle crossed the screen line, and whether intermediate stops, if applicable to a particular trip, were made. The survey was conducted over a 3-month period.

Indiana State Highway Commission

In 1970, the Indiana State Highway Commission produced a truck-taxi survey manual for planning areas within the state (Indiana State Highway Commission, 1970). The manual included a sample ratio table based on the population of the study area to be surveyed. The manual recommended obtaining the sample population from the Bureau of Motor Vehicles. From this list, vehicles garaged outside of the study were to be eliminated and publicly owned vehicles included. In general, it recommended that for a study population of over 1 million, a minimum of 2 out of every 25 trucks (an 8 percent sample), should be surveyed. Each selected vehicle owner should be contacted by mail to inform them of the survey and to solicit cooperation. The next step is a face-to-face interview with the respondent. The preliminary interview would include the delivery of the trip log and a full explanation of how to complete it. Next, the actual interview is scheduled with the respondent in which the trip log is collected and reviewed with the respondent. The survey data collection would include vehicle type, classification, origin and destination information, trip beginning and ending times, cargo description, and approximate daily mileage.

CHICAGO AREA TRANSPORTATION STUDY

In the 1970s, the Chicago Area Transportation Study (CATS) began developing separate trip forecasting models for passenger vehicles and commercial vehicles. It was one of the first of such efforts in the country. There was a recognition that commercial vehicles had very different travel characteristics than passenger vehicles and that their impact on the urban roadways necessitated a separate approach and technique in forecasting future trips. In addition to the 1970 Origin-Destination Household Survey, a separate commercial vehicle survey was conducted to collect data on truck travel characteristics. The 1970 survey consisted of field interviews of owners or operators of vehicles drawn at random from the state's motor vehicle registration database. The respondents reported data on origin-destination, commodity and goods movement by weight. The data provided CATS with the ability to model passenger and commercial vehicle trips through the 1970s and the early 1980s. As a result of CATS's modeling efforts, two reports based on the 1970 data were published. One was written by Southworth and Chon (1981) and another by Southworth, Lee, Griffin, and Zavattero (1983). The former looked at vehicle emissions of trucks, and the latter was on truck/freight planning for the Chicago region. The Southworth and Chon report documented the methods used to estimate regionwide truck emissions in the Chicago area (Southworth and Chon, 1981). The analysis relied heavily on the 1970 CATS Commercial Vehicle Survey data to produce truck trip estimates for the emissions model input.

In 1986, CATS began to update their commercial vehicle data. The 1970 data on commercial vehicles were determined to be dated and did not represent commercial vehicle travel at the time. Changes in commercial vehicle activity, coupled with major

revisions to rules and regulations (Motor Carrier Act of 1980) convinced CATS that new data were needed. In the early 1980s, CATS experimented with statistical techniques to create an acceptable formula to indirectly estimate truck travel. The effort, to conserve time and resources, was unsuccessful. As a result, there was a recognition that new data was needed. However, the scale of resources committed to the 1970 surveys was not available. As a result, a more cost-conscious commercial vehicle survey was conducted in 1986 to provide updated truck data. The survey process and results are documented in two reports. The first report presents the details of administering the survey (Rawling and Reilly, 1987), while the second documents the results (Reilly, Rosenbluh, and Rawling, 1987).

Survey Methodology

The 1986 CATS Commercial Vehicle Survey was based on a random sample of registered commercial vehicles in the state Department of Motor Vehicles (DMV) database. Vehicle counts by license plate types were obtained with the cooperation of the Secretary of State's Office. The population to be surveyed was obtained from a random sample of seven counties by three license plate types: (1) weight plates, (2) mileage plates, and (3) International Registration Plan (IRP) plates. The total population for the 1986 Commercial Vehicle Survey was determined to be 359,383 vehicles. There were 305,183 weight and mileage plate vehicles and 50,400 IRP plate vehicles registered in northeast Illinois. An addition to the 1986 survey, not included in the 1970 survey, was the sampling of the utility vehicle fleet. This included a sizeable number of vehicles that had fixed assignments and routes and made fixed number of trips (postal service vehicles, gas company trucks, etc.) The 1986 CATS survey included, for the first time in a commercial vehicle survey in the U.S., school buses and U.S. Postal Service (USPS) vehicles. The school buses survey results were summarized in a separate report and will be discussed in the section on *methodological issues* (Rawling and Reilly, 1987). The USPS operated 3,800 vehicles in the northeast Illinois area, the largest fleet of any operator. The following groups of vehicles, however, were not included in the survey:

- M-plates (municipal and other local government fleets);
- U-plates (State of Illinois vehicle fleet);
- federal and military vehicles;
- taxis, commuter vans, dealership vehicles;
- ambulances and tow trucks;
- vehicles registered outside the six northeast Illinois counties.

The weight, mileage and IRP plate vehicles were grouped into the following weight categories:

(1) *B* license plates (vans, pick-ups and panel trucks of 8,000 lbs. or less of gross vehicle weight);
(2) *Light* vehicles (D to J, MD to MJ plates, 8,001-28,000 lbs. GVW);

(3) *Medium* vehicles (K to T, MK to MT plates, 28,001-64,000 lbs. GVW);
(4) *Heavy* vehicles (over 64,000 lbs GVW).

To provide a profile of trips generated and destined to different land uses, survey respondents were asked to provide land use data. The eleven land use categories coded from the survey results are:

- Residential
- Retail
- Manufacturing
- Terminal/Warehouse
- Public/Government
- Office/Service
- Construction
- In Transit
- Landfill
- Agricultural
- Other/Missing

The survey was administered in January and February of 1986. January 21, 1986 was the target date set for weight and mileage plates. February 25, 1986 was the target date for IRP plates. The survey spanned fifteen months and cost slightly over $200,000.

Survey Data

The sample was weighted to ensure that each weight group was represented. The *B* weight group was sampled at 2 percent because B trucks represented 66.9 percent of the total commercial vehicle population. The *light, medium,* and *heavy* vehicles were sampled at 6 percent, and all IRP trucks (approximately 85 percent are heavy trucks) were sampled at 10 percent. This was to ensure a usable return of sample vehicles working in the area. For the USPS fleet, 129, or 3.4 percent of the 3,800 vehicle fleet, was sampled. An effort was made to find an equal distribution of USPS vehicles according to vehicle types and geographic areas for which the USPS fleet serves. After a month-long letter and telephone campaign to major IRP operators, CATS failed to reach 34 companies (operating 881 vehicles) and was refused by seven companies (operating 176 vehicles). A composite summary of the sample size distribution and return rates is shown in (**Table 3-1**).

The data was coded by trip frequency, distance, purpose, land use, etc. The trip end and the addresses were geocoded to the section (square mile) level of the range-township system and the 1,542 CATS zone system. Information for the USPS vehicle fleet was taken directly from the USPS operations management and converted into the standard trip diary format.

Table 3-1. 1986 CATS Commercial Vehicle Survey Sample Size Composite Summary

Vehicle Class	Class Total	% Total	No. of Samples	% Sampled	Samples Returned	% Returned
B trucks	240,600	66.9	4,748	2.0	310	6.5
Light Medium Heavy	68,383	19.0	4,067	5.9	811	19.9
IRP	5,038	14.0	5,038	10.0	2,256	44.8
Total	359,383	100.0	13,853	3.9	3,377	24.4

Source: CATS 1986 Commercial Vehicle Survey (Rawling and Reilly, 1987)

Prior to estimating the number of commercial trips for the study area, the CATS researchers felt it important to exclude, for travel estimating purposes, two groups of vehicles: (1) those solely in personal use, and (2) vehicles in commercial service but not in service on the survey date. First, B plate vehicles for personal use were removed from the analysis and assumed to have been represented in the home interviews as personal use vehicles. Second, the "working population" of commercial vehicles were identified for the analysis. "Working population" is defined as "vehicles reported to have no work on the survey date [including] those out of service, sold or for sale, in for repair, only used on site, in seasonal use, or registered to a company which was out of business" (Reilly, Rosenbluh and Rawling, 1987). The study was unclear, however, on whether vehicles which had "no work", but had the potential to make trips, were included in the analysis. In the report (Reilly *et al*, 1987), the graphs, showing the distribution of trip frequency by vehicle class, did not present data for trucks that made no trips on the survey day. Omitting trucks that did not, but had the potential to make trips on the survey day would skew the analysis and overestimate the number of trips generated.

Survey Instrument

The CATS Commercial Vehicle survey instrument was designed to meet three criteria:

(1) A physically manageable and convenient product;
(2) A device that made the least personal demand on the respondent (considered most likely to be the driver), and

(3) A format that would obtain the desired data in way that could be coded and processed efficiently.

A small portable logbook format, postage-paid mailback provision, and self-adhesive seals were designed to make the survey more manageable and easier to administer. A total of 17,834 surveys were mailed or hand-delivered. A sample of the survey instrument used can be found in **Appendix III**.

Truck Model Output

The data from the surveys were used to calibrate the truck models for *present* and *future* scenarios. The following were the types of outputs that were created from the truck models:

- Separate and combined absolute 24-hour volumes for heavy, medium and light commercial vehicles;
- Separate and combined volumes for truck weight types, with VEQs applied;
- Separate and combined volumes for truck weight types, as a percentage of all vehicles (with or without VEQs applied);
- Volume/capacity (v/c) ratio.

Study Findings

The 1986 CATS Commercial Vehicle Survey produced the following conclusions:

- Twenty-six percent of the usable returns showed trips originating in a county different from the county of registration. The study also found a high level of reciprocity, in which a truck trip found originating in a county different from the county of registration was offset by another trip originating from within the county and registered in another.
- B trucks made more residential trips than any other truck category (probably due to the close association between B trucks and personal use). Of the B plate vehicles reported, 21 percent were in personal use. The state vehicle registration files also showed that a large number of B vehicles registered to names of individuals as opposed to companies or corporations.
- Almost three-quarters, or 73.8 percent, of all IRP vehicles were from outside the six-county study area; 7.5 percent were non-operational on the survey day. Only 18.7 percent of IRP vehicles surveyed were in use within the study area during the survey day.
- With the exception of heavy trucks, trip frequency increased with vehicle weight. B trucks made on average 6.9 trips per 24-hour period, and medium trucks made 9.3 trips for the same time period.
- Heavy trucks made much longer trips (24.9 miles), compared to light trucks (9.6 miles); 7.5 percent of heavy trucks had an average trip length of over 60 miles.

- Weighing the average trip frequency and trip length by the number of working vehicles in each class, the study found that almost two-thirds, or 65.2 percent, of all commercial vehicle miles of travel were made by B trucks. When weighing the average trip frequency and trip length by the number of working vehicles in each class **and** by the appropriate vehicle equivalency (VEQ) factors, the results showed that almost half, or 49.1 percent, of all commercial vehicle equivalent miles of travel were made by B trucks. Comparatively, heavy trucks, commonly perceived as having the major impact on VMT, accounted for 28.1 percent of the VEQ miles traveled and only 12.4 percent of the actual VMT.
- B class truck trip ends dominated all land uses, except for the landfill and in-transit categories.
- Retail attracted many more B class, light, and medium truck trips. This is perhaps due to the fact that light or medium trucks are more suitable for delivery than heavy trucks.
- A strong relationship existed between heavy trucks and terminal/warehouse land uses; 42.6 percent of heavy trucks were destined to terminal/warehouse facilities.
- Heavy trucks were also found to dominate the "in transit" category. Of all the heavy trucks, almost 9 percent were found to be "in transit", i.e., leaving the region. Of all the commercial vehicle trips in the "in transit" category, 44.8 percent were made by heavy trucks.
- There was a greater concentration of trip ends in the Chicago area. Trips decreased as distance increased from the Chicago core area. Heavy truck activity concentrations can be found in west Cook County and northwest Cook County in the vicinity of the O'Hare Airport.
- Commercial vehicle activity concentrated in certain satellite centers radiating outward from the Chicago area.
- There was a forecasted increase of 52 percent of commercial B plate vehicles and a 10 percent increase for heavy trucks from 1986 to 2010. This means that there would be an overwhelming increase in real vehicle numbers, from 240,000 to 365,700, of B plate vehicles. Chicago Freight Advisory Committee members and freight consultants revealed that there was a growing proliferation of small commercial vehicles. This was because smaller vehicles were more maneuverable, cheaper, disposable after a few years of use, did not require special driver training, could be driven home with the driver, and did not require special garaging. They were more suitable for the growing service, air freight, fast food, electronics, security, laundry and dry cleaning industries. Small commercial vehicles were advantageous for a wide range of quick-response, just-in-time businesses, with high value/weight products such as the financial and legal records delivery industries. The projected steady increase in heavy truck registration, on the other hand, was attributed to a steady trend for truckload activity (economy of scale).
- A need exists for the development of a coding scheme on restricted links for trucks in the modeling network. Since commercial vehicles are converted to

passenger vehicle equivalents, it was difficult to identify which trips were truck trips and exclude them from being assigned to some routes where, in practice, they were forbidden by law.

Over the last two decades, CATS has developed and refined the truck travel forecasting effort. Many studies since have cited CATS's pioneering efforts in truck travel forecasting. Since the 1986 CATS survey, several reports have been written based on the data and findings of the commercial vehicle survey (Englund and Ryan, 1986; Stenzel, 1986; Reilly, Rosenbluh and Rawling, 1987; Rawling, 1987; Rawling 1988; Rawling and DuBoe, 1991). These analyses ranged from corridor/route analysis, the effects of toll facilities on truck route choice, creating separate truck origin-destination matrix tables, and truck speed simulation models to truck trip mapping (i.e., the representation of truck activity on a regional or subregional network). CATS argued that having a proper profile of the motor freight industry was essential for planning purposes. As an example, CATS was able to target the trucking industry as part of a public information program/traffic mitigation project associated with the I-94 Dan Ryan reconstruction project (Rawling, 1988). CATS contended that having a good profile of the freight industry was useful in maintaining the necessary public-private dialog that helped minimize construction impacts for the project.

PHOENIX

In 1991, the Arizona Department of Transportation, Transportation Research Center, funded a commercial vehicle travel survey within the Phoenix metropolitan area. The study was conducted by Cambridge Systematics, Inc., Cambridge, Massachusetts. The primary objectives of the study were to collect truck travel data to develop commercial vehicle trip generation, trip distribution, and traffic assignment models. The models were developed to be incorporated into the Urban Transportation Planning System-based travel model maintained by the Maricopa Association of Governments (MAG). The methodology for data collection, the types of information provided by the survey, the transferability of the study findings to other urban areas, and model development possibilities are summarized in a final report to the Arizona Department of Transportation (Ruiter, 1992).

Survey Methodology

The survey only included commercial vehicles registered within the MAG study area. Commercial vehicles registered outside Maricopa County were not included in the survey. The purpose of the survey was to develop new models for internal commercial vehicle trips only. Two sources of data were used to determine the total number of commercial vehicles to be sampled. *The Department of Motor Vehicles (DMV)* produced a computerized file of 157,000 commercial vehicles registered in Maricopa County in 1989 (Ruiter, 1991; Ruiter, 1992). The compiled list of commercial vehicles were then stratified by vehicle weight. The entire DMV file was also sorted by zip code before

sample selection. Subsamples were obtained so that vehicle weight categories would be represented for all geographic areas. The sampling strategy was designed to obtain 40 percent sample of light vehicles (under 8,000 lbs) and 20 percent for each of the three remaining weight categories (8,000-28,000 lbs, 28,000-64,000 lbs, 64,000+ lbs). The second was a list of 2,300 vehicles garaged in Maricopa County. All of these vehicles were owned by the U.S. Postal Service (USPS) but were not registered in Arizona. The USPS vehicles were sampled by weight and by garaging location. They all fell into the two lightest vehicle weight category (2,180 in the under 8,000 lb category and 101 in the 8,000-28,000 lb. category). The selection process provided 1 in 40 postal vehicles in the light category and 1 in 10 in the next heavier category.

The data collection method used was a combined telephone and mailout-mailback survey. The telephone survey utilized screening questions, including the question of who the mailout questionnaire should be sent to. After telephone contacts, 37 percent of the sampled vehicle owners agreed to participate in the survey. The mailback questionnaire, which included a 1-day trip diary, was then mailed to the participants (see **Appendix IV** for sample of trip diary packet). The questionnaire was also mailed to owners who could not be contacted by phone. The overall response rate for the mailback survey was 30 percent with 720 responses, of which 527 vehicles (73 percent) made trips on the survey day. USPS travel forms, detailing daily itineraries for 62 selected vehicles, were also obtained from the manager of fleet operations. The information obtained were used to fill out the trip diary.

Survey Data

The telephone survey to the vehicle owners revealed that only 75.7 percent of registered vehicles from the DMV data list were available for use for commercial purposes. The mailout questionnaires used for the truck survey was patterned after the 1986 Chicago Area Transportation Study (CATS) Commercial Vehicle Survey (Rawling and Ryan, 1987). It was designed to obtain the following data for each sampled commercial vehicle:

- Starting and ending addresses for all trips on the survey day;
- Vehicle type based on number of axles and body style;
- Estimated gross weight;
- Vehicle usage for home-based work and work-related trip purposes;
- Total number of one-way trips on the survey day.

In addition to the above information, the travel diary requested the following information on the first 10 one-way trips made by each vehicle on the survey day:

- Start and stop times;
- Stop odometer readings;

- Name and address of each stop;
- Driver and vehicle activity of each stop;
- Land use at each stop; and
- Vehicle type and total axles for each trip (to determine trailer pick-up and drop-off locations.)

Truck Models

Since the survey included information on land uses at trip ends and the MAG zonal data included the number of residents and employment by land use category, it was possible to analyze trip generation rates by land use categories. The five land use categories used in the analysis were retail, industrial, public, office, and other. The equation for the trip rates is:

$$\text{truck trip rate for land use category } i = \frac{\text{study area trips to land use category } i}{\text{study area employment at land use category } i}$$

An additional land use category - residential land - was also included in the survey. Trip rates for trips to and from this land use category was defined as:

$$\frac{\text{total study area trips to residential land}}{\text{total study area households}}$$

The equation for the trip generation models for each vehicle weight category is:

$$TRIPS_{wi} =$$

$$t*TOTHH_i + u*RETEMP_i + v*INDEMP_i + w*PUBEMP_i + x*OFFEMP_i + y*OTHEMP_i + z*RESHH_i$$

where

$TRIPS_{wi}$ = total average weekday commercial vehicle trips for vehicle weight category w originated from and destined for zone or district i;
$TOTHH_i$ = total households in zone or district i;
$RETEMP_i$ = total retail employees in zone or district i;
$INDEMP_i$ = total industrial employees in zone or district i;
$PUBEMP_i$ = total public employees in zone or district i;
$OFFEMP_i$ = total office employees in zone or district i;
$OTHEMP_i$ = total other employees in zone or district i;
$RESHH_i$ = total resident (non group quarters, non temporary, and non seasonal) households in zone or district i.

For consistency with the MAG's models, a gravity model was used to simulate trip distribution. The iterative application of the TRANPLAN gravity model calculation program was used to calibrate the model, supplemented by a spreadsheet to help make manual friction factor adjustments. The model calibration process involved reestimating each friction factor using a correction term equal to the desired fraction of trips in a travel time range divided by the previously estimated fraction in this range. The travel time ranges were selected to ensure that the resulting friction factors would always decrease as travel times increase. Furthermore, a two step adjustment was made to the calibration process to account for vehicle registration under reporting in Maricopa County:

(1) The commercial vehicle trips were expanded by weight class to account for the average number of axles per vehicle in each weight class.

(2) The total commercial vehicle trips were expanded by VMT so as to match the estimated with the observed VMT for the Phoenix region.

Study Findings

The Phoenix Commercial Vehicle Survey produced the following conclusions:

- Vehicles in the lighter weight categories made more trips; 96.6 percent of all commercial trips were made by the two lightest weight categories. The average trips per vehicle for the 8,000-28,000 lb category, for example, was 9.6 trips; whereas, vehicles in the 64,000+ lb category made only 4.0 trips per vehicle.
- Vehicles in the heaviest category made few but long trips. The average VMT per vehicle for the 64,000+ lb category was 156.8 miles, compared to 56.2 miles for the 8,000-28,000 lb category. Vehicles in the heaviest weight category averaged 33.4 miles per trip, compared to 11 or less miles per trip for the lighter weight categories.
- A total of 79.4 percent of the surveyed vehicles were used for commercial purposes.
- Of the total number of vehicles used for commercial purposes, 41.9 percent were also used for travel between home and work.
- Most trucks started their first trip between 6:00 a.m. and 9:00 a.m. This pattern, however, varies by weight category. Light trucks were more likely to start their first trip between 6:00 a.m. and 9:00 a.m. Heavy trucks (51.8 percent), however, started their first trip before 6:00 a.m.
- The peak period for truck travel occurred between 9:00 a.m. and 2:00 p.m. Heavy trucks, however, have a shorter peak period (11:00 a.m. to 2:00 p.m.). During both of these periods, 13 percent of daily commercial vehicle travel occurred.

- In comparison with AM and PM peaks for private vehicle travel, the results found that the AM peak period travel was as important for commercial vehicles as for private vehicles.
- The trucks surveyed made on average 7.7 trips per day. Light trucks made on average more trips (12.1 trips) than heavy trucks (4.7 trips).
- The average vehicle weight per commercial trip was 11,870 lbs.
- Light trucks (8-28,000 lbs) were found to be heavily used for service delivery and personal business. Heavy trucks were most used for loading and unloading cargo at their trip ends.
- Heavy trucks were found to make high proportion of trips (26.7 percent) to residential land uses. Analysis showed that the reason could be that heavy trucks, to a large extent, were used to delivery construction materials, including lumber and ready-mixed concrete to residential construction sites.
- Trucks in the medium weight category (28-64,000 lbs) were also found to make significant proportion of trips to residential areas. These trips were speculated to be largely solid waste pick-ups.
- Over one-third of all commercial vehicles stops were made on-street. Light vehicles made half of their stops on-street.
- The overall average trip time was 28.1 minutes. Trip time generally increased with vehicle weight.

The Phoenix commercial vehicle survey experience also produced a list of requirements and suggestions for model transferability to other urban areas. These requirements and suggestions include:

- A file from the state vehicle registration agency of all commercial vehicles registered to owners in the study area;
- The ability to geocode street addresses to traffic analysis zones (TAZs);
- Current zonal data on households and employment by type of vehicles and land area;
- A matrix of zone-to-zone off-peak highway travel times in the year of the truck travel survey;
- An existing model system to which truck travel models can be added or replaced;
- Estimates of regional VMT by commercial vehicle type and by private automobiles.

In telephone conversations with the planning staff at the Maricopa Association of Governments, sources revealed that the survey data has been used mainly for truck modeling purposes only.[3-1] In the future, the data could potentially be used for intermodal freight planning and to conduct separate truck assignments independent of passenger vehicle assignments.

[3-1] Telephone conversation with Cathy Arthur, Maricopa Association of Governments, Phoenix, Arizona, November 30, 1994.

Although the models developed for Phoenix have done a relatively reasonable job of forecasting truck travel, the study does cite inherent trade-offs between the cost of conducting a truck survey and the precision of the models in forecasting truck travel. It recommends that growing cities in the South and West whose current or expected future levels of truck travel are similar to those in Phoenix can implement a complete transfer of the Phoenix models. It also suggests that adjustments reflective of local conditions is encouraged to improve model accuracy. These changes include:

- Revisions to the trip generation models implemented in FORTRAN to reflect coefficient changes required to match local measures of vehicle registrations or VMT, or both;
- Revisions of the friction factors inputted to the trip distribution models to reflect changes to match local data on average trip lengths.

PORT AUTHORITY OF NEW YORK AND NEW JERSEY

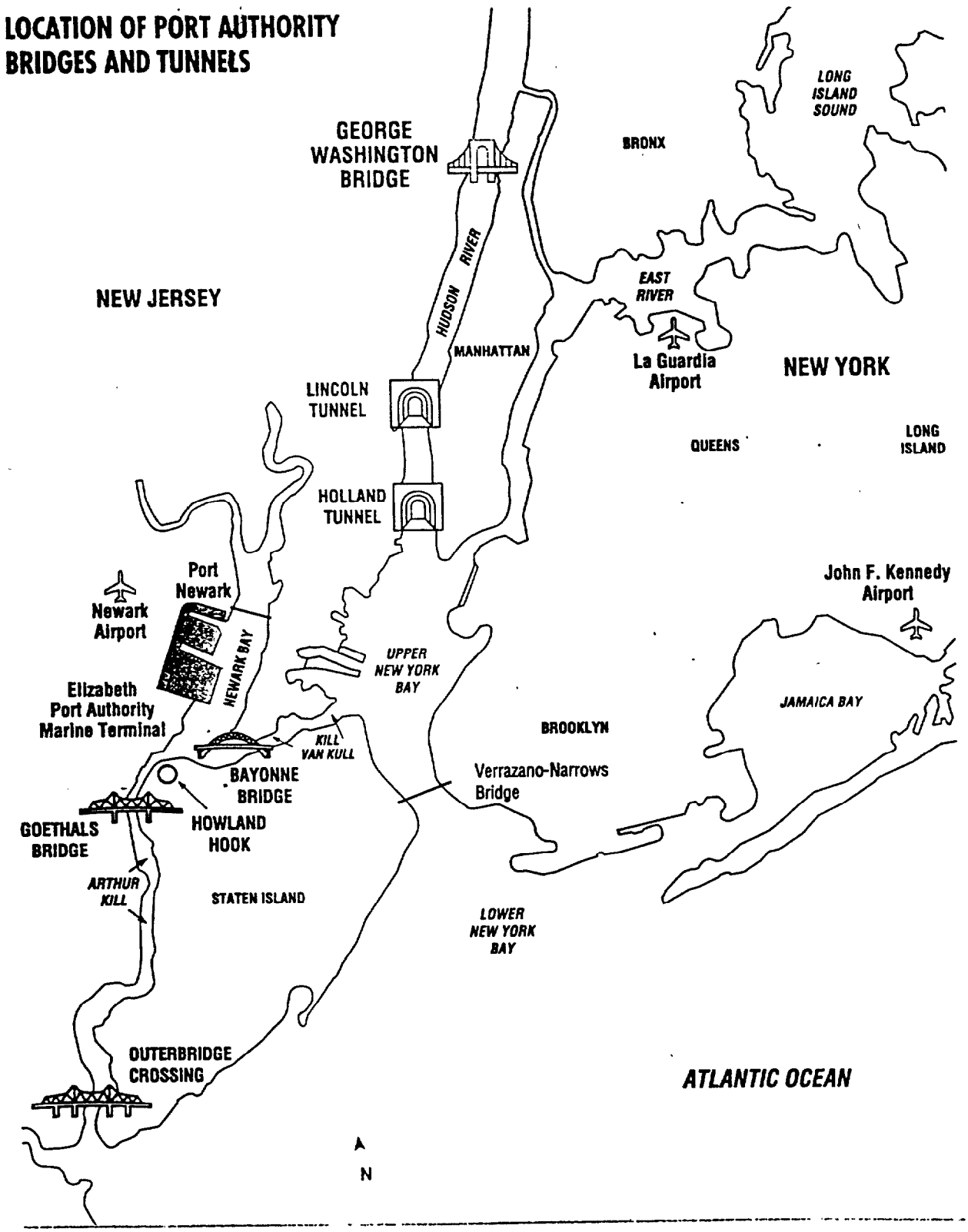
Truck Commodity Surveys

In 1974, 1982, 1985, and 1991 the Port Authority of New York and New Jersey (PANYNJ) conducted Truck Commodity Surveys of trucks traveling eastbound[3-2] on six toll bridge/tunnel crossing facilties. The location of the six crossings - George Washington Bridge, Lincoln Tunnel, Holland Tunnel, Bayonne Bridge, Goethals and Outerbridge Crossing - are shown in **Figure 3-1**. The data collection was part of an ongoing effort to monitor truck traffic passing the toll facilities. Results for the 1974 and 1982 surveys were not available. A final report for the 1985 survey was obtained from the Port Authority, and it summarized the survey methodology and findings (The Port Authority of New York and New Jersey, 1987). A copy of the 1987 Commodity Survey form can be found in **Appendix V.**

Some 15,000 trucks were intercepted at toll queues between November 1984 and November 1985. Trucks with two or three-axles were classified as small trucks, and four or more axles were defined as large trucks. Vans were not included in the survey because the existing toll classification system grouped vans with automobiles. The survey period covered the hours between 4:00 a.m. and 8:00 p.m. Truck drivers were interviewed to obtain information on commodity, trip origin and destination, and the type of facility they were going to. Each interview was completed within 30 seconds to minimize traffic disruption to toll facility operations. A copy of the sample survey form can be found in **Appendix VI.**

[3-2] Westbound data was not collected due to difficulty in stopping trucks and disruption to the traffic flow. Vehicular movement is free-flowing on the westbound direction, with no toll plazas which vehicles can form queues. For these reasons, the survey was limited to the toll direction.

Figure 3-1. Location of Port Authority Bridges and Tunnels



Source: Port Authority of NY & NJ / Interstate Transportation Department / Goods Movement Division

The 1991 Truck Commodity Survey produced the following findings:

- ***Trip frequency***: Most trucks used the Port Authority crossings frequently on a typical weekday. Almost half used one of the crossings at least once a day, and almost 30 percent more than once a week.
- ***Geographic Origin and Destinations***: Two-thirds of the eastbound trucks using the Port Authority crossings began and ended theirs trips within the region, with 85 percent of the total eastbound truck trips terminating within the region.
- ***Facility Origins***: Warehouses were the predominant points of origin - 45 percent of trucks originanted from warehouses. Of the nearly one quarter that originated from factories, nearly 60 percent came from factories within the region.
- ***Facility Destinations***: Most trucks were traveling within and to other warehouses or points of consumption within the region (retail stores, residences). Nearly 40 percent of drivers indicated they were going to warehouses.
- ***Regional vs. Through Traffic***: The majority of the truck traffic served the region. Only about 7 percent of the eastbound truck traffic at the 6 crossings were passing through the region.
- ***Type of Movement***: The most commom type of origin-destination movement was warehouse to warehouse.
- ***Commodity Carried***: Food was the major commodity carried eastbound over the crossings between 4:00 a.m. and 8:00 p.m.
- ***Truck Size***: Truck size was evenly split between small and large trucks.
- ***Peak Period Traffic***: Trucks at the 6 crossings represented an average of 11 percent of the total peak period vehicular traffic. Large trucks accounted for 45 percent of the peak period truck traffic.
- ***Morning Peak Period Traffic***: Over 35 percent of trucks made trips during the morning peak period (6:00 a.m. to 10:00 a.m.). The results, however, vary by individual crossings.
- Close to 80 percent of the trucks were full or partially loaded. Many of the 20 percent "empty" trucks were carrying empty containers.

