

# Design and Implementation of a Statewide Roadside Origin-Destination Survey in Vermont

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The results are summarized of an origin-destination survey conducted to estimate external-to-external and external-to-internal trip tables of a statewide travel demand forecasting model. Costs and effectiveness of the interview technique and the mail-back postcard technique for collecting these data are compared, and the following topics are discussed: roadway selection, survey design, sample size estimation, field data collection, survey results, and survey costs. The results of the study indicate that the interview technique is appropriate for low-volume roadways, whereas the mail-back postcard technique is not cost-effective in these low-volume situations. However, in high-traffic-volume situations, with a good traffic control plan and a well-trained crew, the mail-back postcard technique can be implemented safely with no substantial traffic delays.

The Vermont Agency of Transportation (VAOT) and its consultant, Vanasse Hangen Brustlin, Inc., (VHB), in their efforts to develop a statewide travel demand forecasting model, decided to collect statewide origin-destination (O-D) data for the first time in Vermont. The process of planning, designing, and implementing this unique large-scale data collection effort is described.

Vermont is one of the smallest states in the country in terms of size. It borders New York, New Hampshire, Massachusetts, and Canada. There are approximately 70 roads that can be used to enter Vermont; 25 were selected for roadside O-D surveys. Traffic volumes on these 25 roads represented approximately 90 percent of all traffic entering Vermont.

The most important cordon line information for the study area necessary for model development is the vehicle O-D data. It is also important to gather information regarding the time of day during which the trip was made and the purpose of the trip. This information provides data necessary to synthesize external-to-external trip tables and trip-length frequencies for calibrating external-to-internal travel patterns. The time of travel can also be used to estimate peak period travel from the daily traffic forecasts, and the trip purpose provides information necessary for developing travel demand management strategies. Vehicle type and vehicle occupancy data are also collected.

Two survey techniques, a mail-back survey and an interview survey, were selected for this study. The performance and costs of the two techniques are compared and the steps involved in site selection, selection of survey techniques, sample size estimation, questionnaire design, traffic control, and safety measures are described. Transportation planners should find the description of the data collection effort and the costs associated with it to be helpful because

there has been a renewed interest in such efforts created by recent legislative changes such as the Intermodal Surface Transportation Efficiency Act of 1991 and the Clean Air Act Amendments of 1990.

## ROADWAY SELECTION

To obtain a representative sample of one-way, inbound traffic entering Vermont, 25 roadways crossing the state line were selected for collecting O-D data. The selection of roadways for the survey was based on three primary factors: geographic location, functional classification, and average annual traffic volume. A good sample of statewide O-D data should include different types of roads that are located throughout the state and that represent a wide range of traffic volumes. All Interstates and principal arterials were selected, in addition to half of the minor arterials and one-third of the major collectors. The average annual daily traffic (AADT) along the selected roadways equal approximately 155,000 vehicles, representing 90 percent of total cordon line traffic.

At 20 of the 25 selected locations, surveys were conducted by VHB staff. The other 5 locations were surveyed by the New Hampshire Department of Transportation (NHDT), which is in the process of collecting similar data for its planning studies. The two states cooperated on this effort to save funds and improve the compatibility of the two states' modeling efforts. The data for the five locations surveyed by NHDT are not included in this paper.

The data collected at the selected roadways are being analyzed to develop trip tables. During the analysis, the sample data will be weighted to represent daily traffic volumes at each station, since only the busiest 12-hr period was sampled. The travel patterns along the roadways where O-D data were not collected will be estimated on the basis of O-D patterns for similar roadways in the vicinity.

## SURVEY DESIGN

Survey design includes selection of appropriate survey techniques and adequate sample sizes for surveying, determination of the information to be collected, design of the questionnaires, selection of survey stations, and scheduling of the survey.

## Survey Technique

Various O-D survey techniques were evaluated for possible use, including roadside interviews, mail-back postcard surveys,

license plate trace surveys, license plate mail-out surveys, and tag-on-vehicle/lights-on surveys (1).

The license plate trace method and the tag-on-vehicle/lights-on surveys are suitable for small study areas because vehicles can be tracked over short distances. However, vehicles cannot be tracked over an entire state. In addition, these types of surveys do not produce information about the trip purpose, which is important for model development.