In summary, the survey findings indicated that each crossing serves specific markets and displays distinct characteristics in terms of eastbound truck traffic. The survey displayed an important recognition that truck travel plays a vital role in supporting the region's economy - supplying manufacturing and service firms, linking ports-of-entry to their inland customers, and supplying consumers in the region. The truck survey was important in analyzing regional economic competitiveness of truck freight. Taste (1994) noted that the critical portions of the area's transportation infrastructure were built before interstate highway standards were developed. Thus, the functional adequacy of the infrastructure to handle modern trucks and tractor-trailers, he maintained, has been a key element in most analyses, especially in terms of regional economic competitiveness.

In 1991, the Port Authority conducted its fourth truck commodity survey. Four reports were planned. The survey, however, produced only one report on the analysis of the George Washingon Bridge (The Port Authority of New York and New Jersey, 199?) due to the lack of funding to complete the other three. The purpose was to understand the goods movement role of the six interstate vehicular crossings in the region's businesses, consumers and import/export traffic. The specific objectives were to use the data to help portray the economic functions performed by the trucks that use the facilities and general goods movement flow within the region. The information that was obtained were used to develop strategies for alleviating peak period congestion and facilitate overall freight movement in the New York - New Jersey area. The most recent commodity survey data was used by the Interstate Transportation Department's Goods Movement Division to evaluate freight initiatives such as the Circumferential Commercial Corridor and the proposed Northern Corridor, a dedicated commercial route. The data was also used by other departments and outside agencies to analyze regional highway network changes such as the opening of I-287 and the Gowanus reconstruction project. Moreover, the data has been incorportated into New York and New Jersey's State Intermodal Plans as required under the Intermodal Surface Transportation Efficiency Act (ISTEA).

The survey was conducted on December 10, 1991, and over 4,500 truck drivers were interviewed. The sample represented 35 percent of the total truck toll transactions recorded for that day. Each interview was completed in less than 1 minute and 15 seconds, minimizing disruption to traffic on the bridge. The data were considered typical of weekday traffic. For comparison purposes, the 1991 survey employed the same methodologies used in the 1985 Truck Commodity Survey. Similar types of information were gathered via interviews with truck drivers. The only difference was the incorporation of a series of "reverse trip questions" during the interview process. Since westbound information was not collected for the 1985 survey, the 1991 survey attempted to collect information for return trips. The analysis included truck traffic through and within the region, marine terminal and airport traffic, trucks to Manhattan, Long Island, etc.

The preliminary findings from the George Washington Bridge survey seemed to suggest a shift towards using more large trucks. This was found especially true for the food industry. The report cited that other freight research have shown the shift because of more cargo carrying capacity of larger and wider trucks. The reverse trip findings revealed that nearly half of the trucks interviewed returned empty. Moreover, 73 percent of the truck drivers interviewed in the toll direction indicated that they used the George Washington Bridge on the reverse trip. The survey also found that "through" traffic seemed to avoid the peak period. The overnight, off-peak period (8:00 p.m. - 6:00 a.m.) had the largest percent of "through" traffic. Only 8.7 percent of the morning peak truck traffic was "through" traffic, and 13 percent for midday.

Truck Cordon Surveys

From 1992 to 1994, the Port Authority also conducted three Truck Cordon Surveys at 18 locations (See **Figure 3-2**). The surveys were separated into two phases:

- Phase I (1992): at 3 locations; and
- Phase II (1993/1994): at 15 locations.

The latest survey, being completed in Spring 1994, was a bi-state, multi-agency funded effort. The survey cost was $312,000[3-3] with partnership from the New Jersey Department of Transportation (NJDOT), the New York Metropolitan Transportation Council (NYMTC), and the Port Authority of New York and New Jersey. According to the Port Authority, the latest surveys were conducted at 18 locations with 3 interviewers per toll plaza for 24 hours.[3-4] Out of a total of 38,823 trucks that crossed the Port Authority bridges during the survey period, 14,671 were surveyed. The sampling rate was 37.8 percent. The cost per completed survey came to around $21. The lower cost is a result of higher interviewer productivity. Because the surveys were relatively short to complete (around a minute), each interviewer can survey as many as 40 to 50 surveys per hour. Thus, the number of surveys an interviewer is able to complete is a function truck volume passing through the interview site. The greater number of trucks passing through the interview site, the greater number of surveys the interviewers are able to complete.

In May 1994, a paper was presented at the Transportation Management Conference/Workshop at the State University of New York (SUNY), Graduate Program and International Transportation Research Center (Taste, 1994). The paper detailed the basic issues of a truck driver interview surveys from experiences learned from the Port Authority of New York and New Jersey. The paper stated that good truck data on origin and destination, vehicle type, and commodity flow, will be essential in establishing quantifiable performance measures in formulating Intermodal Management Systems as required under ISTEA.

The paper presented a few issues to be resolved before conducting a field truck driver interview at toll plazas. The following is a summary of a few important points:

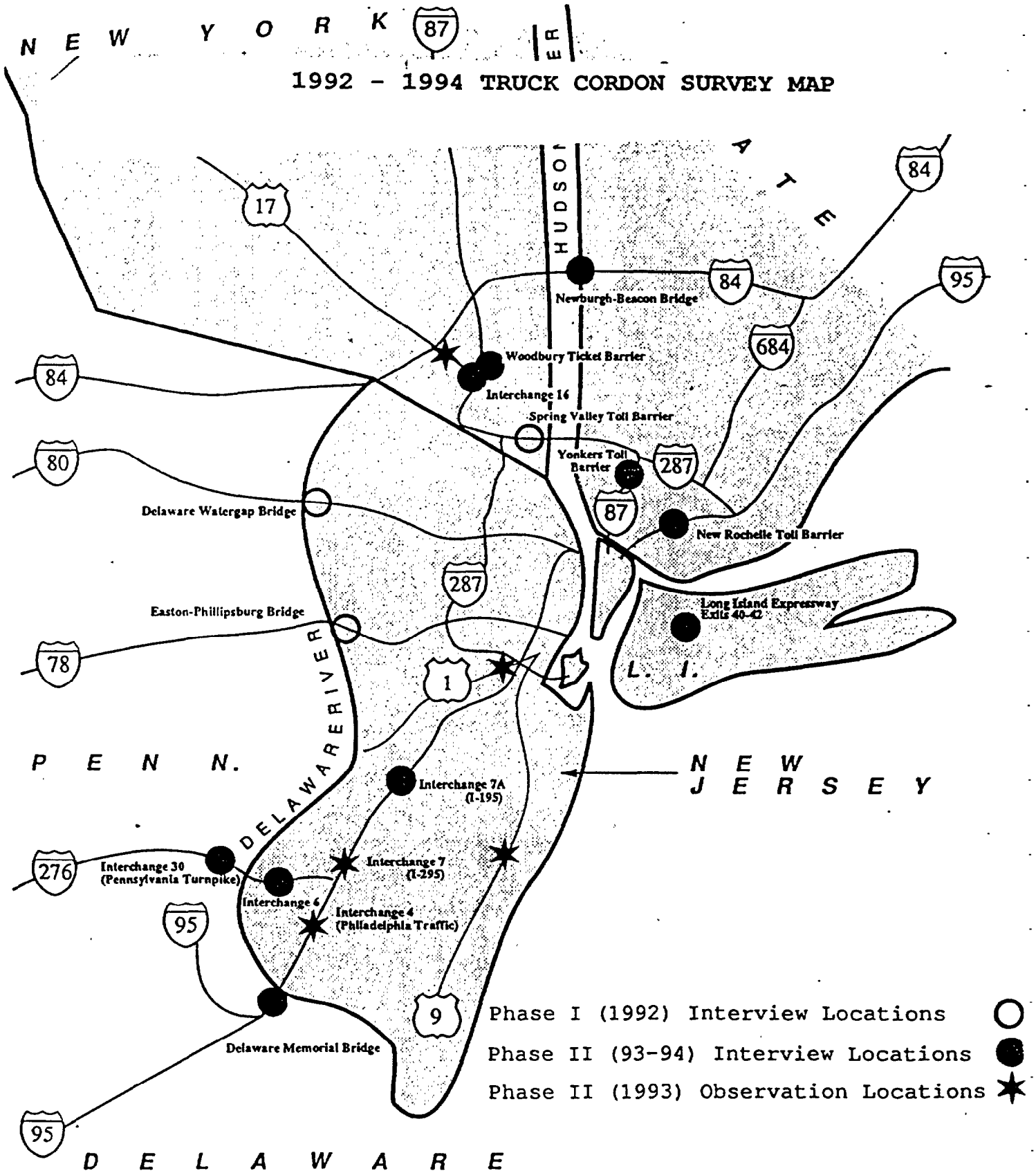
- Obtain official permission to conduct survey.
- Determine manpower estimates (typically by examining toll transaction data).
- Field trip to site and meet toll plaza operations supervisor and staff.

Two types of survey instruments were presented (see **Appendix VII**). The first dealt with "reverse trip" questions for interviews conducted for one traffic direction only

[3-3] The cost only included survey design, data collection and reporting. No analysis was included in the survey cost.

[3-4] Information from Ron Taste, Transportation Planner, Goods Movement Division, Interstate Transportation, Port Authority of New York and New Jersey, December 1994.

Figure 3-2. 1992 - 1994 Truck Cordon Survey Map



(typically the toll direction). The second dealt with "facility type" questions for imtermodal information. In summary, the Port Authority suggests keeping the field interview at toll plazas under one minute to minimize traffic disruption. Furthermore, because of time constraints, the sequence of questions is also important. The survey form should be well designed to work in the dark and in poor weather conditions. The questions should be precise and clear to solicit the proper responses without further explanation from the interviewer.

EL PASO

The Texas Department of Transportation (TxDOT) and the City of El Paso Metropolitan Planning Organization conducted a Travel Study of the El Paso County area in the summer of 1994. The Travel Study was comprised of six separate surveys: the External Travel Survey, the Home Interview Survey, the Workplace Survey, the Special Generator Survey, the Commercial Truck Survey, and the Air Quality Survey (Barton-Aschman Associates, Inc., 1994). Because El Paso County has been identified as a serious non-attainment area for ozone and a moderate non-attainment area for carbon monoxide by standards established by the 1990 Clean Air Act Amendments, and because trucks can be major emitters of pollutants, the Commercial Truck Survey has been a major element of the El Paso Travel Study. The collected data were intended to meet the data requirements for both travel demand and air quality modeling within the El Paso area. A draft report has been produced which includes a brief description of the survey methodology, the survey instructions and instrument.

The Commercial Truck Survey only included trucks registered in El Paso County. Trucks registered outside of the County would have been surveyed in the External Survey. Furthermore, non-commercial light-duty trucks were also excluded from the survey. The survey sample was drawn from the database of Texas Vehicle Information and Computer Services, Inc. (TVICS). This private firm provided the vehicle list by address of owner, type of vehicle, and the gross vehicle weight. Only commercial vehicles registered in the County with a GVW of 8,500 lbs or greater were selected. The TVICS list provided 5,000 commercial of which 2,511 vehicles met the weight criteria. Out of the 2,511 vehicles, 441 were selected to participate in the survey. To avoid oversampling large owners/operators, only 1 out of every 5 trucks were included in the survey for multiple truck ownership. Each selected truck owner/operator was telephoned to solicit participation and requested to record trip information for a specific 24-hour period. Reminder calls were made to the participants one or two days prior to the appointed survey day. Telephone interviews were conducted the day after the assigned travel day to collected the requested information. The actual survey was conducted between June and July 1994. The survey obtained truck travel information on trip origin and destination, trip start and end times, trip purpose, land use at trip ends, truck weight and size, odometer readings, fuel type used, and the business type of the owner or operator. Moreover, "key facility" route information were collected for each trip to

provide basic routing information that can be used to validate truck assignment procedures. A copy of the survey instrument can be found in **Appendix VIII**.

The survey produced a response rate of 42.6 percent with 188 completed and usable questionnaires. The draft report cited that some of the owners said they were too busy to return the questionnaires (Barton-Aschman Associates, 1994). Many, however, preferred to return the forms by mail rather than spend time on the phone to report the requested information. Furthermore, the consultants speculate that the lower response rate might be the fact that the person who agreed to participate was generally not the truck driver. At the time of this report, the results from the survey were not yet available.

NORTH CAROLINA

At the time of this report, the North Carolina Department of Transportation is currently planning for a truck survey in the Triad Area (Greensboro-Winston Salem-High Point). A survey pretest has been completed, which yielded travel information on 500 commercial vehicles. The total cost of the pretest was approximately $92,400.[3-5] The analysis has not be completed, and no information was available. Only a copy of the survey instrument was obtained (See **Appendix IX**).

HOUSTON-GALVESTON

The Houston-Galveston Area Council (H-GAC) has just completed a commercial vehicle survey in November 1994. The survey was conducted by Wilbur Smith Associates. The survey obtained travel information for commercial vehicles with a gross vehicle weight (GVW) of 6,000 lbs or greater and for-hire passenger vehicles such as taxis, limousines, and vans (Wilbur Smith Associates, 1994). The data will be used to estimate truck travel in the region as an input to the regional travel demand model. A random sample of commercial vehicles with GVW of 6,000 lbs or greater were drawn from the Department of Motor Vehicles' registration list.[3-6] A separate database of for-hire passenger carriers were used to obtain the sample for the for-hire passenger vehicle survey. Public transit operators and private fixed-route operators were excluded from the for-hire passenger vehicle survey. The selected sample was designed to obtain 500 useable truck surveys from appropriate commercial vehicles categories, including light-duty gas trucks and heavy-duty trucks. Another 400 usable for-hire passenger vehicle surveys were also completed. The estimated response rate from the survey was between 35 and 40 percent. Survey participants were asked to record 24-hour trip logs during the

[3-5] Information according to Nancy McGuckin, Senior Associate, Barton-Aschman Associates, Inc., Washington, D.C., January 1995.

[3-6] The El Paso Commercial Truck Survey drew the sample frame from the TVICS database. There was no discussion in the study report of whether the same sample frame was considered for the Houston-Galveston survey.

assigned weekday (Monday through Friday) and during Saturday or Sunday. A sample of the survey instrument is included in **Appendix X**. Respondents were requested to provide information on trip origin and destination, departure and arrival times, daily odometer readings, type of fuel used, model year of truck, cargo carried, and land use category of each trip end, etc. The data collection, coding, and reporting of the truck and for-hire passenger vehicle survey cost approximately $150,000 (Wilbur Smith Associates, 1994). Presently, the data coding and analysis is still ongoing. No information is available on the results of the survey. The Texas Transportation Institute (TTI) is expected to perform the expansion and analysis of the data at a later date.

CALGARY

In 1971, the City of Calgary, Calgary Transportation Study conducted home, truck, taxi and external origin-destination surveys. The surveys were part of a larger study called the Urban Evaluation System. The purpose was to evaluate the inter-relationship between the configuration of transportation and utility systems and the geographical distribution of activities in the study area. The survey procedures for the truck interviews were summarized in a report (Calgary Transportation Study, 1974). Out of the total population of trucks registered in the City of Calgary, 20 percent were sampled to obtain travel information. Every fifth truck from the motor vehicle registration file was randomly selected by the computer. Personal-use trucks, discovered from telephone contacts with owners, were eliminated from the sample. As a result, 3,252 trucks from a total population of 16,540 trucks were selected. Furthermore, 42 of the 450 trucks not registered but were based in Calgary and 22 buses were included in the sample. The survey was conducted between August 16 and the end of September 1971.

The truck survey involved two separate methods. Non-fleet truck owners were surveyed via telephone interviews, and fleet owners were telephoned and followed up with a face-to-face interview. Telephone calls were made to non-fleet truck owners the day prior to the survey day. They were requested to make note of specific information related to the travel of the sampled truck. Another telephone call was then made immediately following the survey day, and the requested information was obtained. Fleet owners were contacted by the phone just like the non-fleet owners but were followed up by a face-to-face interview to obtain the requested truck travel information. The two methods were documented to be successful. Truck travel information such as industry or business type, vehicle type, trip start and end times, commodity carried, and origin and destination information were obtained. A temporary staff of 5 interviewers were hired to conduct the truck interviews. The total personnel cost of conducting the survey was approximately $4,600 and the coding of the survey was approximately $2,000.

Aside from an internal survey of registered commercial vehicles in the study area, an external cordon survey of all vehicles, including commercial vehicles, was conducted

during the daylight hours between 6:00 a.m. and 8:00 p.m. The primary objectives of the external cordon survey were:

1) To determine the total number and classification of all vehicles entering and leaving the City of Calgary; and
2) To obtain origin and destination information from drivers of these vehicles.

In theory, the sampling design estimated that a 50 percent sampling rate would be satisfactory. In practice, however, the field interview achieved close to a 100 percent sampling rate, with the exception of the peak hour periods. Sampling rates for the peak hour periods dropped to 80 percent in order to keep vehicular queues within an acceptable limit. Occassionally, the sampling rate for peak hour periods dropped to approximately 50 percent due to vehicles stalling while waiting in line for interviews. Furthermore, the sampling rate was dependent on the number of interview lanes available. The report estimated that a maximum of 360 interviews per hour per lane was achieved with 9 interviewers per lane. Each interview took approximately 90 seconds to complete. Vehicle classification counts were also conducted at the same time period of the surveys. The external cordon survey employed 37 temporary staff and 4 supervisors.

ONTARIO

The Ontario Ministry of Transportation periodically conducts surveys of commercial vehicles based on 5-year intervals for planning and operational purposes. Roadside intercept surveys were completed in 1978, 1983, and 1988. At other times, ad hoc surveys are conducted at selected locations (Babin, Junor, Little, and Rhone, 1993; Junor, 1993). These ad hoc surveys are designed to address specific needs. For the 1988 Ontario Commercial Vehicle Survey, 19,000 trucks were surveyed to gather truck travel information (Gorys, 1991). The primary purpose of the 1988 commercial vehicle survey was to provide a current profile of trucking activity in the Province for the planning, delivery, and evaluation of Ministry programs. Other than the primary purpose, the survey was also conducted to gather information on the following:

- Nature and extent of dangerous goods movement;
- Structure of the industry between private and for-hire carriers;
- Transborder movement of goods, particularly the degree and nature of traffic made by other provincial and U.S. carriers;
- Seasonal variations in transportation and commodity movements;
- Profile of commercial vehicle drivers (demographics and other characteristics);
- Commodity and load characteristics; and
- Measures of efficiency and productivity on the basis of empty truck movements and ton-miles transported.

Questions were asked in regards to the driver's employment characteristics, such as age, sex, years of experience, recent training, the number of hours expected to work on the particular trip being surveyed, carrier type, union affiliation, method of renumeration, and employee category type. Other information such as the type of commodity hauled, the degree of utilization level of the vehicle, and the origin and destination of the vehicle were also collected. A copy of the sample questionnaire is in **Appendix XI**. The information was cross-checked, whenever possible, through a review of photocopied waybills.

Survey Methodology

The survey was conducted during a 23-week period, from March to November 1988. Interviews were undertaken on 100 days, but not necessarily for the entire day, depending on proper lighting, weather, and safety conditions. It was carried out at 57 locations along principal intercity highway inspection stations, rest stops, and at a few border crossing points (see **figure 3-3**). Where possible, surveys were conducted at the identical 1983 survey locations. The survey consisted of 29 questions, and 8 questions specifically pertained to the driver. The data collection included carrier information, area of registration, load utilization, commodity type and weight carried, and trip origin and destination information. The station inspectors recorded truck body type, number of axles, vehicle weight, etc. Interviewers recorded vehicle plate numbers and then approached truckers to request approval to commence with the survey. Fully completed interviews lasted between 8 to 12 minutes; it was slightly longer when portable scales were deployed. During the duration of the survey, a vehicle classification count of vehicles passing by the interview location was also undertaken. The purpose was to expand the sample data to represent the daily average traffic for the survey location.

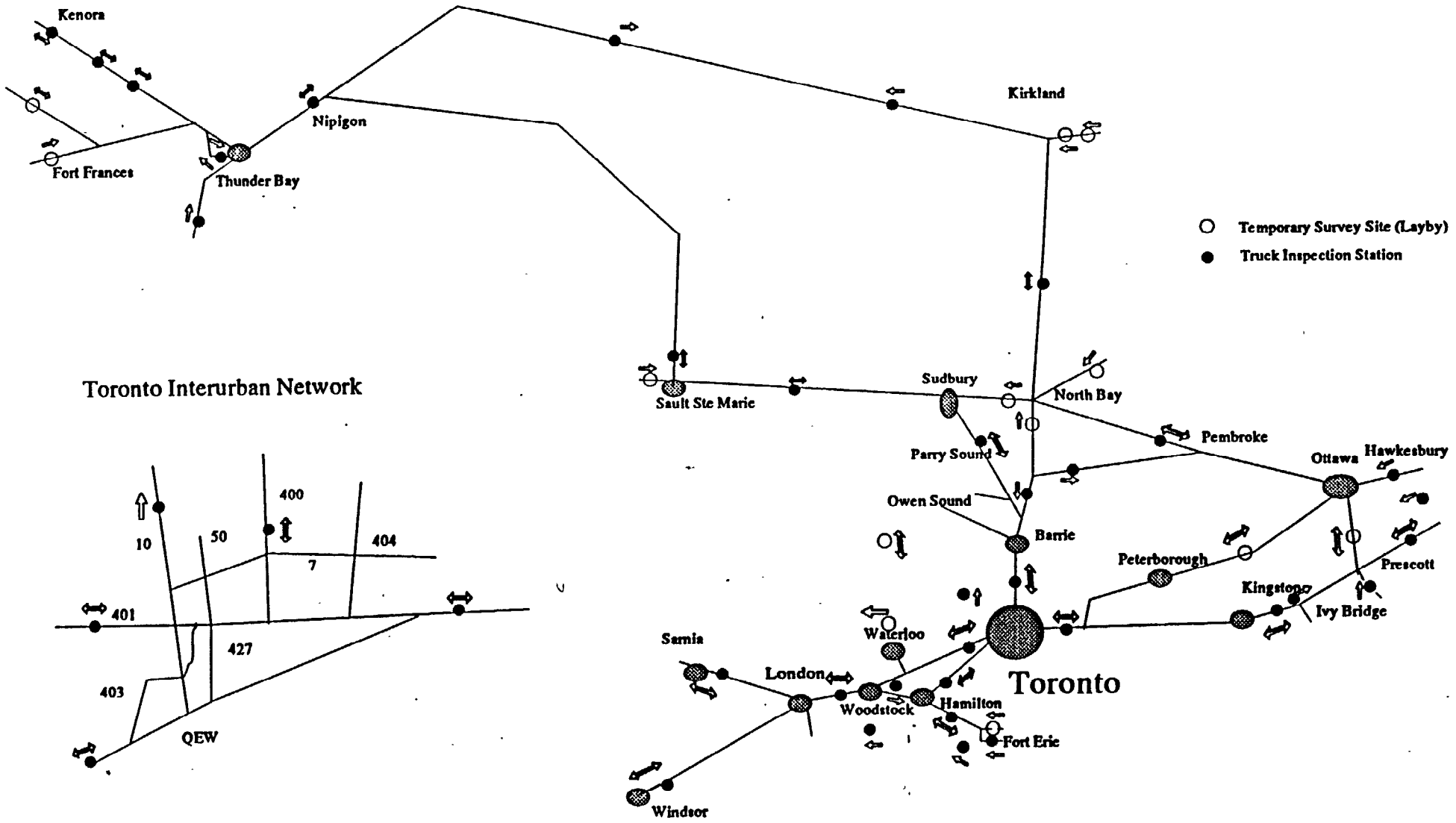
Survey Data

A total of 19,225, or 8.6 percent, of the total population of commercial vehicles were interviewed over a 1,855 hour period. The overall refusal rate for the survey was 3.5 percent. Another 1,363 hour period was used to collect information on vehicle type. No surveys were conducted during this period of time because of weather problems, absence of enforcement staff, equipment, etc. The 7-day, 24-hour vehicle classification counts at two selected inspection stations west of Toronto were conducted to obtain data on daily and hourly variations in truck travel. The sampling rate varied by location, time-of-day, day-of-week, and the degree of traffic passing by the survey locations.

Data Limitations

The survey was not without its limitations. The prime limitation was that the data collected was expanded to reflect a yearly flow of truck traffic. This practice presented questionable results, and was not encouraged by the author, given possible seasonal variations in truck travel. Second, the placement of the interview sites presented a bias towards trucks traveling on the major intercity routes. Since the interview was conducted

EXHIBIT 3.1
1988 CVS SURVEY SITES



Note: Arrows indicate direction of traffic surveyed.

Figure 3-3: 1988 Ontario Commercial Vehicle Survey Sites

at inspection stations along intercity routes, only trucks traveling along these routes would be surveyed. But because the principal purpose of the survey was to sample major intercity traffic, this was not a major concern. Moreover, because enforcement was being practiced during the duration of the survey, there were concerns that vehicles not incompliance would bypass an open inspection station (and hence avoid the chance of being interviewed). However, selected classification counts on known by-pass routes near inspection stations where the surveys were undertaken found this not to be true. Third, the survey does not represent all trucking activity. Since only the major intercity routes were sampled, truck traffic on secondary routes and rural highways, with considerable urban origin or destination, were not adequately represented in the sample. Fourth, only a small proportion of weekend truck travel, on Saturday, was captured. Week-long classification counts at two inspection stations, however, showed that weekend truck traffic was quite low. Saturday travel represented 6.4 percent of weeklong travel, while Sunday represented only 1.1 percent. Lastly, nonresponses, provision of false information, etc., resulted in missing values for incomplete interviews. Nonresponses varied considerably by question type. Typically, they were between 9 to 14 percent for each question. They were a function of language translation problems, refusals, misinformation, and in some instances, unawareness. Whenever possible, missing information were filled in through a review of other surveyed information.

Truck Volume by Time-of-Day

The sampling rate also varied by time-of-day. In general, the results found that it was easier to sample trucks during periods when volumes were lower. Truck volumes were found to be highest during the 4:00 p.m. to midnight period. An analysis of truck volume by hour in proportion to the total traffic volume, however, revealed that trucks accounted for between 10 and 58 percent of the total traffic, depending on the hour surveyed. The greatest proportions were found in the early morning hours (3:00 a.m. to 5:00 a.m.). Overall, trucks were found to constitute 17 percent of the total vehicular traffic. Combination vehicles (tractor-trailer combinations, for example) were most evident during the early morning hours, comprising of as much as 85 percent of all trucks. Straight trucks, on the other hand, were most visible during normal business hours, accounting for as much as 22 percent of all trucks.

Truck Volume by Day-of-Week

The 7-day classification count at the two selected inspection stations found that truck traffic was highest on Wednesdays, and Sundays produced the least amount of truck traffic (**Table 3-2**). The results also revealed that the greatest number of surveys obtained and the highest truck traffic volumes were found during the mid-week (Wednesdays or Thursdays). Despite an effort to minimize sampling on Mondays and Fridays, the survey produced a higher sampling rate on those two days. The author attributed the results to a greater ability to capture truck traffic (given lower volumes generally) on those days.

Table 3-2: Sample Rate by Day-of-Week

Day-of-Week	Surveys Collected	% of Total	Trucks Classified	% of Total	Sample Rate
Sun	0	0.0%	0	0.0%	---
Mon	1,616	8.4	7,078	6.6	22.8%
Tue	3,722	19.4	17,643	16.5	21.1
Wed	5,084	26.5	26,386	24.7	19.3
Thu	4,542	23.6	33,111	31.0	13.7
Fri	3,623	18.8	20,394	19.1	17.8
Sat	638	3.3	2,219	2.1	28.8
Total	19,225	100.0	106,831	100.0	18.0

Source: 1988 Ontario Commercial Vehicle Survey (Gorys, 1991).

Survey Findings

The 1988 Ontario Commercial Vehicle Survey produced the following findings:

- Fully completed interviews lasted between 8 to 12 minutes; it was slightly longer when portable scales were deployed.
- Nonresponses varied between 9 to 14 percent for each question.
- The 7-day classification count found that truck traffic was highest on Wednesdays, and Sundays produced the least amount of truck traffic.
- Truck volume in proportion to the total traffic volume was found to be greatest during the early morning hours (3:00 a.m. to 5:00 a.m.). Overall, trucks were found to constitute 17 percent of the total vehicular traffic.
- Combination vehicles were most evident during early morning hours, comprising of as much as 85 percent of all trucks. Straight trucks were most visible during normal business hours, accounting for 22 percent of all trucks.
- Tractor-trailer units were the predominant type of truck, at 77 percent of the surveyed population.
- Straight trucks (16 percent of the surveyed population) were the second largest truck type group.
- Van body style trucks accounted for about 60 percent of the truck-trailer units. This was a reflection of the operational flexibility of van body style trucks, especially in the transportation of general freight.
- Five-axle tractor-trailer units were the largest group of vehicles, at 57 percent of the total truck population. The 2-axle straight trucks (10.7 percent) and the 6-axle tractor trailer (10.3 percent) were the two next categories.
- Of the vehicles surveyed, 38 percent were equipped with energy-saving devices such as roof-mounted air deflectors, side fairings, and bubble-type devices.

- Private carriers used lighter vehicles than for-hire carriers. The for-hire carrier industry preferred larger vehicles with 6 or more axles.
- The survey of on-board monitoring devices found that logbooks were the principal trip recording devices (53 percent of all vehicles), followed by tachographs (32 percent), and on-board computers (4 percent).
- A total of about 5 to 6 percent of all truck trips surveyed involved the carrying of dangerous goods. Flammable liquids (47 percent) were the most frequently transported dangerous goods, followed by compressed gases (24 percent), and corrosive substances (20 percent).

Survey Data Applications

According to the Ontario Ministry of Transportation, the data collected from the 1988 commercial vehicle survey were of valuable use. They were used to evaluate the geometric design of roads, highways and ramps, pavement and structure rehabilitation planning and scheduling, reciprocity arrangements with adjacent jurisdictions, dangerous goods regulation and enforcement efforts, and driver education programs. They provided useful information for private sector interests on market opportunities, fleet construction and disposition. The 1988 survey also provided time series statistics on commercial vehicle drivers for policy development and analysis purposes. The types of analysis include hours-of-service regulations, evaluation of driver educational resources and recruitment, and comparison of truck-related accidents. Furthermore, data on methods of driver payment, hours-of-service restrictions, and work-related association membership provide insight into issues affecting owners and unions.

VANCOUVER

In 1988, the City of Vancouver and the Greater Vancouver Regional District (GVRD) conducted a truck survey. A detailed description of the survey is documented in the City of Vancouver/GVRD's Truck Study report (Vancouver City Engineering Department and the Greater Vancouver Regional District, 1990).[3-7] A GVRD Truck Model was developed. It was part of a regionwide TRANSPORT 2021 project to recommend a long-range transportation plan for Greater Vancouver with associated policies, demand management measures, and priorities for transportation investment.

GVRD Truck Model

The GVRD Truck Model was developed to estimate 24-hour light and heavy truck travel demand for current and future years. Light trucks are classified as having a gross vehicle weight (GVW) of 4,500-20,000 kilograms (kg). Trucks over 20,000 kg are classified as heavy trucks. The 1988 Truck Survey origin and destination data was used to calibrate

[3-7] At the time of this report, the Truck Study report was not available for review.

the 1989 GVRD Truck Model. The model was subsequently validated to 1991 conditions using truck screenline data. The model is comprised of three main components:

1. **A traffic zone system**: comprised of 445 traffic zones. The size of the zones varies according to population and employment densities. There are 11 external zones (at six border crossings, airport and ferry terminals) at entry points to the region to account for traffic entering and leaving the region.
2. **A regional light and heavy truck network**: The network is comprised of freeway, arterial and collector facilities. Each roadway link contains information on the number of lanes, posted speed limits, capacity, and turning restrictions.
3. **A truck demand modeling procedure**: This is a procedure that predicts the number of 24-hour light and heavy truck trips.

The truck demand modeling procedure is a three-step procedure that includes: 1) trip generation, 2) trip distribution, and 3) trip assignment. The trip generation stage estimates the number of truck trips produced and attracted by each traffic zone based on population, wholesale, manufacturing, and non-wholesale employment for that zone. The trip generation equations for light and heavy trucks are:

$$\text{Light}_i = 0.327Wh_i + 0.0213NWh_i + 0.0103Pop_i$$

where,

Light_i = 24-hour light truck trips produced by zone i
Wh_i = wholesale employment in zone i
NWh_i = non-wholesale employment in zone i
Pop_i = population in zone i

and,

$$\text{Heavy}_i = 0.164Wh_i + 0.0665Man_i$$

where,

Heavy_i = 24-hour heavy truck trips produced by zone i
Wh_i = wholesale employment in zone i
Man_i = manufacturing employment in zone i

The trip distribution stage is applied using the "Fratar" modeling technique. Truck trips between origins and destinations are allocated based on the observed heavy and light truck trip distribution patterns. This stage produces a set of 24-hour trip tables for light and heavy trucks. External truck trips are subsequently added to these trip tables.

The final step involves trip assignment - allocating light and heavy truck trips to the computerized network. The network assignment is based on the link travel times derived from the 1991 automobile assignment. The three-step modeling process, together with the traffic zone system and computerized network system, produces estimates of 24-hour light and heavy truck link volumes. These 24-hour link volumes can be factored down to represent travel demands for different time periods during the day.

The GVRD Truck Model results produced the following findings for the base model year 1991:

- Light truck trips outnumbered heavy truck trips by two to one in the Vancouver region.
- The number of daily truck trips in the GVRD exceeded 100,000 trips, and about 15 percent of all truck traffic in the region had an origin or destination outside the region.
- Truck traffic accounted for 3 percent of total daily vehicular traffic, with almost 85 percent of the truck traffic operating within Greater Vancouver.
- External truck traffic accounted for 15 percent of the total goods movement in the region by volume.
- The modeling effort identified regional roadways that complement primary highways and existing goods movement corridors and that are vital to port and industrial activities.
- Significant increase in population and employment along regional roadways were identified. This assumed growth prompted a need for new and upgraded transportation infrastructure for the movement of goods and passengers within these areas.

The GVRD Truck Model results produced the following projections for the model year 2021:

- Total daily truck trips were forecasted to increase by approximately 85 percent from 1991 to 2021. Light trucks were forecasted to increase with a faster rate than heavy trucks.
- The number of heavy and light trucks entering Vancouver on a 24-hour basis was forecasted to increase by approximately 50 percent.
- Average truck speed was forecasted to decrease by 8 percent.
- Average trip distance was forecasted to increase by 6 percent.
- All the above forecasts indicated that trucks would experience higher levels of congestion in 2021.

The GVRD Truck Model effort produced the following policy recommendations:

- Since trucking is the most competitive mode of goods transport, it should be exempted from the same constraints as automobiles.

- Truck traffic should be permitted to escape auto congestion wherever feasible by separating truck flows from auto flows, consistent with cost-effectiveness.
- Consider opening HOV lanes to truck traffic during the off-peak period, provide that the performance and safety of transit is not compromised.
- The use of inter-regional, long haul roads for commuting should be limited, in order to provide trucks with access to long haul facilities from outside the region.
- Provide adequate off-street loading facilities for both goods vehicle and courier functions.
- Develop fuel taxation policies with commercial vehicles in mind.
- Preserve and protect water/rail access to minimize the need for additional truck trips.

Chapter Four
CALIFORNIA EXPERIENCES

STATEWIDE TRUCK STUDIES

Between 1985 and 1987, the California Department of Transportation (Headquarters) conducted a study to determine the impact of large trucks (3 or more axles and gross vehicle weight of 26,000 lb. or more) during the morning peak, midday off-peak, and evening peak hours on the urban freeways in the Los Angeles, San Francisco, and San Diego metropolitan areas. The lead consultant for the study was Cambridge Systematics, Inc., and a separate technical report and summary report was submitted to Caltrans (Caltrans, 1988; Caltrans, 1988s). The study was conducted to address the following three questions:

1. What are the impacts of large trucks on peak-period freeway congestion?
2. Can freeway and truck management techniques reduce congestion?
3. What are the economic impacts of these techniques?

The study involved videotaping freeway traffic flows at 78 urban freeway sites. The sites were selected according to the following criteria:

- Congested freeway segments with high annual average daily truck traffic reported in the Caltrans reports;
- Freeway segments identified by Caltrans, the California Highway Patrol (CHP), city and county transportation officials, and motor carrier managers as congested, high volume truck routes;
- Freeway segments where Caltrans maintains truck weight stations or has long-term truck counts that could be correlated to the results of the research; and
- Freeway segments needed to improve systematic coverage of the regional freeway networks.

Of the 78 sites, 40 were in the Los Angeles area, 25 in the San Francisco area, and 13 in the San Diego area. The videotapes were analyzed to determine the number and body type of large trucks during the morning peak, midday off-peak, and the evening peak periods. Ninety minutes of videotape were recorded for each site: 30 minutes during the morning peak period (7:00 a.m. - 9:00 a.m.), 30 minutes during the midday off-peak period (11:00 a.m. - 1:00 p.m.), and 30 minutes during the evening peak period (4:00 p.m. - 6:00 p.m.). Each site was videotaped at one direction; paired sites were used to cover both directions. The trucks videotaped were classified according to the number of axles. Trucks with three or more axles were further classified by configuration (straight, single trailer, double trailer, tractor-only/other) and by body type (van, refrigerated van, flat bed, tanker, hopper, trash hauler, dump truck, auto rack, cattle rack,

trailer on flat car, container on flat car, construction equipment, and other). The truck configurations were used to deduce the type of motor carrier and commodity being carried.

The study evaluated four freeway and truck management strategies: 1) traffic management, 2) incident management, 3) night shipping and receiving, and 4) peak-period truck bans. It produced the following conclusions about urban freeway truck travel in the Los Angeles, San Francisco, and San Diego metropolitan areas:

- Large trucks accounted for three-quarters of all truck travel (except travel by pick-ups and panel trucks) in the three metropolitan areas.
- Large truck travel was highest during the midday off-peak period, comprising 5.5 percent of all vehicles in the Los Angeles and San Francisco areas, and 2.5 percent of all vehicles in the San Diego area. In the San Francisco area, truck volumes on I-580, east of I-880, were highest during midday. Truck flow on I-880/I-80, south of SR-24, also had the heaviest volume during the midday, from 6.8 to12.0 percent of all vehicles. Truck traffic for this segment of the freeway was heaviest northbound in the morning and southbound during the evening.
- Large trucks have an impact on the freeway equivalent to 1.8 to 2.8 passengers cars. *An MTC internal memorandum, however, suggested that the Bay Area freeway terrain, often with grades of 3 to 4 percent for distances of at least one-half mile, causes large trucks to have a greater impact on traffic. The MTC memorandum suggested that the "6 to 10 passenger car equivalent" should be used in analyzing truck impacts in the Bay Area (MTC, 1989).*
- Wholesale trade, durable goods manufacturing, and non-durable goods manufacturing industries generate the most miles of large truck travel. Together, they generate almost 90 percent of all truck miles of travel.
- Private truck fleets owned by businesses accounted for about half of all truck miles of travel. Most of their trips are short-haul trips (less than 200 miles). Common (for hire) carriers accounted for the other half of all truck miles of travel. About one-third of their trips are short-haul, and two-thirds are long-haul (over 200 miles).
- Few highly congested freeways have a high proportion (more than 10 percent) of large trucks in the traffic stream. At 90 percent of the 78 sites sampled, large trucks were 9 percent or less of all vehicles. However, I-5, I-605, I-710, and SR-60 in Los Angeles and I-80, I-580, and I-880 in San Francisco were identified to be highly congested with more than 10 percent of the traffic comprised of large trucks.
- As a general pattern, highly congested freeway segments tend to have lower truck volumes than moderately congested freeway segments.
- The impact of large trucks on freeway traffic flow is modest; the perceived impact, however, is greater. Large trucks create a psyehological, if not an actual, barrier to passenger vehicle drivers entering or exiting the freeway. They create visibility problems for passenger vehicle drivers. Moreover, their lack of

maneuverability relative to passenger cars in congested and unstable traffic flows contributes to accidents.

- Truck accidents and incidents were estimated to account for 19 million vehicle hours of delay per year at a cost of over $200 million per year.
- Five to ten percent of all truck incidents were found to cause major incidents which closed two or more freeway lanes for at least two hours.
- The sites selected represent a broad range of freeway conditions, but **the results should not be considered as a statistically significant sample of all freeway segments and time periods for the study areas.**

LOS ANGELES AREA

The Southern California Association of Governments (SCAG) and Caltrans conducted an urban goods movement study in the late 1970s. A working paper (number VI) was published as part of a series of reports on urban goods movement in the Los Angeles area (SCAG and Caltrans, 1979). The study is based on a sample of freight revenue bills of every regulated (for-hire) truck carrier who moved freight within the state on specified sample days. The study data was obtained from the California Public Utilities Commission (PUC) 1976 survey data. The PUC conducts annual freight surveys. The freight bill data used for the study included month of shipment, minimum rate tariff category, shipment mileage, shipment weight, freight charges, and origin and destination data by city and by the 62 metropolitan zones of Los Angeles and Orange counties.

The sample consisted of a total of 65,346 freight bills for the State of California, of which 37,301 freight bills originated from the six-county SCAG region and 27,413 destined for the region. Of the total samples in 1976, 65 percent had at least one trip end in the SCAG region, and 34 percent had both ends in the SCAG region. The results also found that 35 percent of the freight trips were just passing through the SCAG region. The analysis showed that for-hire truck activity was greatest in Central Los Angeles and declined with distance from the Central Los Angeles area. The core industrial regions (City of Vernon, Southgate, etc.) accounted for one-fourth the value of Los Angeles county freight bills and close to 5 percent of the value of all California freight bills. Moreover, Los Angeles and Imperial counties had the highest number of outflowing trips (49 percent and 56 percent) than any of the other counties. Freight flow from Los Angeles County represented 75 percent of the total outflow from within the SCAG region to outside the region. A possible explanation could be that Los Angeles County is the largest producer of manufactured products, and Imperial County produces the largest amount of agricultural products in the SCAG region.

SCAG also conducted a truck movement study for the Los Angeles region in 1988 (SCAG, 1988). The report contained compilations and discussion of local, state, and federal regulations and legislation that would affect restrictions on truck delivery hours.

It discussed issues that would affect heavy truck delivery scheduling, such as time-of-day patterns, truck volumes and level-of-service on the state highway system, the delivery needs of selected high-volume goods movement facilities, delivery needs of selected economic sectors, and factors limiting shifts of truck delivery hours. Another truck route study conducted by SCAG documented commercial vehicles regulations in the Los Angeles six county area (Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties) by weight class (SCAG, 198?). The study found that commercial vehicles with gross weight exceeding 3 tons were restricted by the largest number of local jurisdictions in the region.

In 1988, SCAG also published a report on how to manage the increased truck traffic in and out of the Port of Hueneme in Ventura county (SCAG, 1988). The study was prompted over concerns of increased truck traffic and their associated impacts on traffic congestion, air pollution, noise, and pavement conditions. The Port truck trips were projected to increase by 118 percent by the year 2010, from 286 trips (1986) to 623 trips per day. As part of the study, truck drivers were interviewed at the principal entry/exit gate to the port. The intercept surveys were conducted for seven consecutive days, 18 hours per day from 6:00 a.m. to 12:00 midnight. Time-of-day information, trip origin and destination, type of commodity carried, type of business or industry, and route information were collected. The survey produced 691 responses.

The following is a summary of the main findings:

- Most truck trips occurred between 8:00 a.m. and 4:00 p.m., with fairly even distribution within those hours.
- The largest share of truck trip destinations, 43 percent, were local (Ventura county). Another 26 percent of truck trips had destinations in the Los Angeles county; 21 percent were within California, and 10 percent were destined for other states. Trips destined to Canada represented 31 percent of all out-of-state destinations.
- The distribution for trip origins was similar to the distribution for trip destinations: 46 percent from local, 22 percent from Los Angeles county, 24 percent within California, and 8 percent from out-of-state.

In 1989, SCAG published a report, documenting new methods of estimating heavy truck VMT, both spatially (by location) and temporally (by time-of-day) (SCAG, 1989). Short of conducting a truck travel survey, SCAG set out to develop a new methodology for estimating truck travel based on existing data on trucks. The purpose was to gather detailed travel information on heavy trucks and to apply the information to regional travel demand, fuel consumption, air quality and emissions models. Although the then current method for estimating truck travel gave reasonable results for emissions produced by heavy trucks in the air basin, it was not adequate in providing locational or temporal information about emissions in the region. Trucks were implicitly included in the trip generation phase for the regional travel demand model as passenger vehicle equivalents.

Light-duty and medium-duty trucks were assumed to represent 82 percent of the registered commercial vehicles in the region, and heavy trucks (over 8,500 lbs. GVW) were excluded from the models. Moreover, the 82 percent of commercial vehicles represented in the regional model were assumed to have similar travel characteristics to passenger vehicles. Truck travel estimates were derived using factors developed from other truck travel information. Oftentimes, the source of information can often be dated or provided on an aggregate level. Furthermore, these factors varied according to each link's facility type, area type classification, and by the time-of-day. As a result, truck data for the SCAG region was collected from various sources to come up with a better method of estimating truck travel. The major source of information for the study was obtained from Caltrans. Other commercial vehicle information were obtained from DMV files, the Los Angeles Department of Transportation (LADOT) Downtown Cordon Count Study, and numerous reports from other agencies.

Data obtained from Caltrans included master truck annual average daily truck (AADT) information, truck miles of travel, highway performance and monitoring system (HPMS) information, and truck counts at weigh stations (Caltrans 1987). The truck AADT information was collected from traffic volume counts at 970 count locations at the Caltrans district level. The counts were conducted from 9:00 a.m. to 3:00 p.m. (District 7) or 9:30 a.m. to 11:30 a.m. and 1:00 p.m. to 3:00 p.m. (District 8). The data were then expanded to reflect 24 hour volumes based on factors developed from previously collected 24-hour counts. The estimated ADT volumes are compiled and sent to Caltrans Headquarters to be published. The truck miles of travel data was obtained by axle type (2, 3, 4, and 5+) (Caltrans, 1987). The VMT were estimated from truck AADT information. The HPMS information from the Federal Highway Administration (FHWA) was obtained from Caltrans, which publishes an annual California HPMS report (Caltrans, 1987). Data such as county, functional class, area type, facility type, truck designations, AADT, speed limit, percent trucks, and capacity were extracted from the report. The truck information were for the peak and off-peak periods. Truck weigh-in-motion (WIM) machine counts were obtained from Caltrans for six locations. The data obtained were classified into 15 vehicle classifications, and truck data were grouped into axle groups. In general, the WIM truck data showed that the 2-axle and 5 or more-axle trucks represented the largest share of truck travel in the SCAG region and that truck traffic occurred in the midday off-peak period. There were no evidence of directional differences; however, the distribution of truck traffic was significantly different from passenger vehicle traffic.

Data from the DMV were obtained for the number of vehicles registered by vehicle types for each county (California DMV, 1987). Statistical records were also obtained on motive power for vehicles by body type and weight divisions, stratified by axle groups. Los Angeles Downtown cordon counts were also obtained from LADOT's Bureau of Transportation Planning (LADOT, 1984). The data included machine and manual vehicular and pedestrian counts entering and leaving downtown Los Angeles by location and by half-hour periods. The truck information, however, did not include truck counts by types or weight class. Moreover, large truck peak hour population data were obtained

from the Caltrans *Urban Freeway Gridlock Study* for reference and cross-checking (Caltrans, 1988). Truck travel distribution by truck classification, fuel type, area and road type traveled were also obtained from the University of Michigan Transportation Research Institute's *Analysis of Heavy-Duty Truck Urban Use Data* for the SCAG region.

Based on the analyses of the collected data, various assumptions were made on truck travel in the SCAG region. These assumptions were used to develop the new methodology for estimating truck travel. First, routes with high truck volumes were assumed to display insignificant variations over time and that the routes will continue to be the major truck network in the future. Second, the information used for the models assumed that regional truck travel movements were mainly on freeways, not arterials. Heavy trucks will continue to carry goods and commodities using the same established routes. Third, the new methodology assumed that most manufacturing, heavy industrial, and other employment sites using heavy trucks will be located near freeways. Fourth, the gasoline truck fleet is assumed to be less polluting and equipped with some type of catalytic control by the year 2010. Diesel trucks were assumed to have a 74 percent increase in miles traveled and an increase of 38 percent for TOG, 23 percent for CO, and 20 percent for NOX. The majority of diesel trucks were also assumed to comprise of 4 or more axles and make a large share of their trip on freeways.

The new methodology was based on 1984 data and applied to 1987 commercial vehicle information as they became available. The base year used for model calibration was set at 1987. The modeling zone system was consisted of 1,555 zones, based on the 1980 census tracts. The new highway network was built from scratch, converting the links from UTPS HNET format to TRANPLAN HWYNET format, utilizing a new node number system, facility type designation (freeway, major arterial, primary arterial, secondary arterial, HOV, and centroid connector), and a different coordinate system. The highway network produced 13,000 two-way links. TRANPLAN's graphic Highway Network Edit and Display System (HNEDS) software was used to display the freeway network on a graphic terminal monitor and coded in the proper freeway route number for each link. The TRANPLAN network was converted to ASCII format and a freeway route file was created. The same procedures were used to code state route numbers to the arterial links. Freeway ramps, however, were not coded in the network, and cordon stations were re-assigned from the low order of zone numbers to higher order of zone numbers. All the travel demand model data were then merged with Caltran's 1987 truck count data to develop heavy duty vehicle to light duty vehicle (HDV to LDV) factors. The factors were calculated by dividing the daily truck volume by the daily model volume (AMPK + PMPK + OFFPK). Three sets of factors were developed:

1. RTE*FT*RSA. This factor was developed to identify highway links as either intra or inter-state routes (RTE). It represented weighted mean truck percentages for each route by facility type (FT), and by regional statistical analysis (RSA) district. There were 808 observations used to develop 259 factors. Comparison of the sum of the mean values showed that the model estimates were within -3 percent of the counted vehicles.

2. FT*RSA. This factor was applied to links with no route number coded. It represented weighted mean truck percentages for each facility type and the RSA location where counts were taken. A factor was developed for each facility type at the RSA level. The 808 observations were used to develop 119 factors. Comparison of the sum of the mean values found that the model estimates were within 1.8 percent of the counted vehicles.

3. FT*CO. This factor was applied to links with no route number coded and no truck percentage number for that link's RSA code. It represented weighted mean truck percentages for each county by facility type. A factor was developed for each facility type at the county (CO) level. The 808 observations were used to develop 20 factors. Comparison of the sum of the mean values showed that the model compared within -0.4 percent of the counted vehicles.

In applying the above factors for estimating heavy truck VMT, the following assumptions were made:

- Assume zero heavy truck volumes on secondary arterials, centroid connector links, and HOV links. Due to the lack of travel information, truck traffic was not estimated for the connector links and secondary arterials.

- Assume 50/50 split by direction of travel for truck volumes for all time periods. The assumption was based on 24-hour volume count data from 3 sites.

- Assume that trucks travel at the same speed as other vehicle types.

After the LDV to HDV factors (TRKPCT) were calculated, the total daily truck volumes (TRKADT) were estimated. The TRKADT were calculated by applying the TRKPCT factor to the modeled light-duty vehicle ADT (AMPK + PMPK + OFFPK), such that:

$$TRKADT = ADT * TRKPCT$$

The daily truck volumes were then allocated to the three time periods based on factors developed using the 1988 Weigh-in-Motion (WIM) 24-hour machine count data from five sites in the region.

The VMTSUM program was then used to calculate the VMT by county, by the area inside or outside of the SCAG region, and by the area representing the South Coast Air Basin (SCAB). The data were also used to provide information for input into the BURDEN and DTIM air quality models maintained by the California Air Resources Board (CARB). The results found that the 1987 model run overestimated truck counts by 2 percent compared to an over estimation of 18 percent for the 1984 model run. A

comparison of the heavy-duty vehicle VMT as a percentage of the total VMT varied from 5.8 percent to 6.1 percent. A comparison of the speed ranges by county found that the median speed for HDVs were significantly higher than for LDVs.

SACRAMENTO AREA

In 1992, Caltrans conducted a Truck Travel and Goods Movement Study in the Sacramento metropolitan region. The study was aimed at understanding truck travel patterns and goods movement across the Sacramento area. Barton Aschman Associates produced a proposal to conduct a truck travel survey in the Sacramento area. A work plan was produced (Barton Aschman Associates, Inc., 1992).[4-1] The work plan included sampling frame, sample design, survey design, and a discussion of field survey safety issues. Seven potential data collection techniques were examined and an alternative approach was recommended. The seven potential approaches included:

1. Mail-back survey based on license plates
2. Video surveillance
3. Manual license plate survey
4. Automated/Electronic data collection
5. CB radio/Cellular phone
6. Mail-back survey form/roadside distribution
7. Roadside interviews

The roadside interview method combined with automated classification counters were judged the best survey approach to meet the study objectives. A summary of the evaluation (advantages and disadvantages) is presented in **table 4-1**.

SAN FRANCISCO BAY AREA

Bay Bridge Truck Travel Study

In 1985, the Caltrans conducted a San Francisco Bay Bridge Truck Travel Study. The purpose was to improve truck and/or vehicular travel approaching the Bay Bridge. The information produced from the study were used to evaluated proposals to eliminate the weave for trucks coming from I-880 and a Caltrans proposal to install automated vehicle identification (AVI) systems on trucks accessing the toll plaza. Truck travel patterns to the Port of San Francisco were also studied.

[4-1] At the time of this study, no reports were available, indicating that any truck surveys were conducted in the Sacramento area.

Table 4-1: Comparison of Survey Methods for the Sacramento Truck Travel and Goods Movement Study

Survey Methods	Advantages	Disadvantages
Mail-back Survey Based on License Plates	• No disruption to traffic flow • Limited exposure of survey personnel • Minimal personnel requirement(2 persons per direction) • Minimal euipment required(1 tape recorder per person)	• Potentially low response rate • Time lag between trip date and receipt of postcard survey form; loss of details • Difficulty identifying actual driver • Time consuming • Bias toward owner/operator • Possible difficulty reading license plates
Video Surveillance	• No disruption to traffic • Limited exposure of survey personnel • Permanent data record	• High equipment cost and requirements • High personnel requirements • Potential for technical or equipment problems • No info regarding O-D, trip purpose, freight/goods type carried. etc. • Possible difficulty reading license plate from videotape
Manual License Plate Survey	• No disruption to traffic • Limited exposure of survey personnel • Permanent data record	• High personnel requirements • High equipment requirements • No info regarding O-D, trip purpose, freight/goods type carried. etc. • Possible difficulty reading license plate • Lots of room for human error
Automated/Electronic Data Collection	• No disruption to traffic • Limited exposure of survey personnel • Minimal equipment requirements	• No info regarding O-D, trip purpose, freight/goods type carried. etc. • Capability to obtain info of any type extremely limited(inadequate sample size likely due to limited number of active transponders) • Validity/accuracy of classification info questionable • Possible difficulty identifying vehicle owner for follow-up
CB Radio/ Cellular Phone	• No disruption to traffic • Little or no exposure of survey personnel • Moderate equipment and personnel requirements	• No control over sample characteristics • Difficulty obtaining cellular phone numbers for trucks • Potentially low response rate • Safety problem with drivers responding to the survey and driving at the same time
Mail-back Survey/Roadside Distribution	• Survey form could be designed to obtain all desired information • Moderate personnel requirement(2-4 persons per station)	• Potentially low response rate • Potential disruption to traffic • Relatively high exposure of survey personnel • Relatively high equipment requirements(cones, signs, etc.)
Roadside Interviews	• Able to obtain all desired information • Moderate personnel requirement • Better statistical control	• Potential disruption to traffic • Relatively high exposure of survey personnel • Relatively high equipment requirements(cones, signs, etc.)

(Source: Barton Aschman Associates, Inc., 1992)

Survey Methodology

The study was based on data collected from travel time studies and truck surveys. Travel time studies were performed by following vehicles with cars equipped with devices to record time, speed, and distance. Most of the data collected focused on the westbound approach, although eastbound data was also collected. The data collected included truck volumes, travel times, and travel patterns for the westbound Bay Bridge and approaches. The eastbound data collection was limited to truck travel times. Truck surveys were conducted on November 20, 1985 at the westbound toll plazas (for truck lanes 13 through 17). Approximately 1,600 questionnaires were handed out between 5:00 a.m. and 7:00 p.m. for trucks with three or more axles. The questionnaire consisted of 11 questions on a prepaid postcard. Interviews were also conducted at the Port of San Francisco container terminals at Pier 80 and 94/96 between November 18 and 22, 1985. Trucks were stopped at the two locations, and drivers were interviewed outside the entry gates either on or adjacent to the weighing scales. The interviews were conducted during Port operating hours (8:00 a.m. to 5:00 p.m.). A copy of the postcard and Port questionnaires is in **Appendix XII**.

Survey Data

Out of the 1,600 questionnaires distributed at the Bay Bridge toll plaza, 430 were returned. This yielded a response rate of 27 percent. The Port interviews produced 1,538 samples, representing close to a 100 percent sample.

Study Findings

The San Francisco Bay Bridge Truck Travel Study produced the following findings:

- The Bay Bridge data **only represent trucks with three or more axles.**
- During the AM peak period, trucks are expected to encounter 15 to 20 minutes of delay at the I-80/580/880 interchange and the Bay Bridge metering signals.
- Minor delays of about 3 minutes were expected for westbound traffic during the PM peak period on the San Francisco end of the Bridge.
- and I-880 are the two major truck routes used by westbound trucks destined for the Bay Bridge. The two routes carry 49 and 42 percent of the total truck traffic, respectively.
- About 58 percent of the trucks that serve the Port of San Francisco use the Bay Bridge. However, trucks accessing the Port make up only 8 percent of the total Bay Bridge truck volume.

San Francisco Bay Area-Alameda County Truck Travel Survey

In 1991, Caltrans District 4 conducted a study to obtain information to develop a travel demand model for trucks. The study was conducted by Barton-Aschman Associates, Inc. (Schlappi, Marshall, and Itamura, 1993). A *truck intercept survey procedure manual* was produced (Barton Aschman Associates, Inc., 1991). The report documents and summarizes the findings and conclusions by Barton-Aschman Associates of truck travel in the Alameda County and adjacent counties in the San Francisco Bay Area. The report is part of the State Route 61/I-880 corridor study sponsored by Caltrans and the Federal Highway Administration (FHWA). The objective was to develop and evaluate alternative strategies to alleviate congestion on I-880 and improve access to the Oakland Airport and Alameda Island. Although the study focused on the SR 61/I-880 corridor in Alameda County, the model and database included the entire nine-county San Francisco Bay Area in order to consider the many truck trips that had one trip end originating, destinating, or passing through Alameda County. Using the already operating Alameda Countywide Transportation Model, the purpose of the study was to create a submodel to forecast truck travel demand to enhance the ability to monitor congestion in the study corridor by forecasting future travel demand. Two areas were identified as critical gaps in the knowledge of truck travel in Alameda county: (1) time of day patterns and (2) origin and destination data.