The license plate mail-out survey involves recording license plate numbers of vehicles on a selected roadway, tracing vehicle ownership, and mailing a survey to owners. Because this method does not require vehicles to be stopped to receive the survey, it is less disruptive to traffic flow. However, because of the large number of out-of-state vehicles expected to be traveling into Vermont and the amount of work involved in tracing their ownership, this method was not considered appropriate. Furthermore, since the surveys are mailed at a later date to the owner of the vehicle (and not necessarily to the motorist who made the trip on the survey day), the accuracy of the data from this method is expected to be lower than that of the roadside postcard survey.

The roadside interview involves directing vehicles into a designated interview area and asking a series of short questions. The advantages of this technique are that it provides more complete information than other techniques and has a higher response rate. The disadvantage is that it generally requires more personnel and traffic control measures than other techniques.

Postcard surveys are distributed to motorists either at a location where they normally stop or after they are brought to a stop on a roadway. The advantages of this technique are that postcards can be distributed quickly and with fewer personnel than are required for interviews. The disadvantage is that a higher number of vehicles must be sampled to obtain an adequate number of completed surveys because the typical response rate for mail-back surveys is generally between 15 and 30 percent. The postcard technique is generally suitable for higher-volume roads where conducting interviews could cause longer traffic delays or at locations where it is not feasible to conduct interviews.

The roadside interview and the postcard survey were selected for the Vermont study because both methods are appropriate for large study areas and both can be adapted to collect information needed for the traffic model, including trip purpose. The survey method chosen for a particular site was based on several factors, including traffic volume, physical constraints, language needs along the Canadian border, and restrictions set by the U.S. Customs and Immigration offices at the Canadian border sites. In addition, the sample size requirements described in the following section were an important criterion for determining the survey method at each site. Because of lower response rates, the mail-back postcard surveys generally are not able to obtain adequate sample sizes on low-volume roads. Interviews can be conducted along low-volume roadways to obtain the necessary sample size and at other sites where the surveys are not expected to have an adverse impact on traffic operations.

### Sample Size

Generally, O-D surveys rely on one of two sampling approaches (2). The first approach focuses on providing a sufficient sample size for direct estimation of traffic flow at an aggregate (district-to-district) level. The second approach focuses on the statistical

requirements of estimating a proportion as it relates to a variable of interest, such as average trip length or trip purpose. Neither approach correlates explicitly with the primary purpose of the O-D survey—estimation of external trip tables.

For the purposes of this study, two requirements were established. The first was that the survey should result in a reasonably accurate external-to-external trip table; the second was that it should provide average trip length data for calibration of the external-to-internal trips. The sampling rates for the first approach mentioned above are generally higher, and therefore critical. As a result, the first approach was selected to meet the sample size requirements for the purposes of this study.

The required sample size for each survey station is defined as the minimum number of usable postcards or interviews completed. The sample size is usually represented as a rate that is the ratio of the total number of vehicles sampled to the total number of vehicles passing through. The sample size formula is given by (3,4)

$$r = (Z^2 pq) / [(N - 1) W^2 + (Z^2 pq)]$$

where

$r$  = sampling rate,

$p$  = proportion of total traffic volume at the survey station that has a particular O-D pair,

$q = (1 - p)$ ,

$W$  = desired accuracy: (percent error  $\times p$ ),

$N$  = traffic volume at the survey station, and

$Z$  = normal variate that is associated with a specified level of confidence in estimating the O-D interchange volume.

For the purpose of this study the desirable sample sizes were estimated at 90 percent confidence, errors within  $\pm 15$  percent, and  $p = 15$  percent or lower. A sample calculation for a roadway with a one-way, 12-hr volume equal to 1,300 vehicles follows:

$$p = 0.15$$

$$q = 0.85$$

$$W = \text{percent error} \times p = 0.15 \times 0.15$$

$$N = 1,300$$

$$Z = 1.645, \text{ the normal variate for 90 percent confidence}$$

$$r = (2.706 \times 0.15 \times 0.85) / [(1299 \times 0.0005) + (2.706 \times 0.15 \times 0.85)]$$

$$r = 0.34$$

Because sample sizes were calculated on the basis of historical traffic volumes and because of the fluctuations in day-to-day traffic, sampling rates were estimated conservatively for a range of traffic volumes and not for individual roadways. The following sampling rates were determined to meet the sample size criteria presented above: a sampling rate of 0.34 for roadways with traffic volumes under 5,000 vehicles during the 12-hr survey period; a rate of 0.24 for roads with volumes between 5,000 and 10,000 vehicles during the 12-hr survey period; and a rate of 0.14 for roads with volumes between 10,000 and 20,000 vehicles during the 12-hr survey period. For roads with volumes over 20,000 vehicles, a lower rate could be used; however, there were no roads in Vermont in this category.

The estimated number of postcards to be distributed and interviews to be conducted at each site are presented in Table 1. The AADTs used to estimate the sample sizes were obtained from his-

TABLE 1 Estimated Required O-D Sample Sizes and Survey Types

Route Number	Functional Classification	Two-Way AADT*	Estimated One-Way 12 Hr. Volume**	Sample Rate	Sample Size	Required Surveys		Survey Type
						Mail-back x0.30	Interview x0.95	
US 2	Principal Arterial	3,386	1,270	0.34	432	-	455	Interview
VT 314	Major Collector	1,727	648	0.34	220	-	232	Interview
VT 17	Minor Arterial	2,075	778	0.34	265	-	278	Interview
US 4	Principal Arterial	7,634	2,863	0.34	973	3,245	-	Mail-Back
VT 149	Major Collector	2,787	1,045	0.34	355	-	374	Interview
VT 9	Principal Arterial	9,130	3,424	0.34	1,164	3,881	-	Mail-Back
VT 114	Major Collector	3,065	1,149	0.34	391	-	411	Interview
US 2	Minor Arterial	4,138	1,552	0.34	528	-	555	Interview
VT 10A	Major Collector	14,414	5,405	0.24	1,297	4,324	-	Mail-Back
NH 119	Minor Arterial	6,700	2,513	0.34	854	2,848	-	Mail-Back
NH 25	Major Collector	3,000	1,125	0.34	383	1,275	-	Mail-Back
VT 123	Minor Arterial	4,500	1,688	0.34	574	-	604	Interview
US 7	Principal Arterial	4,956	1,859	0.34	632	2,107	-	Mail-Back
VT 100	Major Collector	2,878	1,079	0.34	367	-	386	Interview
I 91	Interstate	14,471	5,427	0.24	1,302	4,342	-	Mail-Back
VT 142	Major Collector	1,168	438	0.34	149	-	157	Interview
I 81/US 7	Interstate	2,929	1,098	0.34	373	1,244	-	Mail-Back
VT 139	Major Collector	1,215	456	0.34	155	517	-	Mail-Back
I 91/US 5	Interstate	5,069	1,901	0.34	646	2,154	-	Mail-Back
VT 147	Major Collector	1,117	419	0.34	142	475	-	Mail-Back
<b>Total</b>					<b>11,203</b>	<b>26,411</b>	<b>3,453</b>	

\* AADT based on previous years' traffic counts provided by VAOT.

\*\* Estimated 12-hour volumes are equal to two-way AADT divided by two, then multiplied by 0.70 to obtain a 12-hour estimate.

This number was chosen based on an analysis that showed that approximately 70 percent of AADT volumes were present on the roadways between 7:00 AM and 7:00 PM.

toric traffic volume data provided by VAOT. The minimum number of usable surveys required for each location was estimated on the basis of the sampling rates described above. A return rate of 30 percent was assumed for postcard surveys and a response rate of 95 percent was assumed for interview surveys.

### Survey Questionnaires

The mail-back postcards and the interview forms were designed to gather specific information about the one-way, inbound trips, including:

- Trip origin, including street address, city or town, and zip code;
- Trip destination, including street address, city or town, and zip code;
- Trip purpose;
- Vehicle occupancy; and
- Vehicle type.

This information will provide sufficient detail to identify O-D traffic analysis zones and develop the trip tables for the model. However, two formats are required because of the difference in the way the questions are asked of motorists and in the way responses are recorded.

### Postcards

The mail-back postcards provided precise instructions to respondents in order to gather the required information about the one-way trip. Since respondents had no chance to ask questions about proper recording of answers on the postcards, the instructions had to be as clear and concise as possible to reduce error.

The postcards were divided into a question portion and an answer portion. The answer portion was detachable and had the address and prepaid postal imprint on the back. This allowed adequate space to provide instructions while still meeting U.S. Postal Service requirements to minimize postage costs. Postcards in two languages (English and French-Canadian) were distributed at sites along the Canadian border for those motorists unable to respond in English. Each postcard was individually numbered to determine the time and location of distribution. A sample postcard is shown in Figure 1.