Survey Methodology

Four travel surveys were conducted to obtain information regarding travel patterns of trucks operating within Alameda County:

- ***Truck classification counts*** at 11 freeway locations along the I-80 and I-880 corridor for a five to seven-day period.
- ***Truck-intercept surveys*** at nine California Highway Patrol (CHP) weigh stations. Over 8,000 interviews, at four toll bridge crossings, and almost 700 postcard surveys were completed. See **Appendix XIII** for a sample of survey and classification count forms.
- ***Employer surveys*** of truck trips. A combined telephone and mail-back survey contacted 550 Alameda County employers representing 36,000 employees. The response rate was over 79 percent and produced detailed truck trip data for over 2,200 truck trips.
- ***Surveys and interviews*** at the Port of Oakland with terminal operators and Port planning staff. Data for almost 5,000 daily truck trips were produced.

The surveys were designed to obtain three truck travel patterns for two, three, and four or more-axle trucks:

- ***External-external trips*** - refers to an origin or destination outside the nine-county Bay Area region.

- ***Internal-external trips*** - refers to trips that have *either* an external origin or destination.
- ***Internal-internal trips*** - are further subdivided into garage-based trips and linked trips. *Garage-based* trips are trips where the truck travels from its origin to a destination and returns to its origin. *Linked* trips involve departure from the origin and travel to several destinations before returning to the point of origin.

The truck intercept surveys and employer interviews also asked what type of goods were being hauled. Goods were classified into ten categories:

- Agriculture
- Chemicals
- Construction
- Construction Materials
- Empty
- Manufacturing
- Miscellaneous Freight
- Retail
- Service
- Waste

The purpose was to examine freight movement and its relationship to truck travel. However, no detailed commodity data (weight or volume of goods carried) were collected.

Truck Travel Survey Data

The employer survey data represented all trucks garaged in Alameda County and was used to create the internal-to-internal trips model. Consequently, trips recorded in the employer survey with an external origin or destination was assumed to be accounted for in the intercept and bridge crossing survey data and were not included in the internal-internal model. The employer survey results found that most trips (59 percent) were *linked* trips, and 35 percent and 6 percent of the trips were *garage-based* and *internal-external* trips. Although daily internal-external trips were only 14 percent of the total truck trips, they constituted 32 percent of the total vehicle-hours traveled (VHT). The survey results also found that two-axle trucks had shorter trip lengths than four or more-axle trucks. Moreover, linked trips were approximately 30 to 50 percent shorter than garage-based trips. Among the ten goods categories carried, the study found that for internal-to-internal trips for 3 or more-axle trucks, *empty* trucks represented a large proportion of trips (40 percent), followed by retail-related trips (24 percent). For 2-axle trucks, however, retail-related trips predominated.

Truck Model

As part of the SR 61/I-880 corridor study, the Barton-Aschman study developed a truck travel demand model to forecast 24-hour and P.M. peak-hour estimated volumes for two-axle, three-axle, and four or more-axle trucks. Peak-hour volume estimates were generated using factors derived from survey data. Goods movement forecasts were not developed because of their complexity in urban areas, with multiple origins and destinations.

The travel demand forecasting process consisted of four components or submodels:

(1) Trip generation
(2) Trip distribution
(3) Peak-hour factoring
(4) Trip assignment

The model was developed using existing Bay Area highway networks, 1990 Metropolitan Transportation Commission (MTC) zonal socioeconomic data, and results of various surveys conducted in 1991 as part of the overall truck study. Truck volume counts from 1991 were used to validate the travel model.

Study Findings

The study findings produced the following conclusions:

- The peak period for truck travel occurs in the midday. The findings were consistent with other Bay Area and national studies (California Department of Transportation, 1988; Grenzeback, Reilly, Roberts and Stowers, 1990).
- Most truck trips in the San Francisco Bay Area (nine counties) are local or regional. At five CHP weigh stations and four bridge crossings, 98 percent of the truck trips surveyed had either their origin or destination in one of the nine Bay Area counties.
- Many of the approximately 5,000 daily truck trips in the Port of Oakland area are local trips that never access a freeway. Furthermore, 59 percent of truck trips to the Port were found to originate in the nine-county Bay Area. The San Joaquin Valley accounted for 19 percent of trips originating to the Port.
- To collect truck trip log data, a sample of employers is more effective than a sample of vehicles. Vehicle registration data has several disadvantages. *First*, firms with large fleets are more likely than firms with small fleets to be selected for the survey sample. This is important, because studies have found that truck travel for small firms vary widely, and firms with small truck fleets were found to make frequent short trips (Rawling and Reilly, 1987). *Second*, because many owners lease their trucks, a sample of employers showed that they are more capable than truck owners to complete the trip log. The study found that a

sample of employers was more likely to be representative of truck usage than a sample of registered truck owners.

- Most employers (68 percent) did not own or leased trucks. A survey of *business services* employers found that 97 percent of those contacted did not own or lease trucks.
- The Alameda County employer survey found that almost 30 percent of the daily truck trips were retail-related trips. Retail-related truck trips per truck was the highest. Each retail-related truck made an average of 5.3 trips per day.
- Overall, there was an average of 12.6 daily truck trips per 100 employees. Truck trip generation, however, was found to vary greatly among employment categories. Daily truck trips per 100 employees ranged from 0.9 for *business services* to 33.2 for *other employment* (which included trucking and warehousing).
- Three-axle trucks accounted for the smallest percentage of total travel (7.5 percent of trips) and the smallest portion of VHT (6.9 percent). Based on the results, the report suggested that three-axle trucks should perhaps be grouped with two-axle trucks.
- The truck model results found that daily internal-to-external trips were 14 percent of the total truck trips, yet they constituted 32 percent of the total VMT.

Inlight of the study findings, the report recommended the following:

- The origins and destinations of trips that begin and end within the study area should be geocoded to the transportation analysis zones (TAZs) rather than at the city or zip code level. This would improve the accuracy of truck trip generation models based on zonal socioeconomic attributes.
- A large sample of employers (about 1,500) or a sub-sample of employers with three or more-axle trucks would be desirable.
- The employer survey should include wholesale employers as a separate category, since wholesales generate a relatively higher number of freight trips.
- Time-of-day (24-hour), day-of-week, and seasonal variations in truck travel should be examined.

Chapter Five
OTHER RESEARCH AND STUDIES OF TRUCK TRAVEL CHARACTERISTICS

Hourly Distribution of Internal Truck Trips in Urban Areas

Many state departments of transportation (DOTs) collect vehicle volume and classification data on urban highways. Typically, the short-count technique is widely used by highway and traffic engineers. This procedure utilizes information collected from short durations, say, 3-hour counts, and are expanded to represent 24-hour totals. Extensive databases exist for deriving expansion and adjustment factors for short-counts to reflect weekly or annual totals. However, little data exist for the hourly distribution of truck trips for urban areas. Moreover, little, if any, data exist for hourly distribution of truck trips on arterials.

It is known that the hourly distribution of truck trips in urban areas are significantly different than that of total vehicular traffic (Wilbur Smith and Associates, 1966). Chatterjee also believed that the hourly distribution of truck traffic varies according to the functional classification of roadway and size of trucks (Chatterjee, Wegmann, Brogan, and Phiu-Nual, 1979). Furthermore, it is reasonable to believe that truck traffic varies by geographic area within a metropolitan area. Hourly distribution of truck data from 12 urban areas in the country were examined (Chatterjee *et al*, 1979). The results found that a relatively high degree of stability existed. The 24-hour distribution found that truck traffic was generally highest during the midday period and decreases as the evening peak period approaches.

Truck Trip Generation by Land Use

Currently, some metropolitan areas estimate commercial vehicle trips as a percentage of non-home-based trips produced and attracted in a zone. The 1961 Puget Sound Regional Transit Study (PSRTS), for example, found commercial vehicle trips to be 37.8 percent of non-home-based trips estimated in a zone and used the estimate as the regional model strategy (DKS Associates, 1994). Most metropolitan areas assume that truck trips generated in a zone is a function of employment and commercial land use activities in that zone. However, employment alone is not an accurate estimator of truck trips, because many commercial trips are also related to household activities, particularly the deliveries of goods. Early research in truck trip generation in metropolitan areas was summarized in studies by Wilbur Smith and Associates (Wilbur Smith and Associates, 1961; Wilbur Smith and Associates, 1969). In general, the studies found that commercial land uses generated the greatest number of truck trips per acre, and residential land uses generated the fewest. This finding was found to be true across different cities in the country. Another study for the Nashville Metropolitan Area Transportation Study looked at truck trip generation by weight class (Wilbur Smith and Associates, 1961). The study

also found that commercial land uses generated the greatest number of truck trips. Moreover, industrial land uses were found to produce a significant number of heavy truck trips and that a large number of trips for residential land uses were made by light commercial vehicles.

A more recent study done by CATS found that although commercial land uses represent only 3.5 percent of the developed land in the study area, they generated over 37 percent of the total truck trips (Zavattero, 1977). Manufacturing land uses accounted for another 12 percent of total truck trips and only an additional 4.4 percent of the developed land. Another study by Brogan also used truck trip origin-destination data from four case-study cities (Flint, Michigan; Columbus, Ohio; Kenosha, Wisconsin; and Racine, Wisconsin) to develop truck trip rates by land use and truck weight types (Brogan, 1977). The study found commercial and industrial land uses to be the greatest generators of truck trips. Trip rates for residential land uses, however, were found to vary for different urban areas.

Between 1983 and 1986, the Caltrans District 4 conducted several trip generation studies at hundreds of locations in the San Francisco Bay Area. These studies were initiated to develop and update trip end generation factors for various land uses. On-site observations, vehicle volume, vehicle classification, and vehicle occupancy counts were conducted. Truck volume counts included $1^1/_2$-ton trucks with dual rear wheels, but excluded pick-ups and vans. Many of the results were used by the Institute of Transportation Engineers (ITE) in their *Trip Generation* manual. These studies provide yet another source of data for understanding truck trip generation by land use types.

The Florida Department of Transportation has also compiled its own commercial vehicle trip generation data. The Florida DOT conducted studies for Boward County, Palm Beach, and Tampa to determine the attraction variables and trip generation rates for trucks and taxis (DKS Associates, 1994). It used dwelling units and total employment as independent variables in its analysis. Moreover, the 1991 Phoenix Commercial Vehicle Survey also provided detailed truck trip generation rates by land use types. The results of the last three sources listed above are summarized in **Table 5-1**.

Methods for Estimating Truck Trip Matrices

List and Turnquist (1993) wrote a paper that describes a new truck trip matrix estimation technique that would allow wide variations in data input for estimating truck flows in urban areas. The method is linked to a GIS environment for data management and easy display of the results. The method was illustrated through a case study using truck data from the Bronx in New York City. The paper was drawn from a larger report, which included a second case study and additional material (List and Turnquist, 1993). The proposed technique allows data input for multiple vehicle classes. It includes three main assumptions: 1) each link has a "directional flag" (i.e., i→j, j→i, or both), 2) each link has a use label (truck classes), and 3) each link has a travel time which may vary by

Table 5-1: Comparison of Commercial Vehicle Trip Rates			
VARIABLE	PHOENIX	BAY AREA	FLORIDA(1)
(Trips per Household)			
Single Family	N/A	0.20	N/A
Multi-Family	N/A	0.06	N/A
Total	**0.28**	**0.16(2)**	**0.20 - 0.40**
(Trips per Employee)			
Retail	0.76	0.35 - 1.64	N/A
Office	0.33	0.07	N/A
Industrial	0.79	0.09 - 0.20	N/A
Public	0.32	0.15 - 0.30	N/A
Schools	0.32	0.19	N/A
Other	0 94	N/A	N/A
Total	**0.55(3)**	**N/A**	**0.34 - 0.64**

(1) Taxi included.
(2) Total rate based on applying single family and multi-family rates to Puget Sound household data.
(3) Total rate based on applying rate by employment category to Puget Sound employment data.
(Source: DKS Associates, 1994)

the time-of-day. Furthermore, each zone is assumed to be non-overlapping, with a centroid where trips originate and terminate. The proposed technique also assumes that the types of data are of three basic types: 1) link volumes or classification counts, 2) partial origin-destination (O-D) estimates for various zones, time periods and truck classes, and 3) originating/terminating (OT) data indicating the total number of trucks originating and terminating in a particular zone or entry node on the network's periphery. The 1991 Truck Commodity Survey data, as well as 8 different data sources were used to test the new method. Three time periods (6-10 a.m., 10 a.m.-3 p.m., and 3-8 p.m.) and three truck classes (vans, medium, and heavy trucks) were considered. A total of 9 O-D matrices were estimated. The results found that heavy trucks generally traveled on the expressway system, and most external-to-external heavy truck trips occurred in the PM peak period. This paper is one of the first that addresses the problem of using partial and fragmented data in estimating truck flow matrices.

Passenger Vehicle Equivalencies (VEQs)

The operational effects of trucks on freeways have been a subject of interest in the 1950s and 60s. One of the purpose was to determine the equivalency - in terms of the number of passenger cars - of trucks in the traffic stream. This practice of assigning VEQs was a recognition that commercial vehicles have unique operating characteristics such as slower acceleration and deceleration, longer turning times and a wider turning radius, and greater lane occupancy which affects adjacent vehicles. The first comprehensive set of values for such equivalencies were presented in the 1965 Highway Capacity Manual and later revised in 1985 (Transportation Research Board, 1985).

In 1964, the Puget Sound Regional Transportation Study attempted to apply passenger vehicle equivalency factors to trucks in order to estimate truck trips. A staff report documented the procedures of applying weight factors to truck trip ends when estimating their passenger vehicle trip equivalents (Cowan and Walker, 1964). The weight factors were divided into vehicle types and were based on highway capacity

studies and VEQs developed in other studies. In general, it suggested that 1 light truck was equivalent to 1 passenger vehicle, 1 medium truck to 2.5 passenger vehicles, and 1 heavy truck to 5 passenger vehicles. The report documented 1985 truck trip forecasts based on the 1961 base year estimates. The procedures were:

1. Identify the distribution of truck trips in commercial use by type for the base year and forecast year (assuming the same percent distribution of truck trips by type for the forecast year as for the base year);
2. Based on changes in historical trends, forecast changes in distribution of truck trips in commercial use by type for the forecast year;
3. Weight the two distributions (from steps 1 & 2) by the appropriate equivalency factors;
4. Divide the sum of weights by the total number of trucks for the forecast year. The result is the average passenger vehicle trip equivalency factor.

There are three apparent problems with the above methodology. First, the forecast assumes that the distribution of trucks by type does not change over time. This assumption is simplistic; for example, a CATS study projected that light and heavy trucks were forecasted to increase by 52 percent and 10 percent respectively from 1986 to 2010 (Rawling and DuBoe, 1991). Second, the assumption that the number of trips per truck remains constant for each truck type is unsupported. Furthermore, this assumption does not take into account changes in truck fleet composition, land use, and regional economic development over time that would likely change the number of trips, or trip length, each truck makes. Rawling cited that the industrial dispersion that has taken place since 1970 in northeastern Illinois has been significant and has probably contributed to longer trips overall (Rawling, 1988). Moreover, truck trips tend to vary by geographic location. The 1986 CATS Commercial Vehicle Survey showed that truck trips were typically concentrated at major industrial, commercial centers, and along certain corridors (Reilly, Rosenbluh, and Rawling, 1987; Rawling and DuBoe, 1991). The proposed methodology of converting truck trips to passenger vehicle trip equivalents is simply unvalidated by the lack of spatial and temporal data on truck travel.

For modeling purposes, the CATS 1970 and 1986 Commercial Vehicle Surveys also utilized the practice of "translating" commercial vehicles to passenger vehicle equivalents and then conduct one aggregate trip assignment (CATS, 1977; CATS, 1979; corridors (Reilly *et al*, 1987). Since the 1970s, CATS has also developed computer models that add commercial vehicle trips (truck trips) to separately-calculated passenger vehicle trips (person trips). The procedures used to achieve the model estimates are outlined fully in a 1986 CATS Working Paper (Englund and Ryan, 1986). CATS practice was not to do separate forecasts and trip assignments for commercial and passenger vehicles but to "translate" commercial vehicle trips into passenger equivalents (VEQs) before assigning vehicle trips to the highway network. This practice was initiated with the recognition that trucks are slower, wider, and longer than cars and that they affect traffic flow and the performance of all vehicles on the network. The purpose

is to do one aggregate trip assignment, using passenger vehicle equivalents to represent commercial vehicles. The VEQ factor is as follows:

- 1 B truck or light commercial vehicle = **1** passenger vehicle;
- 1 medium commercial vehicle = **2** passenger vehicles;
- 1 heavy commercial vehicle = **3** passenger vehicles.

In general, the 1985 Highway Capacity Manual suggests that an urban freeway with 10 percent trucks in the traffic stream and grades below 2 percent has an impact equivalent to 2 to 4 passenger vehicles. The effect of heavy trucks was found to increase dramatically with the gradient of the roadway; however, as the percentage of trucks in the traffic stream grew, the effect of additional trucks declined somewhat. The Caltrans Urban Freeway Gridlock Study, however, revealed that research developed for the National Cooperative Highway Research Program (NCHRP) suggests that the 1985 Highway Capacity Manual VEQ estimates are still slightly overstated (Caltrans, 1988). More recent research for NCHRP suggests that trucks have an impact equivalent to 1.5 to 2.0 passenger cars. An MTC internal memorandum, however, suggested that the Bay Area freeway terrain, often with grades of 3 to 4 percent for distances of at least one-half mile, causes large trucks to have a greater impact on traffic. The MTC memorandum suggested that the "6 to 10 passenger car equivalent" should be used in analyzing truck impacts in the Bay Area and not the 1.8 to 2.8 estimates that Caltrans suggested (Metropolitan Transportation Commission, 1989). The literature suggests that there is not a complete agreement on passenger vehicle equivalencies on freeways. The research is limited and inconclusive. For the purpose of truck modeling, VEQs should be used with caution. Moreover, VEQs used should reflect factors such as the topography or grade of the freeway network, the length of different grade changes, congestion level, or whether a segment of the freeway is winding and narrow or straight and wide, etc. Further research and data collection is needed to analyze the affects of trucks on different freeway traffic conditions.

Truck Travel Demand Forecasting and Pavement Management

While there are numerous studies on the effects truck characteristics (weight, axle configurations, tire properties, braking, etc.) have on pavement design and management, there have been few studies in the literature concerning the use of truck travel demand forecasting for pavement design and management. Trucks have often been cited to create the most damage to pavements in the urban roadway system, yet many metropolitan areas have found that limited information on truck travel in their respective regions have limited their ability to relate traffic forecasts with pavement design and pavement rehabilitation programs. Similar concerns have focused on pavement deterioration associated with trucks in general and specific truck types in particular. Such concerns have obvious importance in, for example, developing pavement design and management practices, and in establishing weight restrictions and highway cost allocation policies in an urban area.

Three studies have attempted to discuss the role truck forecasts have in the pavement design process and highway cost allocation. The first report by the Minnesota Department of Transportation discussed the role truck forecasts have in the pavement design process (Hage, 1982). It examined the effects truck traffic have on pavement life. Furthermore, the report briefly discussed the weaknesses of the existing truck forecasting process for use in the pavement selection and design process. The report found that in Minnesota, the trend was to use more larger trucks. This was consistent with the general trend of more capital-intensive modes of economic activity. Second, more and more shippers were found to abandon railroad freight and rely more on trucks. Third, the report cited that the multi-lane, full-access interstate highway system has undoubtedly enhanced trucks' competitive position by shortening delivery times and reducing labor and vehicle operating costs. Moreover, 5-axle trucks were found to effect the most damages on pavement structure. Thus, it was determined that the forecasting process for this class of trucks, as well as for the entire truck fleet, needed further assessment. In particular, there were concerns over the reliability and accuracy of the forecast data in predicting pavement wear.

The first truck forecast reliability issue centered around truck volume forecasts. The report cited that the design and improvement of a pavement were made on the basis of a single vehicle classification count taken in the vicinity of a proposed project. Often, the count was neither current nor ideally located. Furthermore, the report cited that there were demonstrated deficiencies in load forecasting on the basis of a single traffic count, no matter how recent or well located. The report also stated that there were daily, weekly, and seasonal variations in truck travel that would affect pavement wear. It maintained that the existing forecasting procedures did not give adequate attention to these variations.

In summary, the Minnesota DOT report suggested that the current method of forecasting truck travel for pavement design and pavement management might be inadequate. Truck forecasts based on single vehicle classification counts at a limited number of locations may reduce the accuracy of the forecast. Furthermore, using the limited data to make 20-year truck traffic forecasts would be formidable. For metropolitan areas, understanding the origins and destinations of truck travel (where trucks enter or exit critical urban roadways) by vehicle classification, weight, etc., would not only improve truck forecasts, but improve the accuracy to the pavement design and management process. Better truck travel data would help improve pavement deterioration models. Improved heavy truck data, specifically, would help identify pavement "hot-spots," places that are most affected by damages caused by heavy commercial vehicles. Moreover, better truck travel data would likely help identify user costs to the pavement system. Being able to forecast truck volumes and truck types using a certain portion of a facility would help pavement managers better estimate the distribution of user costs of that facility.

Chapter Six
COMPUTERIZED DATA COLLECTION OF TRUCK TRAVEL INFORMATION

Recently, the Intermodal Surface Transportation Efficiency Act (ISTEA) has called for improved data collection and management techniques of Intermodal Facilities. This has spurred the development of computerized data collection methods and related technologies. The Federal Highway Administration (FHWA) has recently funded several case studies that evaluated the use of handheld computer devices for collecting truck travel survey data. Current procedures use manual survey techniques where interviewers solicit responses and records them on a survey form or where respondents are given printed questionnaires to fill out and return. Telephone surveys, mailout-mailback questionnaires, or face-to-face interviews are the most common types of survey techniques. Recent studies have asked whether manual survey techniques themselves are accurate and useful in serving data needs. Compounded with rising costs of conducting surveys, several case studies were conducted to evaluate various computerized data collection methods.

Street Smarts, a transportation planning and engineering company based in Duluth, Georgia, recently tested the feasibility of using computerized data collection devices for collecting truck trip generation data.[6-1]

Handheld computers, called Personal Digital Assistants (PDA's), were selected for analysis based on the following criteria:

- Should be small and lightweight;
- Have a sufficient battery life for daily survey needs;
- Have a sunlight readable display;
- Have means of easily transferring data to a computer for data aggregation;
- Have a time-of-day clock for stamping date and time records; and
- Have sufficient memory (RAM) for daily survery purposes.

Out of the 4 available PDAs evaluated - the Tandy Zoomer, the HP 95LX, the Apple Newton, and the Sharp Wizard - the Tandy Zoomer was selected as the data collection device best-suited for the desired data collection activity. The approximate price of the Tandy Zoomer is $599 per unit. See **Appendix XIV** for a description of the price and characteristics of each tested PDAs and a photo of the Tandy Zoomer. Some of its features include:

- Touch screen capability
- Character recognition

[6-1] Information obtained from an information packet sent from Street Smarts to MTC staff.

- PC Compatible processor
- Big display of characters.

The software developed for the data collection survey form allows the interviewer to make observational entries as the interviewee approaches. It allows the interviewer to enter the answers to interview questions by selecting the desired answer options. The observation and interview entries were also designed to have menu selection responses as often as possible.

Recently, Street Smarts was contracted by the Federal Highway Administration (FHWA) to use handheld computer data collection devices to conduct truck origin-destination and commodity surveys. The purpose of the project was to evaluate existing technologies most appropriate for computerized data collection. The project objectives were to test and develop data collection methodologies and software for computerized data collection at Intermodal Facilities. After the Tandy Zoomer was selected as the most appropriate handheld device, a survey instrument was programmed into the Zoomer as a sample data collection form and used in 3 case studies in Georgia, Florida, and Texas.

In the first case study, a truck survey was conducted at a truck weight and inspection station on I-85 in Georgia. Due to adverse weather conditions, only 131 surveys were collected. Drivers were chosen randomly and directed to park their trucks at the weight station for the interview. This first case study provided information on possible modifications of the existing survey form. Specifically, more precise selections for some commodities and some pickup and delivery choices were identified.

The second case study was at a weight station on I-4 in Plant City, Florida. At this location, 465 surveys were conducted. Four truck parking spaces were used as survey stations. The third case study was conducted at a weight station on I-10 near Houston, Texas. During a 6-hour period, 345 surveys were completed.

In comparing the computer survey technique to manual methods, several conclusions were drawn. First, computer survey tools enhance the accuracy of the data collected because of reductions in the number of internal errors in responses, the use of pick lists, and the field review of data records. Second, computer survey tools also reduce the collection time for each survey by 1) automatically recording the starting and end times of each survey, 2) calculating the data collection time, and 3) creating data files that do not have to be re-entered before it can be processed. The manual survey requires that all data be re-entered before processing. Thus, the data entry process significantly increases the chance of error. Third, computerized data collection reduces the cost of data collection by abolishing the need for data entry and transfer. Moreover, it allows the survey instrument to be changed easily without having to reprint new forms each time a change is made. Lastly, handheld computer devices replaces the need for interviewers to carry extra pencils, erasers, survey forms, or clipboards. This increases the ease of conducting the survey in the field.

Chapter Seven
CONCLUSIONS

THE NEED FOR TRUCK TRAVEL DATA

Truck travel and goods movement is essential to the economic vitality of an urban area. Trucks not only act as the "supply-line" from warehouses to points of consumption (whether they be retail stores or residences), they connect intermodal freight facilities (seaports, airports, railroad and freight terminal facilities). As important as truck travel is to a region, it also has negative effects such as traffic congestion, truck-related accidents, air pollution, noise, and pavement deterioration. In order for an urban area to undertake comprehensive truck/freight planning, accurate and reliable truck travel data is needed for analysis.

Truck travel data for urban areas are important for the following reasons:

In terms of metropolitan area planning needs, improved truck travel data could be used for the following purposes:

1. Truck travel model development
   - Truck trip generation
   - Origin and destination analysis
   - Local and freeway route assignments
   - Congestion and speed simulations
   - Travel time analysis
   - Analyze impact of toll facilities
   - Spatial and temporal (time-of-day, day-of-week, and season) analyses

2. Corridor/Route analysis
   - Evaluate route/corridor traffic management proposals for freight impacts
   - Provide information on truck travel to formulate traffic management plans during roadway reconstructions
   - Assess impact of truck route reassignments or closures

3. Air quality modeling
   - Estimate truck emissions

4. Intermodal Freight Planning
   - Facilitate seaport planning
   - Facilitate airport planning
   - Understand competition and demand of different freight modes
   - Provide data to develop performance measures for Intermodal Management Systems as required under ISTEA

5. Pavement Management Planning
   - Evaluate and design road geometrics
   - Help calibrate pavement deterioration models

6. Truck restrictions and enforcement
   - Route restriction analysis
   - Dangerous goods movement regulation and enforcement analyses
   - Truck driver safety programs

7. Facilitate public-private partnership
   - Open dialog with private freight industries in gathering data
   - Provide truck travel data to public and the freight industry for research and analysis
   - Freight-economic analysis

TRUCK SURVEYS & TRUCK TRAVEL DEMAND FORECASTING LITERATURE

This literature and state-of-the-art review reveals that few urban areas in the country have had extensive experience in conducting truck surveys and truck travel demand forecasting. Most metropolitan planning organizations (MPOs) or regional transportation planning agencies continue to generate their truck trip estimates based on origin-destination surveys conducted in the 1960s and 70s. In the last ten years, only a few metropolitan areas, namely Chicago (1970 and 1986), Ontario (1978, 1983, and 1988), Vancouver (1988), Phoenix (1991), Alameda County, California (1991), New York-New Jersey (1991-94), El Paso, Texas (1994), and Houston-Galveston (1994) have undertaken significant efforts to collect truck travel data or develop new techniques in forecasting truck traffic. Out of the eight urban areas, only Chicago and Phoenix have had their truck model development and methodologies documented in detail, and only Ontario and the Port Authority of New York and New Jersey have systematically and continuously collected truck travel data.

TYPES OF DATA COLLECTED

The eight most recent truck travel surveys all collected origin-destination information (see **Table 7-3**). With the exception of roadside surveys conducted in New York and New Jersey, most truck surveys requested land use at destination and truck odometer readings from the respondents. Most surveys seemed to classify trucks by weight, number of axles, or by truck type. This is reflected in the collection of one or more of the above truck classification information. With the except of roadside surveys, all other survey types included trip diaries that required respondents to either report over the phone or to fill out and return. Most surveys that included trip diaries (Chicago, Phoenix, El Paso, Houston-Galveston, and Alameda County) also collected data on trip

start and end times. The commodity data collected ranged from a simply classification of commodity by type to detailed description of the actual commodity being carried. The Ontario survey is the only commercial vehicle survey that gathered information on truck driver characteristics. The El Paso commercial truck survey was the only survey that collected route choice information for the surveyed trip.

USES OF TRUCK SURVEY DATA

The most common uses of truck data are for regional truck travel model development and corridor/route analysis. Chicago, Phoenix, El Paso, and Vancouver have used their truck survey data to develop regional truck travel demand models. Ontario has seen the most use of its truck survey information. The truck data have been used for time series comparisons, evaluation of road design and geometrics, pavement management planning, truck-related accident analysis, dangerous goods movement regulation and enforcement, understanding truck driver characteristics and for planning truck driver education programs. El Paso has mainly used its truck data for regional travel and truck emissions modeling. The Port Authority of New York and New Jersey has used its truck data for traffic management purposes during highway and bridge/tunnel reconstructions. It has also used the truck data for extensive freight-economic analysis. Chicago has used its truck data to generate truck activity maps of the Greater Chicago region. Truck speed simulations and modeling the effects of toll facilities on truck route choice have also been analyzed.