### Interview Forms

The interview forms consisted of a set of questions with instructions to the interviewers and interview response sheets. The instructions guided the interviewers through the questions and reminded them of the level of detail needed in the responses. In addition, a separate detailed project description sheet, intended to be handed to any

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and New Hampshire Department of Transportation**

## Questions

Please take a moment to answer a few questions about your trip into or through Vermont (excluding any return trip). Your responses will be used to help determine the need for transportation improvements in this area. **Please record your responses on the attached card ▶**

- 1 Where did your trip begin? (the last place you entered your vehicle prior to receiving this card, excluding short stops for gas or food) .....1
- 2 What type of place is your trip start point? .....2
- 3 Where did your trip end? (the first place you exited your vehicle after receiving this card, excluding short stops for gas or food) .....3
- 4 What type of place is your trip end point? .....4
- 5 If your trip ended outside of Vermont, please specify which route you used to leave the state (check one).....5
- 6 What was the purpose of your trip? .....6
- 7 How many people were in the vehicle, including the driver?.....7
- 8 What type of vehicle were you in?.....8
- 9 Please add any comments on transportation you may have .....9

Please complete, detach, and return the answer portion of the postcard as soon as possible. No postage is necessary. **Thank you very much for your cooperation!**

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and New Hampshire Department of Transportation**

## Answers

Information should be provided only for the trip you were making when you received this card.

Street Address \_\_\_\_\_  
 Nearest Intersection/Landmark \_\_\_\_\_  
 Town \_\_\_\_\_ State/Province \_\_\_\_\_ Zip \_\_\_\_\_

Your Primary Residence     Workplace     Store  
 Your Summer Residence     Hotel/Motel     Recreation Area  
 Other (please specify) \_\_\_\_\_

Street Address \_\_\_\_\_  
 Nearest Intersection/Landmark \_\_\_\_\_  
 Town \_\_\_\_\_ State/Province \_\_\_\_\_ Zip \_\_\_\_\_

Your Primary Residence     Workplace     Store  
 Your Summer Residence     Hotel/Motel     Recreation Area  
 Other (please specify) \_\_\_\_\_

I-89     I-91     I-93     Route 4     Route 7     Route 9  
 Other (please specify) \_\_\_\_\_

Work Commute     Business Related  
 Shopping     School  
 Recreation     Other (please specify) \_\_\_\_\_

1     2     3     4     5 or more

Passenger vehicle/motorcycle     Pick-up truck/van  
 Truck (2+ axles, more than 4 tires)     Other \_\_\_\_\_

Comments \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

FIGURE 1 Sample postcard used in survey.

motorist who wanted to know details about the surveys, was prepared. The project description sheet provided motorists with the name and telephone number of a contact person within VAOT from whom more information could be obtained.

### Survey Station Selection

Site visits were made to identify potential locations along each route where O-D surveys could be conducted. The following criteria were used to identify precise survey stations for each roadway:

- **Sight distance:** The primary consideration in selecting survey locations was safety. This required visibility and sight distance to be evaluated. Survey stations were located on flat, straight stretches of road. Locations near curves, hills, and other obstructions to visibility were avoided.

- **Roadway cross section:** Wherever possible, survey stations were placed where roadway width was at its maximum and in an area with shoulders. This was particularly important for interview sites, where three travel lanes were needed (see section on traffic control plans). In addition, culverts, ditches, utility poles, and private property were avoided. In general, the more room available and the fewer obstacles present, the safer the traffic operations were through the site.

- **Proximity to state line:** Because this survey was aimed at external-to-internal and external-to-external trip data, it was important to be as close as possible to the state line. The greater the dis-

tance from the border, the greater was the possibility of intervening land uses that would attract trips that could not be surveyed.

- **Minimizing delays for traffic flow:** Wherever possible, sites were selected at locations where vehicles normally stop. Types of sites that fell into this category were a ferry dock at the origin of one route, signalized intersections, and the U.S. Border Inspection Stations at the Canadian border.

### Survey Scheduling

The surveys were conducted on Tuesdays, Wednesdays, and Thursdays during June, for 12 hr at each site (7:00 a.m. to 7:00 p.m.). The following issues were considered in scheduling the surveys:

- **Month:** The choice of month depended on whether typical or peak data were desired. The objective of this study was to obtain data for typical or average conditions. An examination of monthly traffic counts from permanent traffic count stations revealed that traffic conditions in June are generally typical; therefore, June was chosen as the survey month.

- **Day of week:** The choice of day of week also depended on the type of traffic model being developed. The Vermont model is an average weekday daily model. Therefore, surveys were conducted only on weekdays. In addition, Mondays and Fridays were eliminated because of their proximity to the weekend.

- **Time of day:** For safety reasons, it is best to conduct O-D surveys during daylight hours. An analysis of traffic counts from

the permanent count stations revealed that the 12 hr with the most traffic volume were generally between 7:00 a.m. and 7:00 p.m. The permanent count station data indicated that these 12 hr generally accounted for over 75 percent of total daily traffic volume.

Contingency days were included in case specific surveys had to be canceled for any reason. Rain was the primary concern because of its impact on the survey crew and safety and visibility issues. In addition, personnel problems, including absent temporary employees or police, could force cancellation or suspension of operations.

**FIELD DATA COLLECTION**

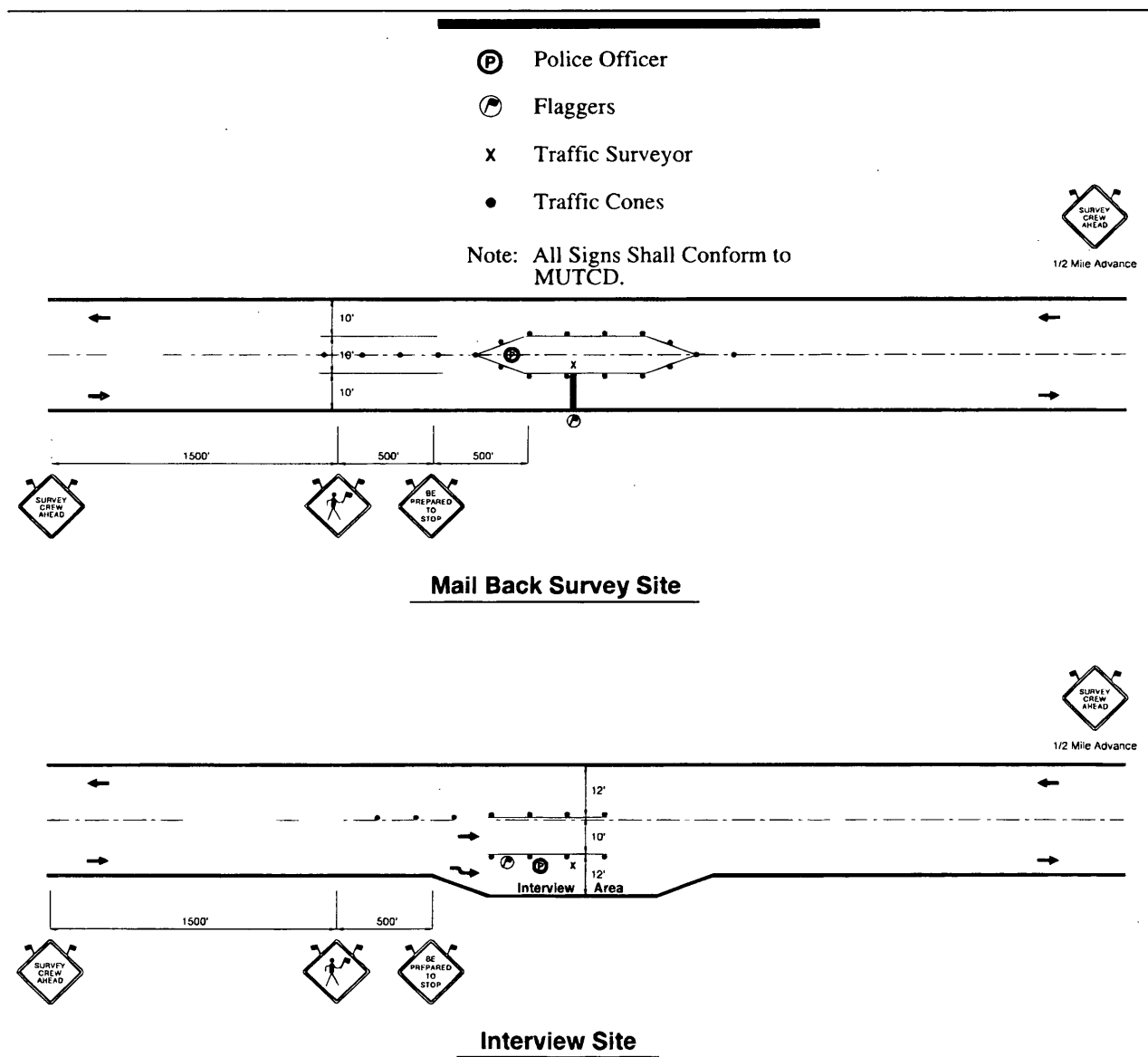
Great care was taken to ensure that the surveys were conducted in a safe and efficient manner. Methods for setting up the survey stations, distributing postcards, and conducting interviews, including

the safety and training measures taken, are described. In addition, the survey responses are summarized.