TRUCK TRAVEL SURVEY METHODS USED

The most common survey method for conducting truck travel surveys in urban areas was the *combined telephone-mailout-mailback* method. Three urban areas in the country - Phoenix, Alameda County, California, and Houston-Galveston - have recently conducted truck travel surveys using this method. The most common source for drawing the survey sample is the Department of Motor Vehicle (DMV) registration files. Other sample sources include lists of truck registration files available from commercial vendors (R.L. Polk, Texas Vehicle Information and Computer Services, Inc., etc.). However, to collect truck trip log data, a sample of employers is more effective than a sample of registered vehicles. Vehicle registration data has several disadvantages. *First*, firms with large fleets are more likely than firms with small fleets to be selected for the survey sample. Studies have found that truck travel for small firms vary widely, and firms with small truck fleets were found to make frequent short trips (Rawling and Reilly, 1987). *Second*, because many owners lease their trucks, a sample of employers showed that they are more capable than truck owners to complete the trip log. The 1991 Barton Aschman study of truck travel in Alameda County found that a sample of employers was more likely to be representative of truck usage than a sample of registered truck owners (Schlappi, 1993).

The second most used survey method was the *roadside interview* method. The Province of Ontario, Canada and the Port Authority of New York and New Jersey have

conducted numerous roadside interviews. In general, the combined telephone-mailout-mailback survey method is more cost-effective and yields a reasonably high response rate. Roadside interviews produce very high response rates with complete information. Moreover, they are ideal for cordon surveys or surveying trucks traveling in from outside the survey area. A summary of different survey characteristics for eight urban truck travel surveys is found in **Table 7-1**, and a summary of different truck travel survey methods (typical response rate, advantages, and disadvantages, etc.) is found in **Table 7-2**.

NUMBER OF COMPLETED SURVEYS AND RESPONSE RATE

The approximate number of completed surveys from the eight urban truck surveys varied from 188 to 19,225. In general, roadside surveys produced the highest number of completed surveys and the best response rate (nearly 100 percent). Mailout-mailback surveys produced the lowest overall and item response rates (See **Table 7-1** and **Table 7-2**).

SURVEY COST

Telephone interviews are the most costly to conduct. They require a large amount of staff and time for data collection. "Phone-tagging" is a common problem which is time-consuming for this survey method. Combined telephone-mailout-mailback surveys are the most cost-effective to conduct. They yield reasonably high response rates over mailout-mailbacks alone. The phone contact portion of the survey can also help to assess non-response bias when analyzing and weighting the mailback survey samples. A 1994 combined mailout-mailback survey conducted in Houston-Galveston cost $167 per completed survey.

COMPARISON OF SURVEY FINDINGS

A summary of the general findings from various truck travel surveys are as follows:

Characteristics of Commercial Vehicles

Average Vehicle Weight

The only survey that reported average vehicle weight was the 1991 Phoenix Commercial Vehicle Survey. The average vehicle weight per commercial trip was 11,870 lbs.

Table 7-1: Summary of Truck Travel Surveys in Urban Areas

Survey Location	Survey Year	Survey Method	Approx. Number of Completed Surveys	Response Rate	Data Applications	Total Survey Cost	$/Survey
Chicago	1986	Mailout-Mailback	3,506	25.3%	• Truck travel model development • Corridor/Route analysis • Effects of toll on trucks • Truck speed simulation model • Truck activity mapping	$200,000	$57/survey
Ontario	1988	Roadside Interview	19,225	96.5%	• Time series comparison • Evaluate & design road geometrics • Pavement management planning • Truck accident analysis • Dangerous goods regulation & enforcement analysis • Truck driver characteristics • Driver education program	NA	NA
Phoenix	1991	Combined Telephone-Mailout-Mailback	720	30.0%	• Truck travel model development	$90,000(1)	$125/survey(1)
N.Y. & N.J.	1991	Roadside Interview	4,500	NA	• Evaluate dedicated route/corridor proposal • Traffic management for highway reconstruction • Time series freight analysis • Freight-economic analysis	NA	NA
Alameda County, Calif.	1991	Combined Telephone-Mailout-Mailback & Roadside Interview	2,200 over 8,000	79% NA	• I-880 corridor analysis • Create truck travel submodel for corridor analysis • Generate 24-hour & PM peak volumes by axle	$285,000(2)	NA
N.Y. & N.J.	1992-94	Roadside Interview	14,671	37.8%(3)	NA	$312,000(4)	$21/survey
El Paso	1994	Telephone Interview	188	42.6%	• Truck travel model development • Part of regional travel study • Truck emissions analysis	$65,000(5)	$345/survey(6)
Houston-Galveston	1994	Combined Telephone-Mailout-Mailback	900	35%-40%	• Truck travel model development	$150,000	$167/survey

(1) Cost included data collection, data coding, and model development.
(2) The cost included sample design, survey design, data collection, coding, data reporting, and model development. Approximately, $5,000 was also included in the total cost for conducting vehicle classification counts at 11 locations along I-80 and I-880.
(3) This was the sampling rate. No response rate was given.
(4) This was a multi-agency effort, with partnership from the New Jersey Department of Transportation (NJDOT), the New York Metropolitan Transportation Council (NYMTC), and the Port Authority of New York and New Jersey. The survey was conducted at 18 locations with 3 interviewers per toll plaza for 24 hours.
(5) Cost included sample design, survey design, data collection, coding, reporting, survey analysis, and model development.
(6) The higher cost was due to a high number of incomplete surveys

Table 7-2: Summary of Truck Travel Survey Methods

Survey Methods	Place (year) of Surveys	Typical Completed Surveys (% of Total Pop.)	Typical Response Rate	Advantages	Disadvantages
Telephone Interview	N.Y.(1964) Calgary(71) El Paso(94)	4%-15%	40%-50%	• High response rate • Easy to follow-up	• Can only call during business hours • "Phone-tagging" problem • Limited time on phone if respondent is busy • Requires access to vehicle registration file
Mailout-Mailback	Chicago(86)	1%-5%	10%-45%(1)	• Less costly • Good response rate w/ certified mail • Only follow-up of non-responses is necessary	• Low overall & item response rate • Possible bias due to better response from some drivers/owners • Low response from small truck owners • Low response from out-of-state trucks • Need to follow-up on non-responses • Difficult to ensure that the driver will fill out the form, instead of the owner or fleet manager who receives the survey forms • Requires access to registration file
Combined Telephone -Mailout-Mailback	Phoenix(91) Houston(94) Alameda, CA(91)	3%-10%	30%-80%(2)	• Improved response rate over mailout-mailback alone • Early identification of owners who agree to participate & potential non-responses through phone contact • Phone contact may help adjust sample size for mailout-mailback	• Same disadvantages as telephone survey method above • High cost of telephone follow-ups • Need phone reminders for trip diary • More costly than above methods
Roadside Intercept/ Interview	Calgary(71) Ontario(78, 83, 88) N.Y. & N.J. (74, 82, 85, 91-94) Alameda County, CA (91)	8%-35%(3)	95%-100%	• Complete information • High response rate • Better sampling control • Good representative sample of trucks entering or leaving a cordon line • Easy comparison with mainstream traffic through field counts at survey location	• Potential disruption to traffic • Quality and conduct of survey affected by weather, lighting • Hazardous to survey crew • Time constraint • No follow-up possible • Enforcement problems • Drivers avoiding the survey station • Only represent trucks traveling on road along survey station, not entire region

(1) The higher response rate was due to better survey participation from large truck fleet operators.
(2) The higher response rate was due to an employer survey conducted in California (1991 Caltrans-Alameda County Survey).
(3) The higher percentage is from the 1988 Ontario survey which surveyed 57 locations over a 1,855-hour period throughout the Ontario Province.

Table 7-3: Types of Data Collected

Survey Location	Survey Year	Survey Method	Sample Source	Weight	Axle	Truck Type	O-D	Odometer	Commodity	Land Use	Driver Info	Route Info	Develop Model
Chicago	1986	Mailout-Mailback	DMV	•		•	•	•		•			Yes
Ontario	1988	Roadside Interview	Road-side(1)	•	•	•	•	•	•		•		
Phoenix	1991	Combined Telephone -Mailout-Mailback	DMV	•	•	•	•	•		•			Yes
N.Y. & N.J.	1991	Roadside Interview	Toll Plaza		•	•	•		•				
Alameda County, Calif.	1991	Combined Telephone -Mailout-Mailback & Roadside Interview	DMV, Port of Oakland Road-side(1)		• •		• •	• •	• •	• •			Yes
N.Y. & N.J.	1992-1994	Roadside Interview	Road-side(1)		•	•	•		•				
El Paso, Texas	1994	Telephone Interview	TVICS(2)		•	•	•	•	•	•		•	Yes
Houston-Galveston	1994	Combined Telephone -Mailout-Mailback	DMV			•	•	•	•	•			

(1) Sample taken at roadside intercept surveys.
(2) Sample drawn from the Texas Vehicle Information and Computer Services, Inc. (TVICS) database.

Truck Size

The share of different truck sizes used varied from urban area to urban area. The preliminary findings from the 1991 George Washington Bridge survey in New York-New Jersey seemed to suggest a shift towards using more large trucks. The 1991 New York-New Jersey Truck Commodity Survey, however, found that truck size was evenly split between small and large trucks.

Characteristics of Commercial Vehicle Trips

Trips by Vehicle Type

Light trucks make more trips than any other truck types. The 1991 Phoenix survey found that 96.6 percent of all commercial trips were made by the two lightest weight categories. In Los Angeles, San Francisco, and San Diego (1985-87), large trucks accounted for three-quarters of all truck travel (except travel by pick-ups and panel trucks).

Average Trip per Commercial Vehicle

Light trucks have a higher average trip frequency than for heavy trucks. In Phoenix, the trucks surveyed made on average 7.7 trips per day. Light trucks made on average more trips (12.1 trips) than heavy trucks (4.7 trips).

Regional vs. Through Trips

The 1986 CATS survey found that of all the heavy trucks, almost 9 percent were found to be "in transit", i.e., leaving the region. Of all the commercial vehicle trips in the "in transit" category, 44.8 percent were made by heavy trucks. The 1991 New York-New Jersey Truck Commodity Survey found that the majority of truck traffic served the region. Only about 7 percent of the eastbound truck traffic at the 6 crossings were passing through. In California, the 1991 Barton-Aschman study found that most truck trips in the San Francisco Bay Area (nine counties) are local or within-region. At five CHP weigh stations and four bridge crossings, 98 percent of the truck trips surveyed had either their origin or destination in one of the nine Bay Area counties.

Average Trip Length

Heavy trucks make longer trips. The 1986 CATS survey found that heavy trucks made, on average, 24.9 miles per trip, compared to 9.6 miles for light trucks. The survey also found 7.5 percent of heavy trucks made an average trip length of over 60 miles. In Phoenix, vehicles in the heaviest weight category averaged 33.4 miles per trip, compared to 11 or less miles per trip for the lighter weight categories.

Vehicle Miles Traveled

Heavy trucks log a higher VMT per day than light trucks. The 1991 Phoenix survey found that the average VMT per vehicle for the 64,000+ lb category was 156.8 miles, compared to 56.2 miles for the 8,000-28,000 lb category. The Caltrans Urban Freeway Gridlock Study (1988) found that wholesale trade, durable goods manufacturing, and non-durable goods manufacturing industries generate the most miles of large truck travel. Together, they generate almost 90 percent of all truck miles of travel. Moreover, private truck fleets owned by businesses accounted for about half of all truck miles of travel. Most of their trips are short-haul trips (less than 200 miles). Common (for hire) carriers accounted for the other half of all truck miles of travel. About one-third of their trips are short-haul, and two-thirds are long-haul (over 200 miles).

Time of First Commercial Vehicle Trip

The 1991 Phoenix survey found that most trucks started their first trip between 6:00 a.m. and 9:00 a.m. This pattern, however, varies by weight category. Light trucks were more likely to start their first trip between 6:00 a.m. and 9:00 a.m. Heavy trucks (51.8 percent), however, started their first trip before 6:00 a.m.

Time-of-Day Distribution

Most truck trips seem to occur during the midday period. In Phoenix, the peak period for truck travel occurred between 9:00 a.m. and 2 p.m. The 1991 Barton-Aschman Study of Alameda County also found truck trips converging during the midday. In Ontario, the overnight, off-peak period (8:00 p.m. - 6:00 a.m.) had the largest percent of "through" traffic. Only 8.7 percent of the morning peak truck traffic was "through" traffic, and 13 percent for midday. In California, the Caltrans Urban Freeway Gridlock Study cited that large truck travel was highest during the midday off-peak period, comprising 5.5 percent of all vehicles in the Los Angeles and San Francisco areas, and 2.5 percent of all vehicles in the San Diego area. In the San Francisco area, truck volumes on I-580, east of I-880, were highest during midday. Truck flow on I-880/I-80, south of SR-24, also had the heaviest volume during the midday, from 6.8 to12.0 percent of all vehicles. Truck traffic for this segment of the freeway was heaviest northbound in the morning and southbound during the evening.

Truck Travel During Peak Periods

The 1991 Phoenix survey found that peak period for truck travel occurred between 9:00 a.m. and 2 p.m. The results, however, vary by individual location. Heavy trucks, however, have a shorter peak period (11:00 a.m. to 2 p.m.); 13 percent of total daily commercial vehicle travel for heavy trucks occurred between this period. In Ontario, truck volume in proportion to the total traffic volume was found to be greatest during the early morning hours (3:00 to 5:00 a.m.). The survey also found that through traffic seemed to avoid the peak period. In New York and New Jersey, over 35 percent of trucks made trips during the morning peak period (6:00 a.m. to 10 a.m.). In comparison with AM and PM peaks for private vehicle travel, the results found that the AM peak period travel was as important for commercial vehicles as for private vehicles.

Truck Travel During Peak Periods as Percent of Total Vehicular Volume

In New York and New Jersey (1991), trucks at the 6 crossings represented an average of 11 percent of the total peak period vehicular traffic. Large trucks accounted for 45 percent of the peak period truck travel, and over 35 percent of trucks made trips during the morning peak period (6:00 a.m. to 10 a.m.). In Ontario (1988), trucks were found to constitute 17 percent of the total vehicular traffic. The 1988 Caltrans Urban Freeway Gridlock Study found that few highly congested freeways in California have a high proportion (more than 10 percent) of large trucks in the traffic stream. At 90 percent of the 78 sites sampled, large trucks were 9 percent or less of all vehicles. I-5, I-605, I-710, and SR-60 in Los Angeles and I-80, I-580, and I-880 in San Francisco were identified to be highly congested with more than 10 percent of the traffic comprised of large trucks.

Day-of-Week Distribution

Truck traffic typically occurs on the weekday. A 7-day classification count for the 1988 Ontario survey found that truck traffic was highest on Wednesdays, and Sundays produced the least amount of truck traffic.

Average Trip Duration

The 1991 Phoenix survey recorded that the overall average trip time for truck travel was 28.1 minutes. Trip time generally increased with vehicle weight.

Truck Travel by Facility Type

Few surveys or studies have attempted to analyze truck trips based on facility type used. Only the Canadians used facility types to classify their truck trips. The 1991 Barton-Aschman Study also attempted to collect data on facility type used for each truck trip. The result found that many of the approximately 5,000 daily truck trips in the Port of Oakland area are local trips that never access a freeway.

Route Choice for Return Trips

The only survey that analyzed route choice for return trips was the 1991 New York and New Jersey Truck Commodity Survey. It found that 73 percent of the truck drivers interviewed in the toll direction indicated that they would use the same route for the reverse trip.

On-Street Stops

The 1991 Phoenix survey was the only to report the number of on-street stops made by trucks. The results found that over one-third of all commercial vehicles stops were made on-street. Light vehicles made half of their stops on-street.

Commercial Vehicle Trips and Land Use

Trips by Land Use

Light trucks make more residential trips than any other truck category. The 1991 Phoenix survey found that trucks in the medium weight category made significant proportion of trips to residential areas. These trips were speculated to be largely solid waste pick-ups. Heavy trucks in the survey were also found to make high proportion of trips (26.7 percent) to residential land uses. Analysis showed that the reason could be that heavy trucks, to a large extent, were used to delivery construction materials, including lumber and ready-mixed concrete to residential construction sites. The 1991 Phoenix survey also found that of the total number of vehicles used for commercial

purposes, 41.9 percent were also used for travel between home and work. The 1986 CATS survey found that light truck trip ends dominated all land uses, except for the landfill and in-transit categories. Retail attracted many more light and medium truck trips. The survey also found a strong relationship between heavy trucks and terminal/warehouse land uses; 42.6 percent of heavy trucks were destined to terminal/warehouse facilities. The 1991 New York-New Jersey Truck Commodity Survey found that most trucks were traveling within the region and to other warehouses or points of consumption within the region (retail stores, residences).

Facility of Trip Origin

In New York and New Jersey, warehouses were the predominant points of origin - 45 percent of trucks originanted from warehouses. Of the nearly one quarter that originated from factories, nearly 60 percent came from factories within the region.

Activities at Trip Ends

The 1991 Phoenix survey found that light trucks were heavily used for service delivery and personal business. Heavy trucks were most used for loading and unloading cargo at their trip ends.

Other Truck-Related Findings

Truck Travel and Dangerous Goods Movement

The Ontario survey (1988) was the only survey that obtained information on dangerous goods movement. It found that a total of about 5 to 6 percent of all truck trips surveyed involved the carrying of dangerous goods. Flammable liquids (47 percent) were the most frequently transported dangerous goods, followed by compressed gases (24 percent), and corrosive substances (20 percent).

Truck-Related Accidents

The 1988 Caltrans Urban Freeway Gridlock Study found that 5 to 10 percent of all truck-related incidents were found to cause major incidents which closed two or more freeway lanes for at least two hours.

RECOMMENDATIONS

In light of the study findings, this report recommends the following for conducting a regional truck travel survey and truck travel demand forecasting:

Survey Conduct

- For internal-to-internal or internal-to-external truck trips, draw the survey sample from the DMV registration file. Conduct either a telephone or mailout-mailback survey, or a combination of both to obtain a better response rate.
- For external-to-internal or external-to-external truck trips, conduct roadside intercept surveys at various facilities and links in the network. The best places to conduct them are "weigh-in-motion" stations. This would minimize traffic delay for the mainline and would be safer for the survey crews compared to conducting the survey at the roadside.
- Consider conducting intercept surveys at bridge toll plazas. For a better explanation of how to conduct roadside surveys at toll plazas, review the experiences in New York and New Jersey.
- For roadside interviews or cordon surveys, conduct vehicle classification counts at the same time and at the same location where the actual survey/interview is conducted. This will provide the basic information for sample expansion and analysis.
- For obtaining trip diaries, using a combination of fleet-employer samples and truck unit samples is desirable. Sub-sampling fleet employers will provide better sample control and reduce the problem of oversampling large fleet operators.
- Oversample smaller or individual truck operators. The 1986 CATS survey has shown that large fleet operators tend to respond better (more manpower, time, or incentive to reply to surveys) and smaller operators tend to yield higher non-responses.
- To reduce the cost of conducting a full-scale truck survey, consider making the survey a multi-agency effort.
- Consider soliciting the help of private freight/trucking agencies or organizations. Open a dialog with interested parties to facilitate cooperation and to request assistance. Working partnerships with the freight/trucking industry will help in designing and testing pilot surveys and in collecting data that would meet the needs of the private sector, as well as the public sector.

Truck Travel Analysis

- Time-of-day (24-hour), day-of-week, and seasonal variations in truck travel should be examined.
- Analyze trips by facility types used (include questions that obtain facility type information for each trip).

- Conduct further analysis on the impact trucks have on peak period congestion. Several surveys (New York, New Jersey, and Ontario) have found that in comparison with AM and PM peaks for private vehicle travel, AM peak period travel was as important for commercial vehicles as for private vehicles.
- Estimate total truck hours of delay by facility to help reduce truck operating cost.
- Conduct further analysis on the impact of truck traffic on pavement, especially the impact of waste-refuse trucks and buses (considered as "passenger-carrying trucks") on residential arterials and streets.
- The origins and destinations of trips that begin and end within the study area should be geocoded to the transportation analysis zones (TAZs) rather at the city or zip code level. This would improve the accuracy of truck trip generation models based on zonal socioeconomic attributes.
- Exercise extreme caution when using or applying vehicle equivalency factors (VEQs) in truck travel analysis.

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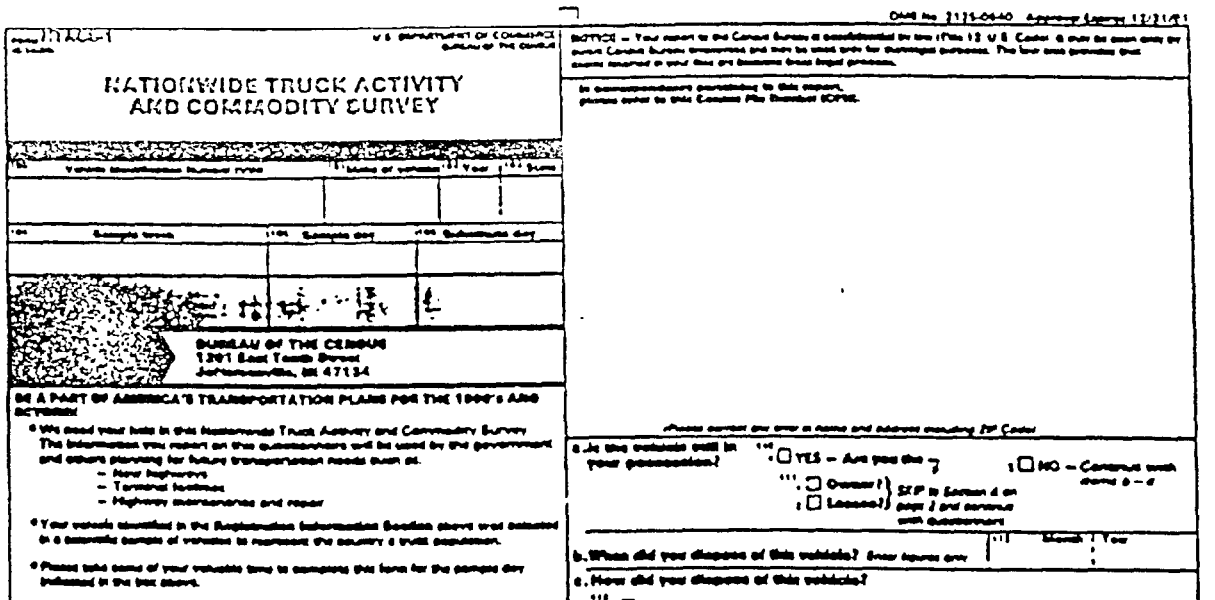
APPENDIX I
NTACS Survey Form
(Poor copy due to poor original survey copy)

THE 1990 NTACS-1 QUESTIONNAIRE

This section contains a copy of the 1990 NTACS-1 questionnaire. Not all NTACS reported data are included in the NTACS Public Use File mainly due to high item nonresponse rates.

Some other data items such as "current home base state" have been suppressed or aggregated for confidentiality reasons.



NATIONWIDE TRUCK ACTIVITY AND COMMODITY SURVEY

BUREAU OF THE CENSUS
1201 East Tenth Street
Jeffersonville, IN 47134

Section A — Vehicle Information

1a. Do you currently operate this vehicle? ☐ YES ☐ NO

If "No" indicate present status: ☐ Sold ☐ Destroyed ☐ Stolen ☐ Other – Specify _____

b. How many months during the past 12 months did you operate this vehicle? _____ Months

2a. Where is the current home base of this vehicle?

1 Home Base – refers to where the vehicle is usually parked or dispatched

City _____ County _____ State _____ ZIP Code _____

b. How many miles was this vehicle driven during the past 12 months? _____ Miles – round off to nearest 1,000 miles

c. In how many states did this vehicle operate during the past 12 months? _____ States

d. List the three States with the highest mileage during the past 12 months –

(1) _____

(2) _____

(3) _____

e. Did this vehicle operate in Canada during the past 12 months? ☐ YES – Mark (X) the provinces and territories

☐ Newfoundland ☐ Manitoba
☐ Prince Edward Island ☐ Saskatchewan
☐ Nova Scotia ☐ Alberta
☐ New Brunswick ☐ British Columbia
☐ Quebec ☐ Yukon Territory
☐ Ontario ☐ Northwest Territories

☐ NO

f. Did this vehicle operate in Mexico during the past 12 months? ☐ YES ☐ NO

3. What percent of this vehicle's fuel during the past 12 months was obtained from –

a. Private fuel dump? _____ %

b. Gas stations (truck stops, etc.)? _____ %

4. SAMPLE WEEK

For each day of the sample week (shown in the Registration information on page 1) check "Yes" if the vehicle operated on that day, otherwise check "No"

(Operating includes traveling empty)

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO	☐ YES ☐ NO

Section B — Vehicle Description

The following questions relate to the vehicle's use during the sample day and the past 12 months. If this vehicle did not operate on the sample day, use the substitute day. If the vehicle did not operate on the sample day or substitute day, call (301) 763–1744 collect.

1. This truck was MOST FREQUENTLY operated as – Mark (X) only one box in each column

	Sample day	Past 12 months
a. Personal transportation	☐	☐
b. Contract carrier	☐	☐
c. Common carrier	☐	☐
d. Other business use	☐	☐

2. How would you best describe this vehicle as it was MOST FREQUENTLY operated during each period? Mark (X) only one box in each column

a. Straight truck with 4 tires without trailer	☐	☐
b. Straight truck with 4 tires pulling trailer(s)	☐	☐
c. Straight truck with 6 or more tires without trailer	☐	☐
d. Straight truck with 6 or more tires pulling trailer(s)	☐	☐
e. Truck tractor (power unit) pulling trailer(s)	☐	☐
f. Truck tractor without trailer	☐	☐
g. Other – Specify in the columns _____	☐	☐

3. Indicate the kind(s) of trailer(s) pulled during each period.

	Mark (X) all that apply	Mark (X) only one
a. No trailer pulled	☐	☐
b. Utility and other trailers less than 20 feet used with straight truck		
(1) One axle on trailer	☐	☐
(2) Two axles on trailer	☐	☐
(3) Three or more axles on trailer	☐	☐
c. One full trailer used with straight truck		
(1) Two axles on trailer	☐	☐
(2) Three axles on trailer	☐	☐
(3) Four or more axles on trailer	☐	☐
d. One semi-trailer		
(1) One axle on trailer	☐	☐
(2) Two axles on trailer	☐	☐
(3) Three or more axles on trailer	☐	☐
e. Two trailers, one semi- and one full		
(1) Three axles on two trailers	☐	☐
(2) Four axles on two trailers	☐	☐
(3) Five axles on two trailers	☐	☐
(4) Six or more axles on two trailers	☐	☐
f. Three trailers, one semi- and two full		
(1) Five axles on three trailers	☐	☐
(2) Six axles on three trailers	☐	☐
(3) Seven axles on three trailers	☐	☐
(4) Eight or more axles on three trailers	☐	☐
g. Other – Please describe in detail the number of trailers and axles on these trailers. Specify in the columns _____	☐	☐

Section B — Vehicle Description — Continued

4. Indicate the body type that most closely resembles this vehicle during the sample period. If the power unit is a truck-tractor indicate the body type of the trailer(s) attached.

Mark (X) only one box in each column.

	Sample day	Past 12 months
A. PLATFORM TYPES, including flatbeds, stakes, and flatbeds with added devices and low bed specialized	302 ☐	304 ☐
B. PICKUP	306 ☐	307 ☐
C. PANEL OR COMPACT VAN	310 ☐	311 ☐
D. MINI-VAN, UTILITY, STATION WAGON (Blazer, Jeep, etc.)	313 ☐	314 ☐
E. VAN TYPES, including enclosed vans, open top vans, drop frame vans, refrigerated, nonrefrigerated, and multistop and high cubes	316 ☐	318 ☐
F. SPECIALIZED USE TRUCKS		
1. Automobile or boat transport	321 ☐	322 ☐
2. Beverage truck	324 ☐	325 ☐
3. Removable dry container on trailer chassis	327 ☐	328 ☐
4. Removable liquid container on trailer chassis	330 ☐	331 ☐
5. Other cargo container chassis	332 ☐	334 ☐
6. Concrete mixer	335 ☐	336 ☐
7. Dump truck	338 ☐	340 ☐
8. Grain hauler (including hoppers, grain boxes)	341 ☐	342 ☐
9. Garbage truck	343 ☐	345 ☐
10. Livestock truck, including livestock stock frame	346 ☐	348 ☐
11. Pole, logging, or pipe truck	349 ☐	350 ☐
12. Tank truck for dry bulk	351 ☐	352 ☐
13. Tank truck for liquids or gases (nonhazardous materials)	353 ☐	354 ☐
14. Tank truck for liquids or gases (hazardous materials — indicate cargo shown placard on tank)	356 ☐	358 ☐
a. MC 307	359 ☐	360 ☐
b. MC-331	361 ☐	362 ☐
c. MC-312	363 ☐	364 ☐
d. MC 337	365 ☐	366 ☐
e. MC 306	367 ☐	368 ☐
15. Utility truck	369 ☐	370 ☐

Check — If none of the above descriptions match the body type of the vehicle, or the trailer usually attached to it, mark the "Other" box and describe the vehicle.

6. Other — Specify on the columns →	371 ☐	372 ☐

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Section C — Vehicle Use

The following questions relate to the vehicle's use DURING THE SAMPLE DAY. If the vehicle did not operate on the sample day, use the subsequent day. If the vehicle did not operate on either day given, call (301) 763-1744 collect.