**Traffic Control Plans**

Typical traffic control plans were developed for three different types of sites, as shown in Figures 2 and 3. The three types of sites are two-lane road mail-back postcard site, two-lane road interview site, and Interstate highway mail-back postcard site.

The differences between the plans that are important to note relate to the number of lanes needed for interviews or postcard distribution. On two-lane roads, postcards were distributed to motorists in their normal travel lane, with a small buffer area between the opposing lanes of traffic in which crew members could work. At interview sites, three lanes were created using traffic cones, two in the direction of the survey and one in the opposite



**FIGURE 2** Two-lane-roadway O-D survey sign package.

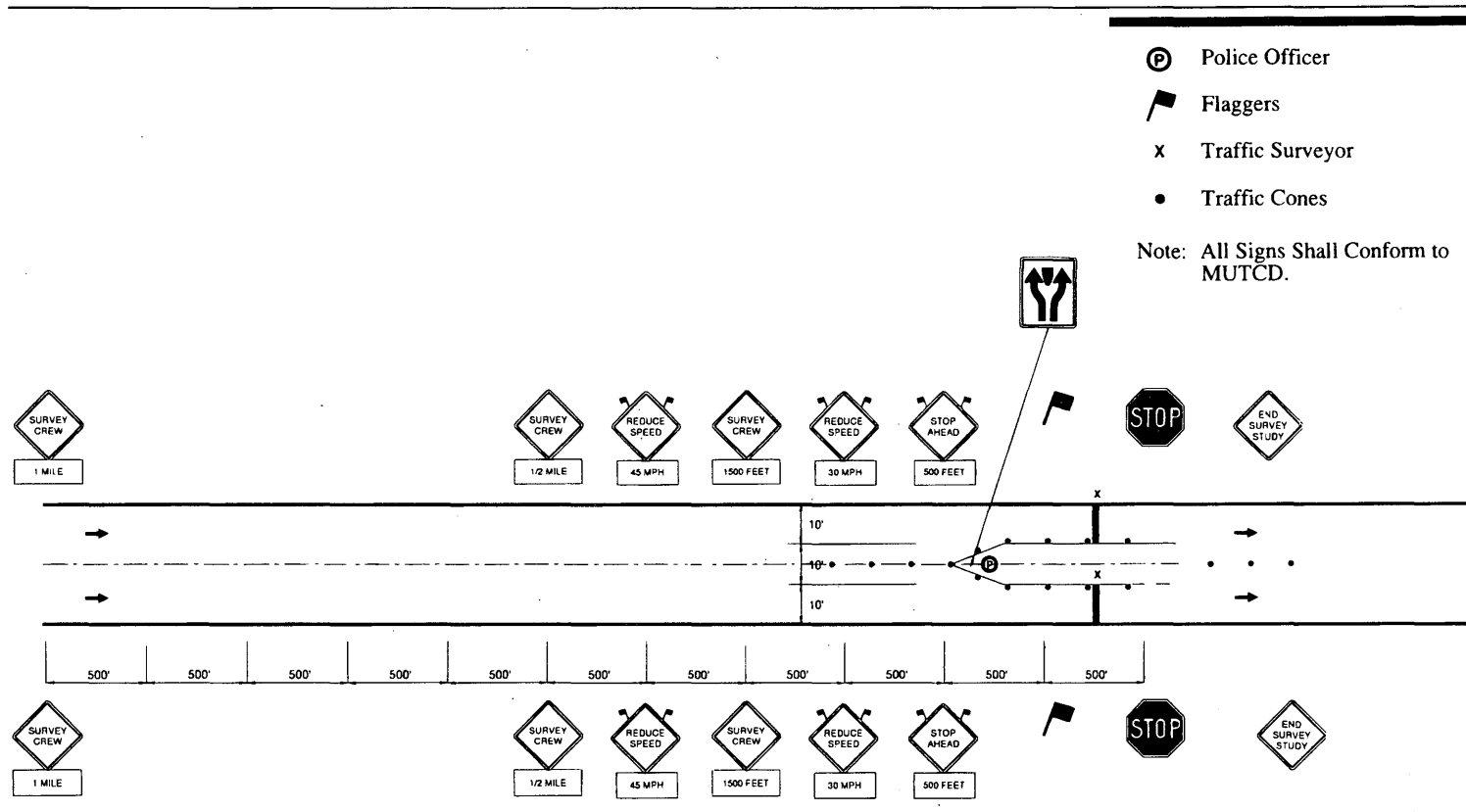


FIGURE 3 Interstate O-D survey sign package.