1. Enter date used (Enter figures only) — Month ____ Day ____ Year ____

2. What was the odometer reading of the vehicle at 12:01 a.m. on the sample day? ____ Miles (If tenths are not estimated)

3a. How many miles did the vehicle travel during the sample day? ____ Miles (If tenths are not estimated)

b. What percent of these miles were on the INTERSTATE HIGHWAY SYSTEM? ____ %

c. What percent of these miles were on roads which had four or more lanes but were NOT on the INTERSTATE HIGHWAY SYSTEM? ____ %

d. What percent of these miles were off-road (little travel on public roads)? ____ %

4a. How much fuel was used during the sample day? ____ U.S. gallons (If tenths are not estimated)

b. How much was paid in highway tolls during the sample day? $ ____

5a. What was the size of this vehicle —

	As it left the starting place on the sample day? (11)	During the sample day when vehicle was at its maximum weight? (12)
Length (ft.) (Front bumper to end of last trailer)	____ ft.	____ ft.
Height (ft.)	____ ft.	____ ft.
Tare weight (empty)	____ lbs.	____ lbs.
Loaded vehicle weight (weight of truck and cargo)	____ lbs.	____ lbs.
Percent of payload space utilized	____ %	____ %

b. How would you best describe the vehicle's loads during the sample day? (If the vehicle was empty the entire day, check the box that typically applies)
1 ☐ Single shipments (Truck load)
2 ☐ Several shipments on a truck or trailer (Less-than-truck load), including shipments consolidated by others

6. Was the vehicle used to haul hazardous materials in quantities large enough to require a special placard due to the Code of Federal Regulations, title 49, Transportation, during the sample day?
1 ☐ YES
2 ☐ NO

7a. How many employees, including owner/operators, were on board the vehicle as it left the starting place on the sample day? ____ Employees on board

b. How many of the employees above the vehicle sometime during the sample day? ____ Employees who drove

8. Mark all boxes that include the hours during which you operated the vehicle during the sample day.
01 ☐ 12:01 a.m. – 4:00 a.m.
02 ☐ 4:01 a.m. – 6:00 a.m.
03 ☐ 6:01 a.m. – 8:00 a.m.
04 ☐ 8:01 a.m. – 10:00 a.m.
05 ☐ 10:01 a.m. – 2:00 p.m.
06 ☐ 2:01 p.m. – 4:00 p.m.
07 ☐ 4:01 p.m. – 6:00 p.m.
08 ☐ 6:01 p.m. – 12:00 a.m.

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Section C — Vehicle Use — Continued

COMMODITY REFERENCE LIST FOR USE IN ITEMS 9(e), 9(f), 13(e), AND 14(d)

(This is a list of products, materials and equipment the vehicle may have carried)

Part A – HAZARDOUS MATERIALS	Hazmat code
Flammable liquids	41
Combustible liquids	42
Corrosive liquids	43
Poison B solids	44
Poison B liquids	45
Flammable solids	46
Oxidizers	47
Flammable gas	48
Nonflammable gas	49
Poison A	50
Corrosive solids	51
Explosives, A or B	52
Blasting agents	53
Radioactive materials	54
ORM – A, B, or C	55
ORM E	56
Hazardous materials not listed above – Specify ↗ ______	57

Part B – PRODUCTS, EQUIPMENT, MATERIALS, ETC.	Commodity code
Agricultural and Food Products	
Live animals – cattle, horses, poultry, hogs, fish, and other marine products, etc.	15
Fresh farm products – grain, grass, flowers, nursery stock, raw milk, raw tobacco, etc.	16
Processed foods – canned goods, prepared meats, frozen foods, beverages, bottled water, dairy products, tobacco products, etc.	17
Mining Products unrefined – crude oil, coal and metal ores	18
Building materials – gravel, sand, concrete, glass, and stone, etc.	19
Forestry, Wood and Paper Products	
Logs and forest products – Except cut lumber and fabricated wood products, tree bark, barks or gums	20
Lumber and fabricated wood products – Except furniture	21
Paper, printed matter and paper products	22
Chemicals, Petroleum, and Allied Products	
Chemicals and/or drugs – Including fertilizers, pesticides, cosmetics, paints, etc.	23
Petroleum, petroleum products, paving, and asphalt or tar cements	24
Plastics and/or rubber products	25
Metals and Metal Products	
Primary metal products – pipes, ingots, billets, metal sheets, etc.	26
Fabricated metal products and bolts and nuts – Except machinery or transportation equipment (See below)	27
Machinery – electrical or nonelectrical	28
Transportation equipment (including complete vehicles) and parts	29
Other Manufactured Products	
Furniture (office and residential) and/or fixtures – not involved in household moving	30
Textiles and apparels – fibers, leather goods, carpets, clothing, etc.	31
Miscellaneous products of manufacturing – Including photographic goods, watches, clocks, jewelry and toys	32
Miscellaneous	
Moving of household and office furniture, including vehicles – from home, offices, etc., under contract	33
Mixed cargo, general freight, personal goods, mail and express traffic, and small packaged freight	34
Tools/parts for specialized use as in craftsman's vehicle	35
Scrap, garbage, trash	36
Industrial waste	37
Other – Please describe in detail ______	38
______	39
NO LOAD CARRIED – Vehicle empty	40

Type of Place Codes

(Refer to these codes for completing items 9(c), 13(d) and 14(b))

- A – Railroad facility (servicing facility)
- B – Railroad facility (pickup or delivery of rail shipment)
- C – Airport (servicing facility)
- D – Airport (pickup or delivery of air shipment)
- E – Harbor or port facility (servicing facility)
- F – Harbor/port facility (pickup or delivery of water shipment)
- G – Truck/bus terminal not part of airport, harbor, or railroad
- H – Warehouse
- I – Tank farm
- J – Power plant/distribution center
- K – House, apartment building
- L – Forest, farm, field, farm building, fisheries
- M – Grain elevator, stockyard
- N – Mine, quarry, gravel pit, stone crusher
- O – Construction site
- P – Manufacturing facility or assembly plant
- Q – Store or other retail or service outlet
- R – Office building, school, hospital, other public facilities
- S – Park or other recreational facility
- T – Other

Section C — Vehicle Use — Continued

9. Enter below the following data for EACH STOP during the entire SAMPLE DAY only. Exclude stops for food, fuel or rest.

SAMPLE DAY STOPS — If traveling at the beginning of sample day, enter where vehicle was at 12:01 a.m. for starting place (a)	Type of place code (See the type of place code list above) (b)	Miles from previous stop (c)	What was the purpose of the stop? Mark (X) all that apply (d)	From the reference list of commodities, on page 4 enter the code and weight for the items picked up and/or delivered at each stop of you. (See instructions sheet) — Items delivered (e): Commodity code	Hazmat code	Weight (lbs.)	Items picked up (f): Commodity code	Hazmat code	Weight (lbs.)
[illegible] Starting place — Date; Arrival time; Departure time a.m./p.m.; City; County; State; Loaded vehicle wt. at departure; No. of trailers attached			☐ Base ☐ Pick up items ☐ Pick up trailer ☐ Delivery ☐ Drop off trailer ☐ Other or in transit – Specify ↗						
Stop 1 — Arrival time a.m./p.m.; Departure time a.m./p.m.; City; County; State; Loaded vehicle wt. at departure; No. of trailers attached		From starting place	☐ Return to base ☐ Pick up items ☐ Pick up trailer ☐ Delivery ☐ Drop off trailer ☐ Other – Specify ↗						
Stop 2 — Arrival time a.m./p.m.; Departure time a.m./p.m.; City; County; State; Loaded vehicle wt. at departure; No. of trailers attached		From stop 1	☐ Return to base ☐ Pick up items ☐ Pick up trailer ☐ Delivery ☐ Drop off trailer ☐ Other – Specify ↗						
Stop 3 — Arrival time a.m./p.m.; Departure time a.m./p.m.; City; County; State; Loaded vehicle wt. at departure; No. of trailers attached		From stop 2	☐ Return to base ☐ Pick up items ☐ Pick up trailer ☐ Delivery ☐ Drop off trailer ☐ Other – Specify ↗						
Stop 4 — Arrival time a.m./p.m.; Departure time a.m./p.m.; City; County; State; Loaded vehicle wt. at departure; No. of trailers attached		From stop 3	☐ Return to base ☐ Pick up items ☐ Pick up trailer ☐ Delivery ☐ Drop off trailer ☐ Other – Specify ↗						
Stop 5 — Arrival time a.m./p.m.; Departure time a.m./p.m.; City; County; State; Loaded vehicle wt. at departure; No. of trailers attached		From stop 4	☐ Return to base ☐ Pick up items ☐ Pick up trailer ☐ Delivery ☐ Drop off trailer ☐ Other – Specify ↗						

ADDITIONAL SAMPLE DAY STOPS

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)

ADDITIONAL SAMPLE DAY STOPS

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)

ADDITIONAL SAMPLE DAY STOPS

(a)	Type of place code — Enter the type of place code from p. 4 (b)	Index from previous stop? (c)	What was the purpose of the stop? Mark (X) all that apply (d)	Items delivered (e): Commodity code	Hazmat code	Weight (lbs.)	Items picked up (f): Commodity code	Hazmat code	Weight (lbs.)
Stop No. — Date — Time of arrival a.m./p.m. — Departure time a.m./p.m. — City — County — State — Loaded vehicle wt. at departure — No. of trailers attached			[ ] Return to base; [ ] Pick up items; [ ] Pick up trailer; [ ] Delivery; [ ] Drop off trailer; [ ] Other – Specify						
Stop No. — Date — Time of arrival a.m./p.m. — Departure time a.m./p.m. — City — County — State — Loaded vehicle wt. at departure — No. of trailers attached			[ ] Return to base; [ ] Pick up items; [ ] Pick up trailer; [ ] Delivery; [ ] Drop off trailer; [ ] Other – Specify						
Stop No. — Date — Time of arrival a.m./p.m. — Departure time a.m./p.m. — City — County — State — Loaded vehicle wt. at departure — No. of trailers attached			[ ] Return to base; [ ] Pick up items; [ ] Pick up trailer; [ ] Delivery; [ ] Drop off trailer; [ ] Other – Specify						
Stop No. — Date — Time of arrival a.m./p.m. — Departure time a.m./p.m. — City — County — State — Loaded vehicle wt. at departure — No. of trailers attached			[ ] Return to base; [ ] Pick up items; [ ] Pick up trailer; [ ] Delivery; [ ] Drop off trailer; [ ] Other – Specify						
Stop No. — Date — Time of arrival a.m./p.m. — Departure time a.m./p.m. — City — County — State — Loaded vehicle wt. at departure — No. of trailers attached			[ ] Return to base; [ ] Pick up items; [ ] Pick up trailer; [ ] Delivery; [ ] Drop off trailer; [ ] Other – Specify						
Stop No. — Date — Time of arrival a.m./p.m. — Departure time a.m./p.m. — City — County — State — Loaded vehicle wt. at departure — No. of trailers attached			[ ] Return to base; [ ] Pick up items; [ ] Pick up trailer; [ ] Delivery; [ ] Drop off trailer; [ ] Other – Specify						

If you made more stops, please copy this page! **Thank you for your cooperation!**

Section C — Vehicle Use — Continued

10. How many stops were made by this vehicle to each TYPE OF PLACE during the sample day? If the place where vehicle was stopped fits into more than one type of place, pick the one that best describes it. (Exclude stops for food, fuel, and rest.)

Code	Type of place	No. of stops	Code	Type of place	No. of stops
A	Railroad facility (servicing facility)		K	House, apartment building	
B	Railroad facility (pickup or delivery of rail shipment)		L	Forest, farm, field, farm building, fisheries	
C	Airport (servicing facility)		M	Grain elevator, stockyard	
D	Airport (pickup or delivery of air shipment)		N	Mine, quarry, gravel pit, stone crusher	
E	Harbor or port facility (servicing facility)		O	Construction site	
F	Harbor/port facility (pickup or delivery of water shipment)		P	Manufacturing facility or assembly plant	
G	Truck/bus terminal not part of airport, harbor, or railroad		Q	Store or other retail or service outlet	
H	Warehouse		R	Office building, school, hospital, other public facilities	
I	Tank farm		S	Park or other recreational facility	
J	Power plant/distribution station		T	Other	

11. How many stops were made for food, fuel, and rest during the sample day? ______ Stops

12. What was the odometer reading of the vehicle at 11:00 p.m. on the sample day? ______ Miles (Estimates are acceptable)

13a. Where was the last pickup or delivery prior to the sample day? Date — Departure time a.m./p.m. — City — County — State — Loaded vehicle weight at departure — No. of trailers attached

b. What type of place was this? Enter the type of place letter code from item 10 above ______ Type of place

c. From the reference list of commodities, enter the code and weight for the items picked up or delivered. (See page 8)

Items delivered: Commodity code	Hazmat code	Weight (lbs.)	Items picked up: Commodity code	Hazmat code	Weight (lbs.)

14a. Where was the first pickup or delivery after the sample day? Date — Arrival time a.m./p.m. — City — County — State — Loaded vehicle weight at departure — No. of trailers attached

b. What type of place was this? Enter the type of place letter code from item 10 above ______ Type of place

c. How many miles from last stop on the sample day? ______ Miles (Estimates are acceptable)

d. From the reference list of commodities, enter the code and weight for the items picked up or delivered. (See page 8)

Items delivered: Commodity code	Hazmat code	Weight (lbs.)	Items picked up: Commodity code	Hazmat code	Weight (lbs.)

CERTIFICATION — This report is substantially accurate and has been prepared in accordance with instructions.

Name — Date — Telephone: Area code, Number, Extension

APPENDIX II
NTTIS Survey Form

State ___ ___ (1 2) Selection No. ___ ___ ___ (3 4 5) Date Code ___ ___ (6 7)

NTTIS COMPANY & POWER UNIT DESCRIPTION

COMPANY DESCRIPTION

OPERATING AUTHORITY:

Is this a daily rental truck? YES[ ]17
Is this truck govt. owned? (city/county/state/federal) YES[ ]16 (8)

→ *SKIP to Power Unit Description below.*

Do any of your trucks ever carry goods interstate (across state lines)?

[ ]1 YES → Are you
- PRIVATE (Carry own goods) [ ]1 → [ ]1
- FOR HIRE (Carry other people's goods) [ ]2 → ICC Authorized (common/contract) [ ]2; Exempt [ ]3 → Is the owner also the driver? YES [ ]1 NO [ ]2

[ ]2 NO → Are you
- PRIVATE (Carry own goods) [ ]1 → [ ]4
- FOR HIRE (Carry other people's goods) [ ]2 → [ ]5 (11) → Is the owner also the driver? YES [ ]1 NO [ ]2

[ ]9 UNKNOWN →
- PRIVATE [ ]1
- FOR HIRE [ ]2 (10) → Is the owner also the driver? YES [ ]1 NO [ ]2 (12)

POWER UNIT DESCRIPTION

Verify the make, model year, and VIN, and ask for the model name and company unit number.

1. Make _____ Year: 19___ ___ VIN _____
2. Model Name _____ Company Unit Number _____
3. *EDITOR:* Code the base state of operation ___ ___ (13 14)
4. POWER UNIT TYPE
   - Tractor [ ]8
   - Straight Truck [ ]1 (15)

   STRAIGHT TRUCK BODY STYLE:
   - Van [ ]1
   - Flatbed [ ]2
   - Tanker [ ]3
   - Refrig. [ ]5
   - Dump [ ]6
   - Refuse [ ]7
   - Other [ ]8 (16)

   _____ *(Specify)*
5. NUMBER OF AXLES
   - Two [ ]2
   - Three [ ]3
   - Four + [ ]4 (17)
6. CAB STYLE
   - Cab Forward [ ]1
   - Cab Over [ ]2
   - Short Conventional [ ]3
   - Med. Conventional [ ]4
   - Long Conventional [ ]5 (18)
7. FUEL
   - Gas [ ]1
   - Diesel [ ]2
   - Other _____ [ ]3 (19) *(Specify)*
8. Power Unit EMPTY WEIGHT: ___ ___ ___ ___ ___ ___ (20 21 22 23 24 25)
9. Power Unit LENGTH: ___ ___ ___ (26 27 28)
10. Estimated Annual Mileage *for this power unit:* ___ ___ ___ ___ ___ ___ (29 30 31 32 33 34)
11. Percent of annual mileage for each trip type *for this power unit:*
    - Local *(Pickup and delivery, with 50 mile radius)* ___ ___ ___ % (35 36 37)
    - Short Haul *(Intercity, one-way, distance 50-200 miles)* ___ ___ ___ % (38 39 40)
    - Long Haul *(Intercity, one-way, distance 200+ miles)* ___ ___ ___ % (41 42 43)

    (Total=100%)
12. Does this power unit ever pull twin trailers?
    [ ] Yes Percent of annual mileage with twin trailers: ___ ___ ___ % (44 45 46)
    [ ] No *(Enter 000.)*

Selection No. ____ (1-4) Date Code ____ (5-6) Quarter ____ (7) Survey Date ____/____/____

NTTIS SURVEY DAY TRIPS

TRIP ____ (8-9)

VEHICLE, CARGO, AND DRIVER

1. OPERATING AUTHORITY (Private Carriers only)
   Were you operating for-hire (e.g., on backhaul)?
   [ ]1 No
   [ ]2 Yes (10) Was it as? ICC (common/contract) [ ]2
   Exempt (interstate hauling only) [ ]3
   Intrastate for-hire [ ]5 (11)

2. DRIVER AGE: ____ Yrs. (12-13)

3. DRIVER YEARS WITH COMPANY: ____ Yrs. (14-15)

4. CONFIGURATION: Any trailers? No [ ]1
   Yes [ ]2 (16)

	Power Unit	1st Trailer	2nd Trailer	3rd Trailer
Type:		Semi [ ]1		
		Full [ ]2	Full [ ]2	Full [ ]2
		Utility [ ]3	Utility [ ]3	Utility [ ]3
		Other [ ]4	Other [ ]4	Other [ ]4
		None [ ]5 (17)	None [ ]5 (18)	None [ ]5 (19)
Body:		Van [ ]1	Van [ ]1	Van [ ]1
		Flatbed [ ]2	Flatbed [ ]2	Flatbed [ ]2
		Tank [ ]3	Tank [ ]3	Tank [ ]3
		Auto C. [ ]4	Auto C. [ ]4	Auto C. [ ]4
		Dump [ ]6	Dump [ ]6	Dump [ ]6
		Other [ ]8 (20)	Other [ ]8 (21)	Other [ ]8 (22)
		(Specify)	(Specify)	(Specify)
No. Axles Used:	____ (23)	____ (24)	____ (25)	____ (26)
Lengths (Ft):	____ (27-29)	____ (30-32)	____ (33-35)	____ (36-38)
Empty Wts (Lbs):		____ (39-42)	____ (43-46)	____ (51-54)
5. CARGO:	____ [ ] (57-58)	____ [ ] (59-60)	____ [ ] (61-62)	____ [ ] (63-64)
Cargo Wt (Lbs):	____ (65-70)	____ (71-76)	____ (77-82)	____ (83-88)
Hazardous Cargo	Yes [ ]1 No [ ]2 (89)	Yes [ ]1 No [ ]2 (90)	Yes [ ]1 No [ ]2 (91)	Yes [ ]1 No [ ]2 (92)

6. GROSS COMBINATION WEIGHT for the trip (Lbs): ____ (93-98) [1] (99) DUP 1-9

MILEAGE

1. Starting Point ____ (City) ____ (State) Time: ____ AM[ ] PM[ ]

2. End Point ____ (City) ____ (State) Time: ____ AM[ ] PM[ ]

3. Via ____
   (Describe route/give road nos., etc.)
   ____

4. Total Miles for Trip: ____ (10-13)

5. Breakdown of Mileage:

	LIMITED ACCESS		US/STATE/MAJOR ARTERY		OTHER	
	Day (6am-9pm)	Night (9pm-6am)	Day (6am-9pm)	Night (9pm-6am)	Day (6am-9pm)	Night (9pm-6am)
Rural:	(14-17)	(18-21)	(22-25)	(26-29)	(30-33)	(34-37)
Sm Urban: (Pink & Orange)	(38-41)	(42-45)	(46-49)	(50-53)	(54-57)	(58-61)
Lg Urban: (Yellow)	(62-65)	(66-69)	(70-73)	(74-77)	(78-81)	(82-85)

6. Specific Large Urban Area: ____ (86-87) [2] (99)

(Over)

APPENDIX III
1986 CATS Commercial Vehicle Survey Form

CHICAGO AREA TRANSPORTATION STUDY
ILLINOIS DEPARTMENT OF TRANSPORTATION

300 WEST ADAMS STREET CHICAGO, ILLINOIS 60606
TELEPHONE: 793-3464

1986
COMMERCIAL VEHICLE SURVEY
Vehicle Trip Record

THIS TRIP RECORD WILL ACCOMPANY THE ABOVE VEHICLE FOR A PERIOD OF 24 HOURS BEGINNING AT 12:01 AM ON TUESDAY, FEBRUARY 25, 1986.

CONFIDENTIAL
The information obtained from this study will be afforded complete confidentiality, and will be used for statistical/analytical purposes only.

A PERSONAL MESSAGE TO THE DRIVER OR DRIVERS

YOUR CHANCE TO GIVE US YOUR TWO CENTS' WORTH

Please take a minute to read this and to look through the Trip Record before starting out. We need your help but we don't want it to be difficult for you.

About CATS

The Chicago Area Transportation Study (CATS) is a government agency that does transportation planning for Northeast Illinois. It does studies of transportation and travel activity, including trucks and buses. CATS also maintains computer programs to project future traffic conditions.

CATS produces two major work items, which are (1) Long Range Transportation Plans (5-year and 20 year projections) and (2) the Transportation Improvement Program, which is a yearly program of specific scheduled improvements such as road surfacing and widening, signalling improvements, grade crossings and separations, etc.

About This Study

This Trip Record will give CATS a "Day in the Life" look at the region's truck fleet - what it does and where it goes. Your help, as follows out the Record, and the information we get from it will be unobtainable any other way. Please keep a record of the activity of Tuesday, February 25, 1986.

NOTE: If the weather on that day is so bad that the vehicle will be unable to complete a full and normal workday, then please keep the Trip Record on another day later in the same week.

About The Results

All information collected from the Survey will be treated in the strictest confidence. Note that we are only interested in the TRUCK. We will only use the results for CATS' planning work. The information will help us in putting together future Transportation Improvement Programs.

The Commercial Vehicle Survey has been endorsed by the Illinois Trucking Association, and by the Chicago Association of Commerce and Industry.

In expectation of getting your help, I thank you.

YOU COUNT TO US. CAN WE COUNT YOU IN?

Yours appreciatively,

F. Gerald Ruering
Chief Freight Planner

We want to give you an idea of what we consider to be a trip, or trips, for the record. We will use an example of a school bus:

TRIP 1:	Bus goes from garage to starting point of scheduled route
TRIP 2:	Bus goes to grade school at end of route
TRIP 3:	Bus goes to high school (pick up party)
TRIP 4:	Bus goes to museum
TRIP 5:	Bus goes to holding area. Driver has lunch
TRIP 6:	Bus goes back to museum
TRIP 7:	Bus returns party to high school
TRIP 8:	Bus goes to grade school
TRIP 9:	Bus works scheduled route (end point might be the same as the end point of TRIP 1)
TRIP 10:	Bus goes to garage (END OF RECORD)

LICENSE PLATE NUMBER: _____
(This will confirm that the Trip Record is on the vehicle for which it is intended)

If the vehicle's normal work is being conducted by another (that is, different) vehicle, then please send the book out with the substitute vehicle.

LICENSE PLATE OF OTHER VEHICLE: _____

IF THE LICENSE PLATE HAS RECENTLY BEEN CHANGED, ENTER NEW PLATE NUMBER HERE: _____

STARTING ADDRESS (12:01 AM, FEBRUARY 25, 1986): _____

AT MIDNIGHT, THIS VEHICLE WAS (Check which applies):

- ☐ PARKED ON STREET
- ☐ PARKED ON COMPANY PROPERTY OR IN COMPANY GARAGE
- ☐ PARKED ON PERSONAL PROPERTY OR IN PERSONAL GARAGE
- ☐ IN TRANSIT (That is, at work)
- ☐ OUT OF STATE

IF THE VEHICLE WILL NOT WORK ON FEBRUARY 25, 1986 BECAUSE THERE IS NO WORK FOR IT, CHECK THIS BOX ☐

IF THE VEHICLE WILL NOT WORK ON FEBRUARY 25, 1986 BECAUSE IT IS NOT OPERATIONAL (For sale; in for service etc.) Check this box ☐

NOTE: This may take you back to the top of the page to enter the plate number of a substitute vehicle.

CONTACT PERSON FOR CATS TO FOLLOW UP WITH:

NAME: _____

TELEPHONE: _____

START TIME:

START ODOMETER READING:

	TRIP 1	TRIP 2	TRIP 3	TRIP 4	TRIP 5	TRIP 6	TRIP 7	TRIP 8
STOP TIME								
STOP ODOMETER								
STOP ON-STREET	☐	☐	☐	☐	☐	☐	☐	☐
STOP OFF-STREET	☐	☐	☐	☐	☐	☐	☐	☐
ACTIVITY AT STOP (Check one)								
Pick up, Load	☐	☐	☐	☐	☐	☐	☐	☐
Drop off, Unload	☐	☐	☐	☐	☐	☐	☐	☐
Load and Unload	☐	☐	☐	☐	☐	☐	☐	☐
Gas Up Vehicle	☐	☐	☐	☐	☐	☐	☐	☐
Meal or other personal	☐	☐	☐	☐	☐	☐	☐	☐
LAND USE AT STOP (Check one)								
Residential	☐	☐	☐	☐	☐	☐	☐	☐
Retail	☐	☐	☐	☐	☐	☐	☐	☐
Manufacturing	☐	☐	☐	☐	☐	☐	☐	☐
Transportation/Utilities/ Communications/Warehousing, including Wholesale	☐	☐	☐	☐	☐	☐	☐	☐
Public & Government, Incl. Museums, Schools, Libraries	☐	☐	☐	☐	☐	☐	☐	☐
Office & Services, incl. Finance Real Estate, Insurance, Hospitals	☐	☐	☐	☐	☐	☐	☐	☐
Other (Write in)								
TRUCK TYPE (Check one)								
Straight Truck	☐	☐	☐	☐	☐	☐	☐	☐
Tractor + Semitrailer	☐	☐	☐	☐	☐	☐	☐	☐
Tractor + Trailer	☐	☐	☐	☐	☐	☐	☐	☐
Bobtail	☐	☐	☐	☐	☐	☐	☐	☐

TRIP	NAME AND ADDRESS OF STOP (Please Include Zip Code)
1	
2	
3	
4	
5	
6	
7	
8	

START TIME:

START ODOMETER READING:

	TRIP 9	TRIP 10
STOP TIME		
STOP ODOMETER		
STOP ON-STREET	☐	☐
STOP OFF-STREET	☐	☐
ACTIVITY AT STOP (Check one)		
Pick up, Load	☐	☐
Drop off, Unload	☐	☐
Load and Unload	☐	☐
Gas Up Vehicle	☐	☐
Meal or other personal	☐	☐
LAND USE AT STOP (Check one)		
Residential	☐	☐
Retail	☐	☐
Manufacturing	☐	☐
Transportation/Utilities/ Communications/Warehousing, including Wholesale	☐	☐
Public & Government, incl. Museums, Schools, Libraries	☐	☐
Office & Services, incl. Finance Real Estate, Insurance, Hospitals	☐	☐
Other (Write in)		
TRUCK TYPE (Check one)		
Straight Truck	☐	☐
Tractor + Semitrailer	☐	☐
Tractor + Trailer	☐	☐
Bobtail	☐	☐

TRIP — NAME AND ADDRESS OF STOP (Please Include Zip Code)

9

10

IF THE VEHICLE MAKES MORE THAN 10 TRIPS FOR THE DAY, WRITE IN THE TOTAL NUMBER OF TRIPS HERE:

FINAL STOP ADDRESS

FINAL ODOMETER READING:

WHAT IS THE MOST COMMON COMMODITY THAT THIS VEHICLE HAULS?

THANK YOU FOR TAKING PART IN THIS IMPORTANT STUDY OF COMMERCIAL VEHICLE ACTIVITY.

IN THE SPACE PROVIDED, WHICH FOLLOWS, PLEASE TAKE THE OPPORTUNITY TO MAKE COMMENTS.

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 12710 CHICAGO, ILL.

POSTAGE WILL BE PAID BY ADDRESSEE

CHICAGO AREA TRANSPORTATION STUDY

300 WEST ADAMS STREET

CHICAGO, ILLINOIS 60606

Please reseal or staple before mailing

APPENDIX IV
1991 Phoenix Urban Truck Travel Survey Form

MARICOPA•ASSOCIATION•OF•GOVERNMENTS
Transportation & Planning Office
1739 West Jackson Street
Phoenix, Arizona 85007
(602) 255-7867

Dear Truck Owner,

Enclosed you will find a Vehicle Trip Record designed to study commercial vehicle transportation and travel activity. The survey will play an important part in planning for future transportation needs here in the Valley. We are interested in learning more about the day-to-day travel behavior of commercial vehicles in Maricopa County. We need your help. The vehicle with the license plate number listed on the label attached to the survey is the vehicle that should have its travel activity recorded on this Vehicle Trip Record. By having the driver of that vehicle fill out a travel log for just one day, you will help us learn more about how to help address Arizona's transportation concerns. We need the travel activity of that vehicle for Tuesday, October 3, 1989.

ABOUT MAG

The Maricopa Association of Governments (MAG) is a voluntary association of local governments that does transportation planning for Maricopa county. Research studies about transportation are conducted so that we can learn more about how to solve traffic problems that affect the Valley. We also maintain computer programs that help us to project future traffic patterns.

ABOUT THE STUDY

This Vehicle Trip Record is being filled out by several hundred commercial vehicle drivers in Maricopa county. Vehicles are randomly selected to participate in the study, and yours is one that has been selected. The information about the use of your vehicle will enable MAG to understand "a day in the life" of this county's fleet of commercial vehicles. We want to know what the vehicle is used for and where it goes. We are interested in the vehicle, but we need your help. By filling out the Vehicle Trip Record, your driver will be giving us information that we cannot get anywhere else. Through your record, we will learn more about that vehicle and others like it.

ABOUT THE RESULTS

All information gathered for this study is coming from individuals just like you drivers who are filling out identical Vehicle Trip Records. All of the information will be treated with the utmost confidentiality. We will use the information only for MAG purposes, to help us prepare future transportation improvement programs. Programs that we hope will help you.

You really count to us. Can we count on you? In expectation of getting your help with this study, I thank you. If you have any concerns about participating in the research, please call our Survey Information telephone line at 967-4441.

To proceed, the addressee should complete the first page of the Vehicle Trip Record and then forward the record to the driver of the appropriate vehicle as indicated on Page 1.

Yours appreciatively,

Roger Herzog
MAG Transportation & Planning
Office Manager

ADOT COMMERCIAL VEHICLE TRIP RECORD

***** A Personal Message To The Driver Or Drivers *****

If you have any questions, please call our Survey Information telephone line 967-4441.

Who should we contact if we have questions about your Vehicle Trip Record?

NAME _____

TELEPHONE NUMBER _____

X X

INSERT LABEL HERE

X X

1. What is the starting address for the vehicle listed on the label above on the survey date (the first Tuesday, Wednesday or Thursday after you received this survey)? Please be specific! Indicate St., Ave., North, South, East or West, nearest intersection if street address is unknown.

Street Address:_____

City:_____ Zip Code:_____

2. Please look at Figure 1 and determine which vehicle looks most like this vehicle. In the space provided below, write in the letter next to the picture of the vehicle which looks most like this vehicle. (If this vehicle normally operates with one or more trailers, write in the letter of the most common tractor/trailer configuration usually used.)

Letter of Vehicle From Figure 1: _____

3. If this vehicle, when used as shown in Figure 1, has more than six tires, please write in an estimate of what you think is its gross weight. If the vehicle has six tires or less, go on to Question 4.

Gross weight _____

4. How will you be using the vehicle today? Please circle "yes" or "no" for each item below to tell us whether you will use the vehicle for that activity today.

a. Transportation between home and work ..... YES NO

b. Any work-related purpose other than commuting .... YES NO->COMPLETION OF DIARY IS NOT REQUIRED. RETURN FORM IN POSTAGE PAID ENVELOPE.

V

PLEASE COMPLETE TRAVEL DIARY.

Before you go on to the Travel Diary on the next page, we want to give you an idea of what we consider to be a trip or trips to be recorded on these pages. We will use the example of a ten-wheel tractor which is normally used with an eight-wheel semi-trailer to deliver building supplies:

Trip 1 Loaded tractor-trailer goes from warehouse to first delivery site, a new residential development under construction.

Trip 2 Empty tractor-trailer returns to warehouse to drop off for re-loading.

Trip 3 Tractor only goes to truck stop (transportation land use) to be refueled.

Trip 4 Tractor goes to restaurant (retail land use); driver has lunch.

Trip 5 Tractor returns to warehouse to pick up loaded trailer.

Trip 6 Loaded tractor-trailer goes from warehouse to second delivery site, where a hospital is being expanded.

Trip 7 Empty tractor-trailer returns to warehouse where it is parked overnight.

Start time: ____ :__ A.M./P.M.
Start Odometer: _____

TRAVEL DIARY

Please record each trip in the order you make it.

Trip #	Start Time (circle A.M./P.M.)	Stop Time	Stop Odometer	Name & Address of stop Please give EXACT street address, St. vs Ave., etc.	Zipcode of stop	Activity at stop See below.	Stop ON or OFF street	Land Use at stop See below.	Vehicle Type See below.	Total # axles
EXAMPLE TRIP: (TRIP #5 IN PREVIOUS EXAMPLE)										
5	12:45 AM (PM)	1:15 AM (PM)	5082.3	1345 N. 10th Street Warehouse #2, Phoenix	85014	1	ON (OFF)	3	4	3
1.	AM PM	AM PM					ON OFF			
2.	AM PM	AM PM					ON OFF			
3.	AM PM	AM PM					ON OFF			
4.	AM PM	AM PM					ON OFF			
5.	AM PM	AM PM					ON OFF			
6.	AM PM	AM PM					ON OFF			
7.	AM PM	AM PM					ON OFF			
8.	AM PM	AM PM					ON OFF			
9.	AM PM	AM PM					ON OFF			
10.	AM PM	AM PM					ON OFF			

If your vehicle made more than 10 trips during the day, write in the total number of trips here: _____

Write in your final odometer reading here: _____

What was your final stop address? _____

ACTIVITY AT STOP
1. Pick up, Load
2. Drop off, Unload
3. Load & Unload
4. Service call
5. Use as vehicle
6. Meal/Other personal

LAND USE AT STOP
1. Residential
2. Retail
3. Manufacturing, Warehousing, etc.
4. Transportation
5. Utilities
6. Communications
7. Hospitals
8. Public/Government
9. Office/Services
10. Other (write in)

VEHICLE TYPE
1. Straight Truck
2. Tractor/ semitrailer
3. Tractor/ Trailer
4. Bobtail
5. Commercial Auto

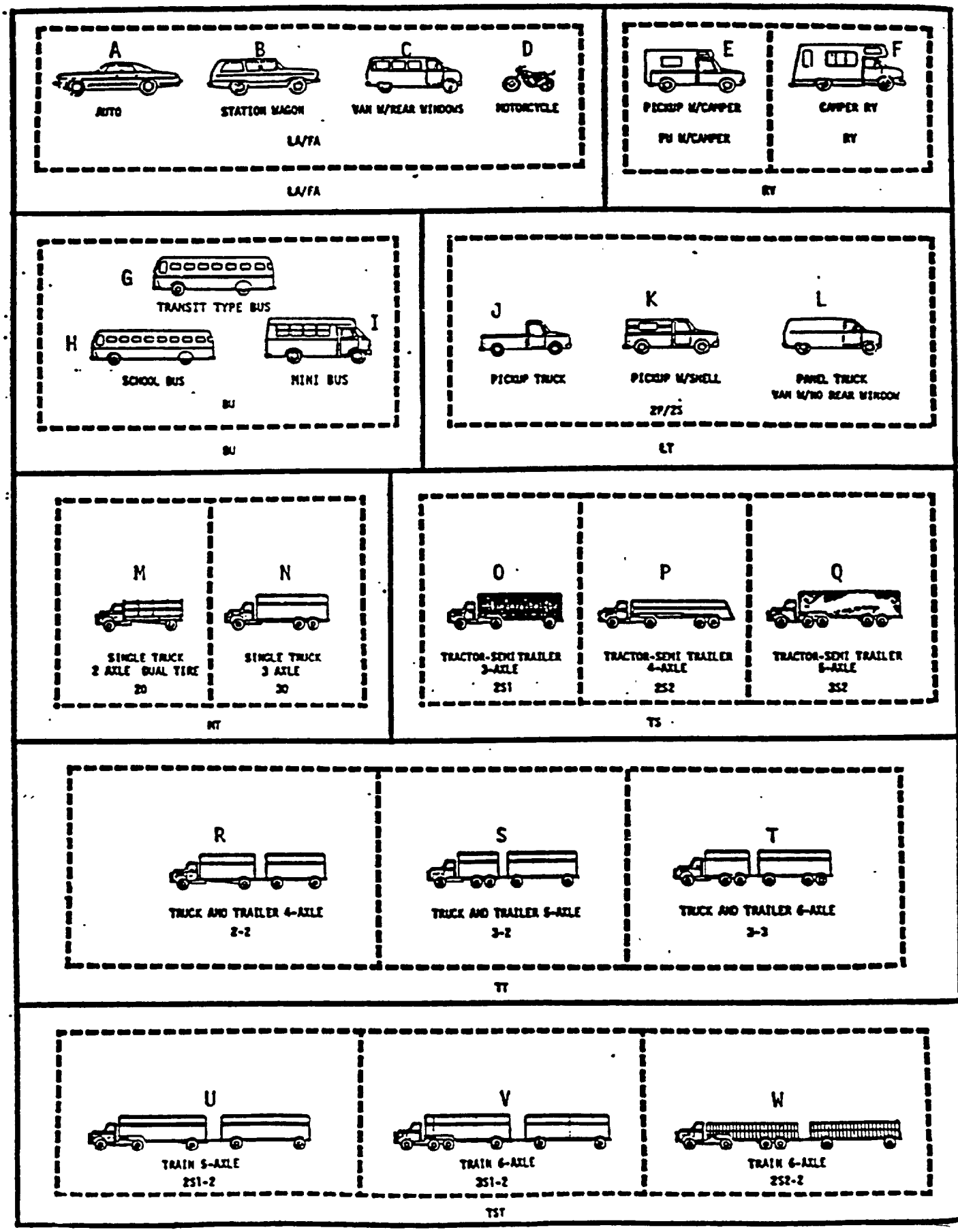
At the end of the travel day for this vehicle, please fold and return the Vehicle Trip Record by mail. Postage is paid.

Please return to:

O'NEIL ASSOCIATES, INC.
412 East Southern Avenue
Tempe, AZ 85282

Figure 1

VEHICLE CLASSIFICATIONS



APPENDIX V
1987 New York-New Jersey Truck Commodity Survey Form

TRUCK COMMODITY STUDY

INTERVIEWER _____

LANE _____ 1-6

PAGE [ ][ ][ ]

FACILITY [ ] 7

DAY TYPE [ ] 8

TIME (1/2 HOUR) [ ][ ][ ][ ] 9-12

DATE _____ PAGE _____

WEATHER _____

REMARKS _____

LINE	OBSERVATION		DRIVER TO BE INTERVIEWED FOR MAJORITY OF LOAD							OBSERVATION
	TRUCK AXLES 0 2 4 5 6 13	TRAILER TYPE 1 Utility 2 Container 3 Flatbed 4 Auto 5 Tanker 6 Double 7 No Trailer 8 Other 14	DESTINATION City, Town or Borough and State 15-19	FACILITY TYPE 1 Truck Term 2 Warehouse 3 Piggyback 4 Pier 5 Fac./Pet. 6 Office 7 Other 20	ORIGIN City, Town and State 21-25	FACILITY TYPE 1 Truck Term 2 Warehouse 3 Piggyback 4 Pier 5 Fac./Pet. 6 Office 7 Other 26	FREQUENCY 1 More Than Once/Day 2 Daily 3 More Than Once/Month 4 Weekly 5 Monthly 6 Other 27	COMMODITY 28-29	LOAD 1 Full 2 Part 3 Empty 30	NAME ON TRAILER
1										
2										
3										
4										
5										
6										

APPENDIX VI
1991 New York-New Jersey Truck Commodity Survey Form

1991 Truck O - D/Commodity Interview Form

Facility:	Date:	Hour Beginning:	Lane:	Interviewer:

OBSERVE		ASK						ASK FOR OTHER HALF OF TRIP	
No. Of Axles:	Trailer Type: 1. Utility 2. Container 3. Flatbed 4. Auto 5. Tanker 6. Double Trailer 7. No Trailer 8. Other	Commodity (Type Freight)	Load 1. Full 2. Partial 3. Empty 4. Doesn't Know	Origin What town did you pick up freight? If Empty: Where was your last stop? If: Newark (Intersection) Jersey City (Intersection) Bayonne (Intersection)	Destination What town will you deliver freight? If: Manhattan (Intersection) Bronx (Intersection) Brooklyn (Intersection) Queens (Intersection) Staten Island (Intersection)	Trailer Width:	Trailer Length:	Water Crossing: 1. Outerbridge 2. Goethals Br. 3. Bayonne Br. 4. Holland Tunnel 5. Lincoln Tunnel 6 G. Washington Br. 7. Teppon Zee Br. 8. Other (which ?) 9. No answer	Commodity: (Type Freight)

APPENDIX VII

1992 New York-New Jersey Truck Cordon Study Survey Form

1992 TRUCK CORDON STUDY – PHASE I

Interviewer:	Lane:	Facility: NYS Thruway Spring Valley Toll SOUTHBOUND (Eastbound)	Page:
Interviewer #:	Hour Beginning:	Date: November 18, 1992	

SITIVE		ASK									
o. of Axles	Trailer Type:	Commodity: What are you carrying?	Load: Are you full?	Pickup: In what town & state did you PICK UP that freight?	Facility Type: What type of facility did you get your freight from?	Delivery: In what town & state will you DELIVER that freight?	Facility Type: What type of facility will you deliver your freight to?	Trailer Width:	Water Crossing: If you cross the Hudson, what water crossing will you use?	Route 287: When Route 287 is completed would you use that connection to get to the Tappan Zee Bridge?
	1. Straight 2. Utility 3. Container 4. Flatbed 5. Auto Carrier 6. Tanker 7. Double Trailer 8. No Trailer 9. Other (specify)	If "garbage" ask for more info (i.e. "municipal waste" instead of "garbage") Driver doesn't know Code "9" If EMPTY leave BLANK	1. Full 2. Partial 3. Empty 9. Does not know BLANK No Answer	If Empty: In what town & state was your LAST STOP? Ask the nearest intersection for: Newark Brooklyn Jersey City Queens Bayonne Bronx Manhattan Staten Island	1. Warehouse 2. Factory/Plant 3. Truck Terminal 4. Port 5. Airport 6. Railyard 7. Office 8. Retail 9. Other (specify)	If Empty: In what town & state is your NEXT STOP? Ask the nearest intersection for: Newark Brooklyn Jersey City Queens Bayonne Bronx Manhattan Staten Island	1. Warehouse 2. Factory/Plant 3. Truck Terminal 4. Port 5. Airport 6. Railyard 7. Office 8. Retail 9. Other (specify) Don't Know (BLANK)		1. Verrazzano–Narrows 2. Holland Tunnel 3. Lincoln Tunnel 4. George Wash. Br. 5. Tappan Zee Br. 6. Bear Mountain 7. Newburgh–Beacon 8. Going to Staten Island 9. Other (specify) 10. Not crossing No Answer (BLANK)	1. Yes 2. No 3. Maybe 4. Not crossing the Hudson 5. Not familiar with Rt. 287 9. Does not know BLANK No Answer

1992 TRUCK CORDON STUDY – PHASE I

Interviewer: | Lane: | Facility: Easton Phillipsburg Bridge I–78 | Page:

Interviewer #: | Hour Beginning: | Date: November 17, 1992

E A S T B O U N D

OBSERVE		ASK					ASK FOR THE EASTBOUND PORTION OF YOUR TRIP				
No. of Axles:	Trailer Type:	Commodity: What are you carrying?	Load: Are you full?	Origin: In what town & state did you PICK UP that freight?	Destination: In what town & state will you DELIVER that freight?	Trailer Width:	Destination: When you make deliveries in the eastbound direction, what town and state do you go to? (Point to the East)-->	Reverse Commodity: What do you carry eastbound?	Origin: Where do you pick up those loads?	Water Crossing: If you cross the Hudson, what water crossing would you use?	Route 287: When Route 287 is completed would you use that connection to get to the Tappan Zee Bridge?
	1. Straight 2. Utility 3. Container 4. Flatbed 5. Auto Carrier 6 Tanker 7. Double Trailer 8. No Trailer 9 Other (specify)	If "garbage" ask for more info (i.e., "municipal waste" instead of "garbage"). Driver doesn't know Code "9" If EMPTY leave BLANK	1. Full 2. Partial 3. Empty 9. Does not know BLANK No Answer	If Empty: In what town & state was your LAST STOP? Ask the nearest intersection for: Newark Jersey City Bayonne	If Empty: In what town & state is your NEXT STOP? Ask the nearest intersection for: Manhattan Staten Island Brooklyn Queens Bronx		If Driver does not know, Code "9" Ask the nearest intersection for: Newark Brooklyn Jersey City Queens Bayonne Bronx Manhattan Staten Island	If "garbage" ask for more info (i.e., "municipal waste" instead of "garbage"). Driver doesn't know Code "9" If EMPTY leave BLANK	If Driver does not know, Code "9" Ask the nearest intersection for: Newark Brooklyn Jersey City Queens Bayonne Bronx Manhattan Staten Island	1. Verrazzano–Narrows 2. Holland Tunnel 3. Lincoln Tunnel 4. George Wash. Br. 5. Tappan Zee Br. 6. Bear Mountain 7. Newburgh–Beacon 8. Going to Staten Island 9. Other (specify) 10. Not crossing No Answer (BLANK)	1. Yes 2. No 3. Maybe 4. Not crossing the Hudson 5. Not familiar with Rt. 287 9. Does not know BLANK No Answer

APPENDIX VIII
1994 El Paso Commercial Truck Travel Survey Form

Indentification Label:

The Communications Group
a. Record Type 20
b. Month _____
c. Travel Date _____

Please answer the following questions about your truck or commercial vehicle:

1. What is the primary business of the owner of this truck? _____

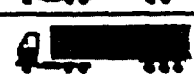
2. Who manufactured this truck? _____

3. What is the model name of this truck? _____

4. What is the model year of this truck? _____

5. What type of fuel does this truck use?
   1 Gasoline
   ☐ 2 Diesel
   ☐ 3 Other _____ (please specify)

6. How was this truck configured on the travel day:

TRUCKS	SINGLE UNIT TRUCKS	2 AXLE, 6 - TIRE			1
		3 AXLE			2
		4 OR MORE AXLE			3
	COMBINATIONS	3 AXLE SINGLE TRAILER			4
		4 AXLE SINGLE TRAILER			5
		5 AXLE SINGLE TRAILER			6
		6 OR MORE AXLE SINGLE TRAILER			7
		5 OR LESS AXLE MULTI-TRAILER			8
		6 AXLE MULTI-TRAILER			9

7. What is the odometer-reading on this truck? _____ miles

Now, please complete the trip diary for each trip (stop) or delivery made today.

[redacted]

he Communications Group
ecord Type 21
ehicle License Number _____

COMMERCIAL VEHICLE TRIP DIARY

INSTRUCTIONS: Please complete the trip diary for each trip made today. You may substitute a manifest if available. Please include each stop as a separate trip, even if only stopping for lunch.

TRAVEL DAY: _____

At 4 AM, this vehicle was at:
1 Your place of business
2 ☐ Other location as shown below

Name of Place _____ Kind of Place _____

Address or Intersecting Streets _____

City _____ State _____ Zip Code _____

Departure Time: ____:____ ☐ AM ☐ Noon ☐ PM ☐ Mdnt

Beginning Odometer Reading: _____ Miles

Cargo at Departure _____

WHERE was this vehicle taken next?	KIND OF PLACE (for example, apparel manufacturer)	PURPOSE of trip (Check one)	ARRIVAL TIME	ODOMETER READING (in Miles)	DEPART TIME	FACILITIES USED to get to this stop (check all that apply)
Name of Place Address or Intersecting Streets City, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other _____	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375
Name of Place Address or Intersecting Streets City, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other _____	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375

HERE was this vehicle taken next?	KIND OF PLACE (for example, *apparel manufacturer*)	PURPOSE of trip (Check one)	ARRIVAL TIME	ODOMETER READING (in Miles)	DEPART TIME	FACILITIES USED to get to this stop (check all that apply)
me of Place dress or Intersecting Streets y, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other ______	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375
me of Place dress or Intersecting Streets y, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other ______	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375
me of Place dress or Intersecting Streets y, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other ______	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375
me of Place dress or Intersecting Streets y, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other ______	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375
me of Place dress or Intersecting Streets y, State, Zip Code	Activity Type	1 ☐ Return to base location 2 ☐ Delivery 3 ☐ Pick-up 4 ☐ Maintenance, fuel, oil, ... 5 ☐ Driver needs (lunch, ...) 6 ☐ Other ______	☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt		☐ AM ___:___ ☐ PM ☐ Noon ☐ Mdnt Cargo at Departure	1 ☐ I-10 2 ☐ Border Freeway 3 ☐ Montana Avenue 4 ☐ Trans-Mountain Drive 5 ☐ Mesa Street 6 ☐ Alameda Avenue 7 ☐ Paisano Drive 8 ☐ North Loop 9 ☐ 375

APPENDIX IX
1994 North Carolina-Triad Area Truck Survey Form

TRIAD AREA, NORTH CAROLINA

TRUCK SURVEY - ADMINISTRATION DATA

Pre Interview

Call Date: ____/____/____

1. Sample Number ____

2. Travel Date ____/____/____ (MONTH / DAY / YEAR)

Day: ☐Mon ☐Tues ☐Wed ☐Thurs ☐Fri

Owner's Name ____

3. Registration Address

____ (STREET NUMBER) ____ (STREET NAME)

____ (CITY)

____ (STATE) ____ (ZIP CODE)

Contact Name ____ (for vehicle information)

Telephone Number: (___) ____

4. Garaging Address (If Different)

____ (STREET NUMBER) ____ (STREET NAME)

____ (CITY)

____ (STATE) ____ (ZIP CODE)

Number of Trucks here: ____

Driver/Dispatcher: ____

____

____

____

On-Site Interview

Vehicle # ____ (from vehicle information sheet)

License # ____

Contact with Driver or Owner

Date	Time	By	Result
____/____/____	____:____	____ (INITIALS)	____
____/____/____	____:____	____ (INITIALS)	____
____/____/____	____:____	____ (INITIALS)	____

Remarks ____

____

____

____

6. Total Trips Reported ____

7. Hours of Vehicle Operation ____

8. Interview Type: (Check one below)

Trips Possible

- ☐ Complete
- ☐ Partial Interview
- ☐ Refused
- ☐ Cannot Find Owner
- ☐ Cannot Find Address
- ☐ Garaged Outside Area

No Trips Possible

- ☐ Out of Area on Travel Day
- ☐ Vehicle Sold or Junked
- ☐ Other ____ (PLEASE SPECIFY)

9. Interviewer Identification and Certification:

I hereby certify that the information on this form has been obtained by me from the respondent and is accurate and complete.

____ (INTERVIEWER'S SIGNATURE) ____ (DATE)

____ (INTERVIEWER'S NUMBER)

Part 1
Vehicle Information

Your Travel Day is:

The label above includes some of the information you provided when our interviewer called. Included are your address, type of company, and the number of persons employed in your company. If any of these items are incorrect, please write the correct information directly on the label.

Please fill out the information below about the vehicles owned by or garaged at your company.

Please assign a *vehicle number* to each vehicle at your company. Then fill in the boxes to the right for each vehicle. Be sure that the vehicle number on this form corresponds to the vehicle number used on the Travel Diary.

Vehicle Number	Type of Vehicle							Typle of Fuel			Number of Axles	Weight (lbs)	
	License Plate #	Year	Single Unit Truck	Combination Truck	Pick-up or Panel	Van	Car	Diesel	Gasoline	Other	2, 3, 4, or 5+	Empty	Loaded
1			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
2			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
3			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
4			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
5			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
6			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
7			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
8			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
9			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			
10			☐	☐	Make Model	Make Model	Make Model	☐	☐	☐			

Part 2
Travel Diary

Travel Day: ☐ Mon ☐ Tues ☐ Wed ☐ Thurs ☐ Fri and Date: ___/___/___

For Truck Number_____ (Write in number from company information form)

Number of Axles? _____ Is this a delivery van, ☐ Yes ☐ No or passenger van? ☐ Yes ☐ No

On this day, was this truck used? ☐ Yes - Continue below
☐ No - Return questionnaire

My First Trip Began at:

What time did you leave this place? (Check AM or PM)
___:___ ☐ AM ☐ PM

☐ Base ☐ Other Location (indicate address below)

Name of Place

Address or Intersecting Streets

City State Zip Code

Mileage for the travel day:

Begin Odometer Number _____

End Odometer Number _____

Instructions:

Please carry this diary with you throughout the travel day shown above.

- Record each trip you make in the order you make it.
- Include the specific data requested for each trip.
- If you are leaving the Triad area and will not come back today, please fill out the information for the trip you *will* make and return this form to the person who gave it to you.

Location Address	When did you get here/leave here?	Did you turn the engine off at this stop?	Activity at Stop (check one for each trip)	Land Use at Stop (check one for each trip)	If auto or van, # of persons in vehicle including driver.	If truck, what are you carrying? (Type of Goods) (check one for each trip)
(1) First, I went to: Name of Place Address or nearest intersection City State Zip	Arrive ___:___ ☐ a.m. ☐ p.m. Depart ___:___ ☐ a.m. ☐ p.m.	☐ Yes ☐ No	☐ 1 Pick-up Load ☐ 2 Drop-off Load ☐ 3 Service Unit ☐ 4 Fuel Unit ☐ 5 Personal Business ☐ 6 Return to base ☐ 7 Other (Please Specify)	☐ 1 Office Bldg. Commercial ☐ 2 Retail/Restaurant/Gas Station ☐ 3 Warehouse/Manufacturing ☐ 4 Residential ☐ 5 Port/Transportation Hub ☐ 6 Utilities ☐ 7 Construction/Gravel/Landfill ☐ 8 Other (Please Specify)	___ # of People	☐ 1 Food or Kindred Products ☐ 2 Tabacco, Textiles, Apparel ☐ 3 Containers returned empty ☐ 4 Mail or Express Traffic/ Small Packaged Freight Printed Matter ☐ 5 Clay, Concrete Glass or Stone Products/Furniture or Fabricated Metal Products/Lumber, Pulp, Paper or Allied Products ☐ 7 Metallic Ores, Coal, Petroleum Natural Gas ☐ 8 Farm, Forest or Marine Products ☐ 9 Machinery Transportation Equipment Equipment or Supplies ☐ 10 Waste or Scrap Material ☐ 11 Hazardous Material ☐ 12 Fak ☐ 13 Other _____
(2) Then, I went to: Name of Place Address or nearest intersection City State Zip	Arrive ___:___ ☐ a.m. ☐ p.m. Depart ___:___ ☐ a.m. ☐ p.m.	☐ Yes ☐ No	☐ 1 Pick-up Load ☐ 2 Drop-off Load ☐ 3 Service Unit ☐ 4 Fuel Unit ☐ 5 Personal Business ☐ 6 Return to base ☐ 7 Other (Please Specify)	☐ 1 Office Bldg. Commercial ☐ 2 Retail/Restaurant/Gas Station ☐ 3 Warehouse/Manufacturing ☐ 4 Residential ☐ 5 Port/Transportation Hub ☐ 6 Utilities ☐ 7 Construction/Gravel/Landfill ☐ 8 Other (Please Specify)	___ # of People	☐ 1 Food or Kindred Products ☐ 2 Tabacco, Textiles, Apparel ☐ 3 Containers returned empty ☐ 4 Mail or Express Traffic/ Small Packaged Freight Printed Matter ☐ 5 Clay, Concrete Glass or Stone Products/Furniture or Fabricated Metal Products/Lumber, Pulp, Paper or Allied Products ☐ 7 Metallic Ores, Coal, Petroleum Natural Gas ☐ 8 Farm, Forest or Marine Products ☐ 9 Machinery Transportation Equipment Equipment or Supplies ☐ 10 Waste or Scrap Material ☐ 11 Hazardous Material ☐ 12 Fak ☐ 13 Other _____

APPENDIX X
1994 Houston-Galveston Area Council Commercial Vehicle Survey Form

COMMERCIAL PASSENGER CARRIER CONTROL FORM

Telephone Number

_____

Company Name: _____

Address: _____

_____

_____

Attention: _____

License Plate Number

_____

_____

Screening Call

Respondent Name

Call	Date	Time	Int	Result
1				
2				
3				

First Follow-Up
(Day Before Survey)

Respondent Name

Call	Date	Time	Int	Result
1				
2				
3				

Second Follow-Up
(Day Before Survey)

Respondent Name

Call	Date	Time	Int	Result
1				
2				
3				

Responses

1. Willing to Participate? Comments

☐ Yes ☐ No

Responses 1st Follow-Up

1. Was questionnaire received? Comments

☐ Yes ☐ No

2. Was a second survey mailed?

☐ Yes ☐ No

Responses 2nd Follow-Up

1. Was questionnaire mailed back? Comments

☐ Yes ☐ No

Result Codes:

01 - Terminated	03 - Over Quota	06 - Call Back	09 - Disconnected	12 - Not Qualified
02 - Refusal	04 - Completed	07 - Busy Signal	10 - Business/Gov't	13 - Spanish
	05 - No Answer	08 - Ans. Machine	11 - Deaf/Language	

Houston-Galveston Area Council
Office of the Executive Director
PO Box 22777 • 3555 Timmons • Houston, Texas 77227-2777 • 713/627-3200

Dear Commercial Vehicle Survey Participant:

Thank you for agreeing to participate in the Houston-Galveston area one-day travel survey. The Houston-Galveston Area Council, assisted by Wilbur Smith Associates, is conducting this survey to help plan for future transportation needs in our area. Your vehicle(s) was randomly selected in the sample of commercial vehicles registered in the Houston-Galveston area, and we need your assistance.

We are enclosing a copy of the one-day travel survey form for your or your truck driver's use in identifying trip information. We would like the truck driver to complete the form for all travel performed by the selected vehicle on the designated date. It is really quite simple and will assist us in studying the way commercial vehicles get around the Houston-Galveston area.

It is important that you complete and return this form even if no trips were made in the Houston-Galveston area on the selected date, as we need to know this information to estimate overall travel characteristics. Please note that this information will be treated confidentially, and will only be used in summary form.

Your cooperation and assistance in providing information for this important survey is greatly appreciated. If you have any questions, please call Wayne Holcombe at 465-7800. Thank you.

Sincerely,

Jack Steele

COMMERCIAL PASSENGER CARRIER SURVE

ATTENTION PASSENGER CARRIER DRIVER!

Here is your chance to participate in decisions about highway and transportation improvements ir the Houston-Galveston area. Roadway modifications will be based upon your survey answers. This survey applies to every trip made in your passenger carrier on the designated travel day.

Thank you for your participation!