direction. The rightmost lane in the survey direction was the designated interview lane. The center lane was used as a bypass lane for motorists who were not stopped. The third lane was used by vehicles traveling in the opposite direction to the survey. The Interstate site was a mail-back postcard site. Cards were distributed to vehicles in both lanes rather than in just one in order to minimize delay and to eliminate lane distribution bias in the sample.

All traffic signs used for the surveys conformed to the standards set in the *Manual on Uniform Traffic Control Devices* (5). The signs included advance warning signs about the survey crew and the flagger and a sign instructing motorists to be prepared to stop. The first sign was placed approximately 0.5 mi in advance of the survey station. The Interstate sign package was more extensive, with the first sign placed 1 mi from the site. The signs instructed motorists to reduce speeds and to come to a complete stop at the survey station. Other on-site safety measures included

- Orange reflective safety vests for all crew members,
- Trained flaggers to direct traffic through the survey site,
- Presence of police officers and their vehicles at all sites where vehicles were stopped by crew members for the survey, and
- Avoidance of the roadway by crew members on break.

### Postcard Distribution

The number of crew members required to distribute postcards ranged from one to four, depending on the traffic volume. The one exception was the Interstate site, which had eight people distributing cards (four in each lane) in order to minimize backups. The crew members were spread out through the survey station to allow cards to be distributed to more than one vehicle at a time. When a crew member was available, the next vehicle would be directed into the survey station by the flagger. The postcards were bundled in envelopes according to the hour in which they were to be distributed. The site supervisor was responsible for switching envelopes between hours.

### Interviews

The number of people required to conduct interviews ranged from two to three, depending on the traffic volume. The interviewers were spread out through the survey station to allow more than one motorist to be interviewed at a time. When an interviewer was available, the next vehicle would be directed into the station by the flagger. The site supervisor was responsible for checking interview response sheets throughout the day to make sure that the interviewers were recording the answers correctly.

### Summary of Surveys

A log of the number of postcards completed and returned, or the number of interviews conducted, was maintained by time of day for each site. The responses were cleaned up and errors were corrected whenever possible. Usable responses were separated from those that could not be interpreted. The review indicated that over 90 percent of all responses received (postcards and interviews) were usable. The most common types of errors observed included

- Answers recorded in the wrong place,
- Incomplete street addresses and ZIP codes, and

- Information provided for the round trip rather than the one-way trip as requested (although this occurred on less than 5 percent of all returned postcards).

The summary of survey responses is presented in Table 2. The number of usable responses was compared with the observed traffic volume at each site. Traffic counts were conducted at all sites for 72 hr around the survey period. It should be noted that the traffic volumes used to estimate sample size represented the AADT for recent previous years and are different from the traffic volumes presented in Table 2, which represent the actual traffic volumes on the survey day. Overall, approximately 24 percent of all the cards distributed were returned and found to be usable. The returns for each site varied from 9 to 33 percent. Over 95 percent of all the interviews conducted were usable. The comparison of the number of surveys with the 12-hr traffic data indicated that the usable surveys included just under 20 percent of the total traffic volume.

Generally, the lowest response rate, ranging from 9 to 20 percent, was observed for the Canadian border sites. The average for all Canadian border sites was less than 14 percent. The reasons for the lower response rate of these sites may have been the need for additional postage on postcards mailed outside the United States and the language difference.

### Minimizing Data Biases

Survey methods are generally susceptible to biases. Measures were taken to minimize biases during the planning and implementation phases, including the following:

- Vehicles were selected at random, including trucks;
- On four-lane roadways, vehicles were surveyed in both lanes or traffic was directed into one lane before being surveyed;
- Cards in two languages were prepared to avoid nonresponse due to language difference; and
- Sites were selected to represent different functional classifications, traffic volumes, and geographical areas.

In addition, biases are also introduced by the unwillingness of certain subgroups within the population to respond to these types of surveys. Nonresponse bias is likely to be higher for the mailback surveys than for the interview surveys. The impact of this type of bias will be analyzed during the analysis phase of this study.