PART 1 VEHICLE INFORMATION

1) Record Type: 23

2) Day of Travel: _____ Month _____ Day

3) Company Name: _____

4) Address: _____

OFFICE USE ONLY

5) Census Tract Number: _____ 6) Traffic Serial Zone Number: _____

7) License Plate Number: _____

8) Make of Vehicle: _____ 9) Model of Vehicle: _____

10) Vehicle Year: _____

11) Vehicle Fuel Type:

- ☐ 1. Unleaded Gasoline
- ☐ 2. Unleaded Gasoline
- ☐ 3. Diesel
- ☐ 4. Propane
- ☐ 5. Compressed Natrual Gas
- ☐ 6. Other _____ Specify

12) Maximum number of passengers vehicle can carry: _____

The next part of the survey asks that you record the following information after each trip made by this passenger carrier vehicle on the designated travel day. A trip is any time the vehicle stops and you or someone else gets into or out of the vehicle.

COMMERCIAL PASSENGER CARRIER SURVEY

OFFICE USE ONLY
Record Type: 24
License Plate:

PART 2
TRIP DIARY

00 My Trip Began At:
Location:
Place, Address, or nearest intersection,
City/State/ZIP

OFFICE USE ONLY
CENSUS TRACT
ZONE NUMBER

Odometer Reading

Departure Time am pm

Number of Passengers

Please indicate the purpose of the trip:
- 1. Base Location / Return to Base Location
- 2. Delivery
- 3. Pick-Up
- 4. Vehicle Maintenance (fuel, oil, etc.)
- 5. Driver Needs (lunch, etc.)
- 6. Other

Please describe the location:
- 1. Residential
- 2. Educational
- 3. Industrial
- 4. Government
- 5. Medical
- 6. Office
- 7. Retail
- 8. Other

01 Then I Went To:
Location:
Place, Address, or nearest intersection,
City/State/ZIP

OFFICE USE ONLY
CENSUS TRACT
ZONE NUMBER

Odometer Reading

Arrival Time am pm

Departure Time am pm

Number of Passengers

Please indicate the purpose of this trip:
- 1. Base Location / Return to Base Location
- 2. Delivery
- 3. Pick-Up
- 4. Vehicle Maintenance (fuel, oil, etc.)
- 5. Driver Needs (lunch, etc.)
- 6. Other

Please describe this location:
- 1. Residential
- 2. Educational
- 3. Industrial
- 4. Government
- 5. Medical
- 6. Office
- 7. Retail
- 8. Other

02 Then I Went To:
Location:
Place, Address, or nearest intersection,
City/State/ZIP

OFFICE USE ONLY
CENSUS TRACT
ZONE NUMBER

Odometer Reading

Arrival Time am pm

Departure Time am pm

Number of Passengers

Please indicate the purpose of this trip:
- 1. Base Location / Return to Base Location
- 2. Delivery
- 3. Pick-Up
- 4. Vehicle Maintenance (fuel, oil, etc.)
- 5. Driver Needs (lunch, etc.)
- 6. Other

Please describe this location:
- 1. Residential
- 2. Educational
- 3. Industrial
- 4. Government
- 5. Medical
- 6. Office
- 7. Retail
- 8. Other

03 Then I Went To:
Location:
Place, Address, or nearest intersection,
City/State/ZIP

OFFICE USE ONLY
CENSUS TRACT
ZONE NUMBER

Odometer Reading

Arrival Time am pm

Departure Time am pm

Number of Passengers

Please indicate the purpose of this trip:
- 1. Base Location / Return to Base Location
- 2. Delivery
- 3. Pick-Up
- 4. Vehicle Maintenance (fuel, oil, etc.)
- 5. Driver Needs (lunch, etc.)
- 6. Other

Please describe this location:
- 1. Residential
- 2. Educational
- 3. Industrial
- 4. Government
- 5. Medical
- 6. Office
- 7. Retail
- 8. Other

04 Then I Went To:
Location:
Place, Address, or nearest intersection,
City/State/ZIP

OFFICE USE ONLY
CENSUS TRACT
ZONE NUMBER

Odometer Reading

Arrival Time am pm

Departure Time am pm

Number of Passengers

Please indicate the purpose of this trip:
- 1. Base Location / Return to Base Location
- 2. Delivery
- 3. Pick-Up
- 4. Vehicle Maintenance (fuel, oil, etc.)
- 5. Driver Needs (lunch, etc.)
- 6. Other

Please describe this location:
- 1. Residential
- 2. Educational
- 3. Industrial
- 4. Government
- 5. Medical
- 6. Office
- 7. Retail
- 8. Other

05 Then I Went To:
Location:
Place, Address, or nearest intersection,
City/State/ZIP

OFFICE USE ONLY
CENSUS TRACT
ZONE NUMBER

Odometer Reading

Arrival Time am pm

Departure Time am pm

Number of Passengers

Please indicate the purpose of this trip:
- 1. Base Location / Return to Base Location
- 2. Delivery
- 3. Pick-Up
- 4. Vehicle Maintenance (fuel, oil, etc.)
- 5. Driver Needs (lunch, etc.)
- 6. Other

Please describe this location:
- 1. Residential
- 2. Educational
- 3. Industrial
- 4. Government
- 5. Medical
- 6. Office
- 7. Retail
- 8. Other

APPENDIX XI
1988 Ontario Commercial Vehicle Survey Form

QUESTIONNAIRE FOR 1993 CVS SURVEY

SITE: ☐☐☐ DIRECTION: N S E W DAY: ☐☐ MONTH: ☐☐☐ TIME: ☐☐☐☐

COMBINATION CONFIGURATION & AXLE SETTINGS

	Power	Dolly	Trailer	Dolly	Trailer
	☐ STRAIGHT	A C	☐ TRAILER #1	A B C	☐ TRAILER #2
	☐ TRACTOR	☐ FULL TRAILER		☐ FULL TRAILER	
AXLES					
LIFT?	☐☐	☐ ☐☐	☐ ☐☐☐	☐ ☐☐	☐ ☐☐☐
UP					
DOWN	X ☐ ☐☐ X	☐ ☐☐☐	☐ ☐☐☐	☐ ☐☐☐	☐ ☐☐☐
LICENSE PLATE Number:					
Jurisdiction: ON					
TDG PLACARD Class: PIN:					
FEATURES CONV: ☐ COE: ☐ SLEEP: ☐ DROME: ☐					

☐ Van	☐		
☐ Refrig. Van	☐		
☐ Flatbed	☐		
☐ Liquid Tank	☐		
☐ Hopper	☐		
☐ Dump	☐		
☐ Veh. Carrier	☐		
☐ Float	☐		
☐ Stake/Rack	☐		
☐ Livestock	☐		
☐ Container	☐		
☐ Conc. Mixer	☐		
☐ Chip	☐		
☐ Other	☐		

TDG PLACARDS Class | PIN

TDG PLACARDS Class | PIN

COMPANY NAME(S) } _____
ON DRIVER DOOR }

VEHICLE & COMPANY INFORMATION

Reg. Gross Weight: ☐☐☐☐00 Jake Brakes: ☐ ABS: Steers: ☐ Drives: ☐ Trailer: ☐

On-Board: Co. Radio: ☐ Cel/Tel: ☐ Tach: ☐ Trip Recorder: ☐ Computer: ☐ Satellite: ☐

Truck Based In: _____ (City/Town) ON _____ (Prov/State) Freight Terminal There? ☐

Dispatch Is In: _____ (City/Town) ON _____ (Prov/State) Freight Terminal There? ☐

For-Hire This Trip? ☐ Same For All Trips? ☐ Company Speed Limit? ☐☐☐ km/hr

Is This Truck Assigned Exclusively To You? ☐ Do You Have A Co-Driver On This Trip? ☐

Where Did You Start This Shift? _____ (City/Town) ON _____ (Prov/State)

Where Will You End This Shift? Same Place: ☐ or _____ (City/Town) ON _____ (Prov/State)

Furthest Point Travelled To During Shift: _____ (City/Town) ON _____ (Prov/State)

FREIGHT DATA

How Many Shipments On-Board? ☐☐☐ Total Cargo Weight / Volume? ☐☐☐☐☐ units _____

How Full (volume)? MT ¼ ½ ¾ FULL — If empty, go to next page —

Where Is Your Next Delivery? _____ (City/Town) ON _____ (Prov/State)

Where Did You Receive That Cargo? _____ (City/Town) ON _____ (Prov/State)

What Is That Cargo?

☐ Household Goods	☐ Mixed Freight	☐ Auto Parts	☐ Vehicles	☐ Food	
☐ Metals/Minerals	☐ Wood Products	☐ Machinery	☐ Textiles	☐ Livestock	
☐ Grain/Feed	☐ Manufactured Goods	☐ Chemicals	☐ Petroleum	☐ Waste	
	☐ Aggregates	☐ Equipment	☐ Furniture	☐ Other	

MINISTRY OF TRANSPORTATION, ONTARIO

QUESTIONNAIRE FOR 1993 CVS SURVEY (Continued)

VEHICLE TRIP

Is this trip: Local: ☐ Peddle Run: ☐ Line Haul: ☐

IF TRACTOR/TRAILER: Where did you pick up this trailer? _____ City/Town, ON Prov/State

Where will you drop this trailer? _____ City/Town, ON Prov/State

— If Empty, go to next section — Is this the truck/trailer the cargo was loaded onto when picked up? ☐

If not, where was the cargo loaded on this truck/trailer? _____ City/Town, ON Prov/State

Airport ☐ Railhead ☐ Port ☐ Terminal ☐ Factory ☐ Producer ☐ Warehouse ☐ Store ☐ Other ☐

Will this truck/trailer carry the cargo to its final destination? ☐

If not, where will the cargo be unloaded from this truck/trailer? _____ City/Town, ON Prov/State

Airport ☐ Railhead ☐ Port ☐ Terminal ☐ Factory ☐ Producer ☐ Warehouse ☐ Store ☐ Other ☐

DRIVER TRIP

Where Did You Start This Trip _____ City/Town, ON Prov/State

Where Will You End This Trip? Same Place: ☐ or _____ City/Town, ON Prov/State

Furthest Point Travelled To During Trip: _____ City/Town, ON Prov/State

Where did you first turn on to this highway on this trip? _____

Where will you finally turn off this highway on this trip? _____

DRIVER PROFILE

Do you have automatic [A] or manual [M] slack adjusters? Are you allowed to adjust them? ☐

When was the last time you attended a driver safety meeting or training course? ☐☐☐ weeks ago.

What was the subject discussed? _____

What are are your instructions in the event of a spill? _____

Are you a: Company driver? ☐ Driver service driver: ☐

Owner-Operator: ☐ If Yes, are you contracted to a carrier? ☐

If No, did you obtain this load through a load broker? ☐

Do you belong to a: Union: ☐ Driver association: ☐ Owner-Operator association? ☐

How many years have you been driving trucks? ☐ What percent of your driving is highway? ☐☐

Are you exempt from keeping a log? ☐ Are you using a logbook/on-board computer? ☐

How many on duty hours so far this shift? ☐☐ How many driving hours so far this shift? ☐☐

How many on duty hours in past 7 days? ☐☐ How many driving hours in past 7 days? ☐☐

Does the truck have seatbelts? ☐ If so, are you wearing one? ☐

Driver License Number? ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐ Jurisdiction: ON _____

THANK YOU FOR YOUR HELP TODAY

Male ☐ Female ☐ Age Range: [20's] [30's] [40's] [50's] [60's]

MINISTRY OF TRANSPORTATION, ONTARIO

EXIT RAMP SURVEY QUESTIONNAIRE

SITE: ☐☐☐ DIRECTION: N S E W DAY: ☐☐ MONTH: ☐☐☐ TIME: ☐☐☐☐

COMBINATION CONFIGURATION & AXLE SETTINGS

	Power	Dolly	Trailer	Dolly	Trailer
	☐ STRAIGHT	A C	☐ TRAILER #1	A B C	☐ TRAILER #2
	☐ TRACTOR	☐ FULL TRAILER		☐ FULL TRAILER	
AXLES					
LIFT?	☐ ☐☐	☐ ☐☐ ☐ ☐☐☐ ☐☐		☐ ☐☐ ☐ ☐☐☐ ☐☐	
UP	☐ ☐☐	☐ ☐☐ ☐ ☐☐☐ ☐☐		☐ ☐☐ ☐ ☐☐☐ ☐☐	
DOWN	X ☐☐ X	☐ ☐☐ ☐ ☐☐☐ ☐☐		☐ ☐☐ ☐ ☐☐☐ ☐☐	

LICENSE PLATE Number: Jurisdiction: ON	☐ Van	LICENSE PLATE Number: Jurisdiction: ON	LICENSE PLATE Number: Jurisdiction: ON
	☐ Refrig. Van		
	☐ Flatbed		
	☐ Liquid Tank		
	☐ Hopper		
	☐ Dump		
TDG PLACARD Class: PIN:	☐ Veh. Carrier	TDG PLACARDS Class | PIN	TDG PLACARDS Class | PIN
	☐ Float		
FEATURES CONV: ☐ COE: ☐ SLEEP: ☐ DROME: ☐	☐ Stake/Rack		
	☐ Livestock		
	☐ Container		
	☐ Conc. Mixer		
	☐ Chip		
	☐ Other		

COMPANY NAME(S) } ON DRIVER DOOR } _____

FREIGHT DATA *Where Is Your Next Delivery?* _____ *City/Town* ON _____ *Prov/State*

Where Did You Receive That Cargo? _____ *City/Town* ON _____ *Prov/State*

What Is That Cargo?

☐ *Household Goods*	☐ *Mixed Freight*	☐ *Auto Parts*	☐ *Vehicles*	☐ *Food*
☐ *Metals/Minerals*	☐ *Wood Products*	☐ *Machinery*	☐ *Textiles*	☐ *Livestock*
☐ *Grain/Feed*	☐ *Manufactured Goods*	☐ *Chemicals*	☐ *Petroleum*	☐ *Waste*
	☐ *Aggregates*	☐ *Equipment*	☐ *Furniture*	☐ *Other*

Where was the cargo loaded on this truck/trailer? _____ *City/Town* ON _____ *Prov/State*

Where will the cargo be unloaded from this truck/trailer? _____ *City/Town* ON _____ *Prov/State*

DRIVER TRIP

Where Did You Start This Trip _____ City/Town ON _____ Prov/State

Where Will You End This Trip? Same Place: ☐ or _____ City/Town ON _____ Prov/State

Furthest Point Travelled To During Trip: _____ City/Town ON _____ Prov/State

Where did you first turn on to this highway on this trip? _____

THANK YOU FOR YOUR HELP TODAY

Male ☐ Female ☐ Age Range: 20's 30's 40's 50's 60's

MINISTRY OF TRANSPORTATION, ONTARIO

APPENDIX XII
1986 Caltrans Bay Bridge Truck Travel Survey Questionnaires

SAN FRANCISCO-OAKLAND BAY BRIDGE
TRUCK TRAFFIC SURVEY

The California Department of Transportation is conducting a study to evaluate the possibility of improving truck access to the San Francisco-Oakland Bay Bridge. Please answer the questions below. Indicate answers on the detachable card at right. Thank you for your cooperation.

1. Where did your trip start? (last pickup or delivery)

2. What route did you use to reach the San Francisco-Oakland Bay Bridge?

3. Where will this trip end? (next pickup or delivery)

4. Will you use the San Francisco-Oakland Bay Bridge to return?

5. How many axles on truck or truck/trailer combination?

6. How often do you cross the San Francisco-Oakland Bay Bridge?

7. Do you use a credit card for payment of tolls?

8. Truck Body type?

9. Home base:

10. Truck ownership:

11. Any comments?

(Detach and Mail)

SAN FRANCISCO-OAKLAND BAY BRIDGE
TRUCK TRAFFIC SURVEY

Print answers on this card. Drop card in any U.S. mail box. (No postage required).

1. Indicate zone on map _____

2. ☐ Route 80 (Eastshore Freeway)
   ☐ Route 880(17) (Nimitz Freeway)
   ☐ Route 580 (MacArthur Freeway)
   ☐ Route 24 (Grove-Shafter Freeway)

3. Indicate zone on map _____

4. ☐ Yes
   ☐ No

5. _____

6. ☐ Less than once per month
   ☐ 1 to 3 times per month
   ☐ 1 or 2 times per week
   ☐ 3 or more times per week

7. ☐ Yes
   ☐ No

8. ☐ Ocean container ☐ Full ☐ Empty
   ☐ Container chassis only
   ☐ Flatbed
   ☐ Tank/Bulk liquid
   ☐ Van
   ☐ Tractor only
   ☐ Other, specify: _____

9. ☐ California
   ☐ Out of state

10. ☐ Operator owned
    ☐ Firm owned

11. _____

PORT OF SAN FRANCISCO
TRUCK TRAFFIC SURVEY

1. Where did your trip start? (last pickup or delivery) Zone : _____

2. What route did you use to reach the Port of San Francisco?

☐ Route 80 (Bay Bridge) ----------->>> If Bay Bridge, from what route?
☐ Route 101 (Golden Gate Bridge)
☐ Route 101 (Bayshore Freeway)
☐ Route 280 (Southern/Junipero Serra Freeway)
☐ Did not use freeway

☐ Route 80 (Eastshore Freeway)
☐ Route 880(17) (Nimitz Freeway)
☐ Route 580 (MacArthur Freeway)
☐ Route 24 (Grove-Shafter Freeway)
☐ West Grand Avenue

3. How many axles on truck or truck/trailer combination ? _____

4. Truck Body type : ☐ Ocean container ☐ Full ☐ Empty
☐ Container chassis only
☐ Flatbed
☐ Van
☐ Tractor only
☐ Other, specify : _____

5. Destination after leaving Port? (next pickup or delivery) Zone : _____

6. What route will you use after leaving the Port of San Francisco?

☐ Route 80 (Bay Bridge) ----------->>> If Bay Bridge, to what route?
☐ Route 101 (Golden Gate Bridge)
☐ Route 101 (Bayshore Freeway)
☐ Route 280 (Southern/Junipero Serra Freeway)
☐ Will not use freeway

☐ Route 80 (Eastshore Freeway)
☐ Route 880(17) (Nimitz Freeway)
☐ Route 580 (MacArthur Freeway)
☐ Route 24 (Grove-Shafter Freeway)
☐ West Grand Avenue

7. How many axles on truck or truck/trailer combination ? _____

8. Truck Body type : ☐ Ocean container ☐ Full ☐ Empty
☐ Container chassis only
☐ Flatbed
☐ Van
☐ Tractor only
☐ Other, specify : _____

9. How often do you travel to the Port of San Francisco?

☐ less than once per month ☐ 1 or 2 times per week
☐ 1 to 3 times per month ☐ 3 or more times per week

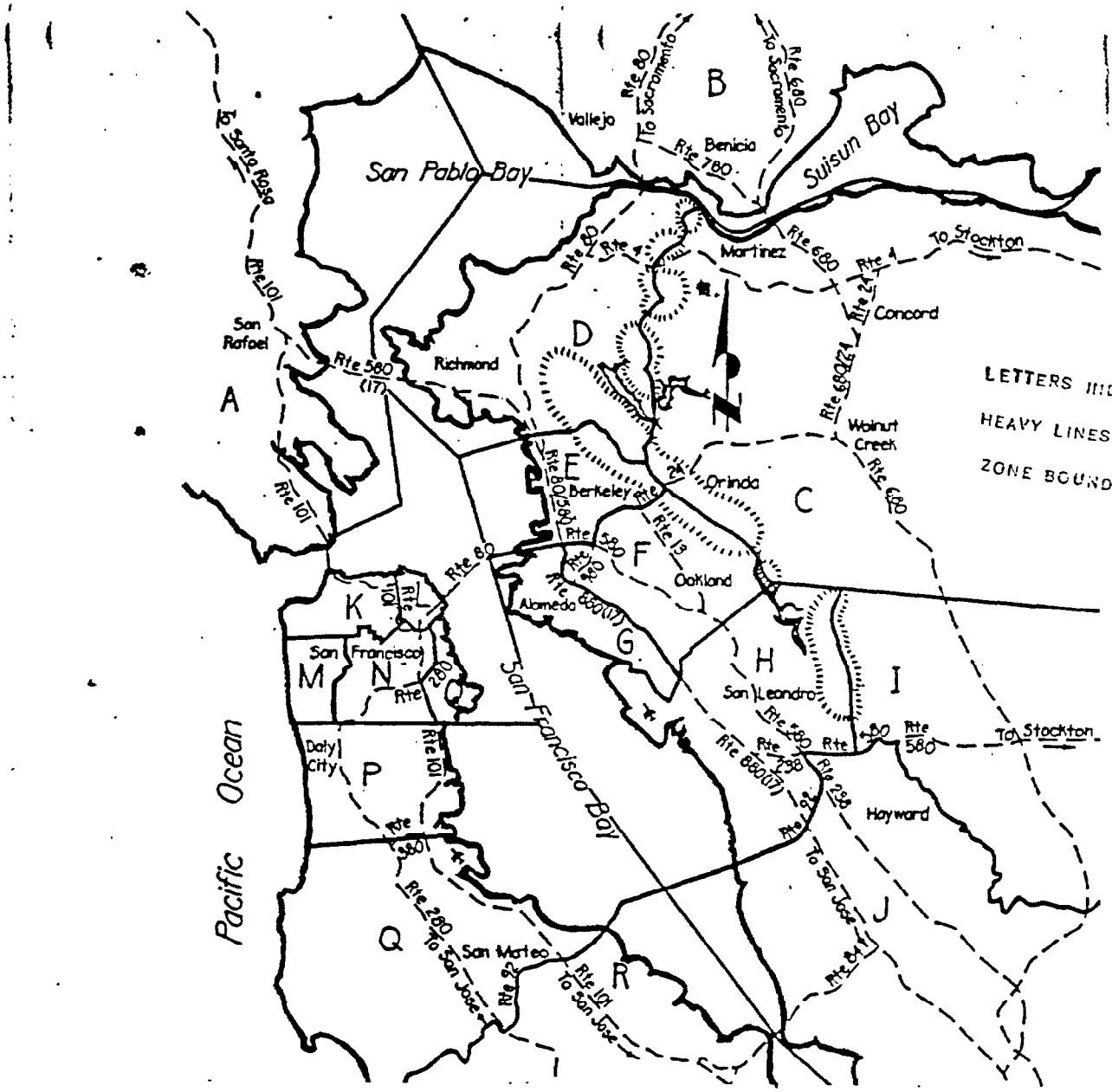
10. Home base : ☐ California ☐ Out of state

11. Truck ownership : ☐ Operator owned ☐ Firm owned

Comments : _____
_____
_____

Date : _____
TOD : _____

PORT QUESTIONNAIRE



(Detach and Mail)

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS · PERMIT NO. 15205 · SAN FRANCISCO, CA

POSTAGE WILL BE PAID BY ADDRESSEE

State of California
DEPARTMENT OF TRANSPORTATION
Highway Operations Branch
District 4
P.O. Box 7310
San Francisco, CA 94120

APPENDIX XIII

1991 Caltrans-Alameda County Truck Intercept Survey and Classification Count Forms

Station # 21 Station Location San Jose Direction of Traffic NB

Date 3-25-91 Hour 4 2b AM/PM Interviewer RG-Marshall Serial Number

Truck EMPTY or FULL (circle one)	What city are you COMING FROM? (circle if this is where the truck is GARAGED, was LAST LOADED or was LAST UNLOADED)	What city are you GOING TO? (circle if this is where the truck is GARAGED, will be NEXT LOADED or NEXT UNLOADED)	Where is this truck GARAGED? (skip only if previously answered)	What TYPE OF GOODS are you hauling? (circle if EMPTY)	Number of AXLES (circle answer)
1 1 Empty (2) Full	San Jose City State (1) Garaged (2) Last Loaded 3. Last Unloaded	Sacramento City State 1. Garaged 2 Next Loaded (3) Next Unloaded	San Jose City State	computer chips (specify) Empty	2 6 3 7 4 8 (5) 9
2 1 Empty (2) Full	Gilroy City State (1) Garaged 2. Last Loaded 3. Last Unloaded	Livermore City State 1. Garaged 2. Next Loaded (3) Next Unloaded	Gilroy City State	garlic (specify) Empty	2 6 (3) 7 4 8 5 9
3 (1) Empty 2. Full	Milpitas City State (1) Garaged 2. Last Loaded 3. Last Unloaded	Reno City NV State 1. Garaged (2) Next Loaded 3 Next Unloaded	Milpitas City State	(specify) (Empty)	2 6 3 (7) 4 8 5 9
4 1. Empty (2) Full	Sunnyvale City State 1. Garaged (2) Last Loaded 3. Last Unloaded	St Louis City MO State 1. Garaged 2. Next Loaded (3) Next Unloaded	Monterey City CA State	airplane parts (specify) Empty	2 6 3 7 4 8 5 (9)

Station # _____ Station Location _____ Direction of Traffic _____

Date _____ Hour _____ : _____ AM/PM Interviewer _____ Serial Number _____

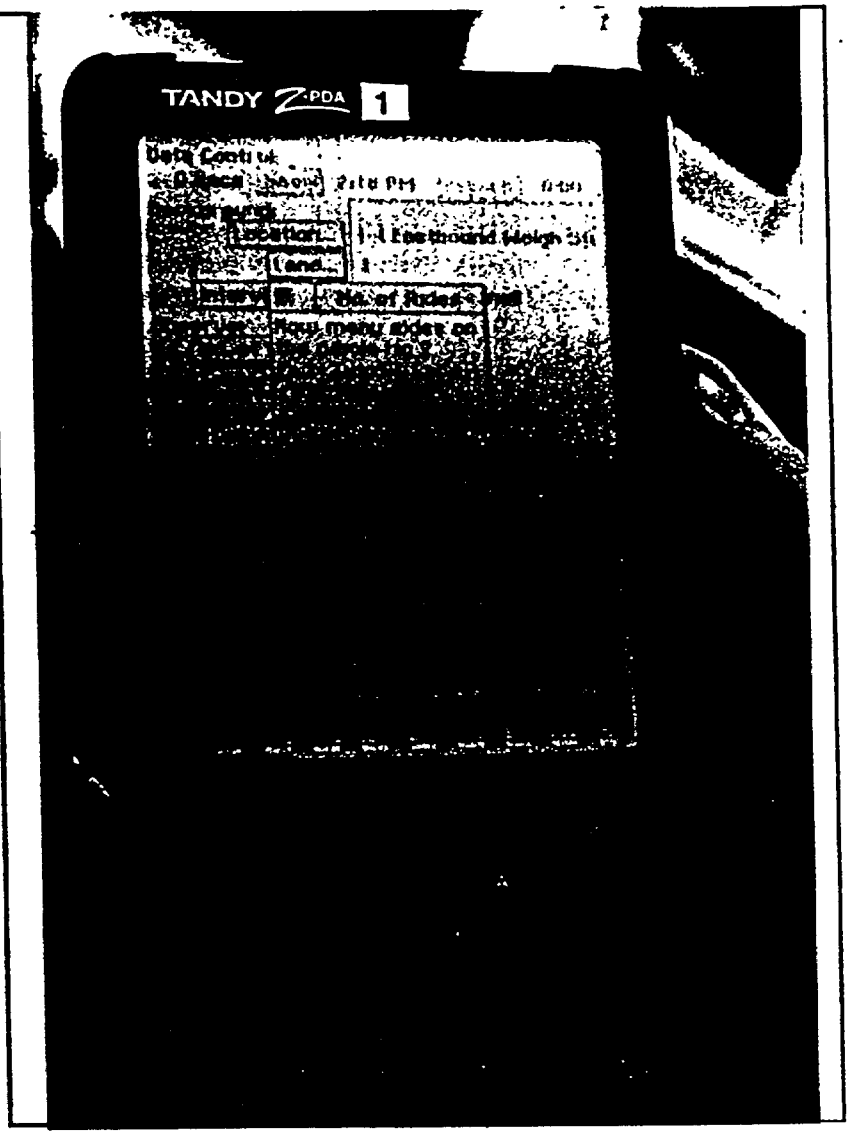
TRUCK CLASSIFICATION FORM

Time Period	2	3	4	5	6	7	8	9	TOTAL
00 - 15									
15 - 30									
30 - 45									
45 - 00									
00 - 15									
15 - 30									
30 - 45									
45 - 00									
00 - 15									
15 - 30									
30 - 45									
45 - 00									
00 - 15									
15 - 30									

APPENDIX XIV
PDA Comparisons and Tandy Zoomer

Criteria	Brand of Personal Digital Assistant			
	Tandy Zoomer	HP 95LX	Apple Newton	Sharp Wizard
Approx. Price	$599	$580	$650	$480
Form Factor	Single Piece	Clamshell	Single Piece	Clamshell
Touch screen	Yes	No	Yes	Yes
RS 232	Yes	Yes	Yes	Yes (Option)
Character Recognition	Yes	No	Yes	No
PC Compatible Processor	Yes	Yes	No	No
Operating System	Geos	MS-DOS	Subset of Mac System	Proprietary
SDK Price	$394 (with Doc)	Free	Unknown	No
Ease of Programming	Moderate	Easy	Difficult	Difficult
Emulation Available	Yes	Yes	No	No
Display Character Size	Big	Small	Big	Small
Keyboard	No	Yes	No	Yes
Expansion	PCMCIA	PCMCIA	PCMCIA	IC Card
Preference	1	2	3	4

DEVELOPMENT OF NOTEBOOK COMPUTER SOFTWARE



Project: Development of Notebook Computer Software to Collect Trip Generation Data at Intermodal Facilities.

Client: Federal Highway Administration

Description of Services: Evaluated existing technology to select most appropriate equipment for data collection use. Developed data collection methodolgy including software for data collection, data aggregation and data processing. Used handheld computer data collection methodology in three case studies to collect truck origin/destination and commodity information.

Project: The overall project was developed to test the feasibility of using computerized data collection for collecting trip generation data at intermodal facilities.

APPENDIX XV
Report Contact List

CONTACT LIST

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Transportation Division
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Earl Ruiter, Principal
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(617) 354-0167

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Intermodal Association of North America
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Maricopa Association of Governments
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Murray McLeod or Greg Little
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Office of Transportation Planning
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