### STUDY COSTS

A summary of estimated costs for design and implementation of the O-D survey is presented in Table 3, which shows that the total study cost was approximately \$121,500. The cost includes consultant staff and VAOT employee labor, temporary labor, traffic control expenses, printing, postage, and expenses for food, travel, and lodging. Generally, one VAOT employee was present at each site that had volumes over 2,000 AADT. The cost estimate does not include expenses incurred by VAOT staff, as those expenses are not known. The costs also do not include data entry and extensive data analysis, which are currently under way.

The costs were broken down by task and by survey type for comparison, as shown in Table 3. The labor costs for the design/planning task accounted for the largest percentage of effort, represent-

TABLE 2 Summary of Results of O-D Survey

Route Number	Bordering State	One-Way 24 Hour Traffic Volume*	One-Way 12 Hour Traffic Volume*	Number of people Interviewed	Usable Interviews	Response Rate**	Number of Post Cards Distributed	Number Returned	Usable Cards	Response Rate***	Usable Sample As Percent of 12 hour Traffic Volume
<i>Interview Sites</i>											
US 2	NY	2,429	1,822	511	503	98.4%	-	-	-	-	27.6%
VT 314	NY	936	754	308	307	99.7%	-	-	-	-	40.7%
VT 17	NY	883	514	456	443	97.1%	-	-	-	-	86.2%
VT 149	NY	2,135	1,626	630	623	98.9%	-	-	-	-	38.3%
VT 114	NH	1,487	1,076	612	600	98.0%	-	-	-	-	55.8%
US 2	NH	1,828	1,412	747	699	93.6%	-	-	-	-	49.5%
VT 123	NH	2,482	1,954	676	563	83.3%	-	-	-	-	28.8%
VT 8/100	MA	1,477	1,134	354	349	98.6%	-	-	-	-	30.8%
VT 142	MA	609	473	228	220	96.5%	-	-	-	-	46.5%
<i>Mail-back Sites</i>											
US 4	NY	3,229	2,309	-	-	-	1,941	456	420	21.6%	18.2%
VT 9	NY	4,871	3,742	-	-	-	2,815	735	678	24.1%	18.1%
VT 10A (EB)	NH	9,085	7,307	-	-	-	2,556	913	847	33.1%	11.6%
VT 10A (WB)	NH	9,090	7,210	-	-	-	2,515	850	755	30.0%	10.5%
NH 119	NH	5,423	4,191	-	-	-	2,241	596	526	23.5%	12.6%
NH 25	NH	1,161	941	-	-	-	769	194	167	21.7%	17.7%
US 7	MA	4,276	3,385	-	-	-	1,029	175	142	13.8%	4.2%
I-91	MA	7,236	5,427	-	-	-	4,304	1,067	1,000	23.2%	18.4%
I-89	CAN	1,696	1,145	-	-	-	768	110	96	12.5%	8.4%
VT 139	CAN	257	243	-	-	-	243	54	48	19.8%	19.8%
I-91	CAN	756	620	-	-	-	595	108	92	15.5%	14.8%
VT 147	CAN	454	376	-	-	-	338	42	30	8.9%	8.0%
<b>Totals</b>		61,800	47,661	4,522	4,307	95.2%	20,114	5,300	4,801	23.9%	19.1%

\*Traffic counts conducted in June, 1994 while surveys were being conducted.

\*\*Number of usable interviews divided by the total number of interviews.

\*\*\*Number of usable postcards divided by the total number of postcards distributed.



TABLE 3 Cost Summary of O-D Survey

		Mail-back Postcards	Interviews	Total
<b>Labor</b>				
	Design/Planning and Site Visits	31,100.00	25,900.00	57,000.00
	Data Collection	21,700.00	18,800.00	40,500.00
	Subtotal	52,800.00	44,700.00	97,500.00
<b>Expenses</b>				
	Travel, food, misc.	5,200.00	4,300.00	9,500.00
	Traffic Control Equipment	1,800.00	1,500.00	3,300.00
	Police Details	2,400.00	2,700.00	5,100.00
	Printing, postage	6,000.00	100.00	6,100.00
	Subtotal	15,400.00	8,600.00	24,000.00
<b>Total Cost</b>		<b>\$68,200.00</b>	<b>\$53,300.00</b>	<b>\$121,500.00</b>
<b>Number of Usable Responses</b>				
		4,800	4,300	9,100
<b>Cost Per Usable Response</b>				
		\$14.21	\$12.40	\$13.35

The split between mail-back and interview techniques was based on exact hours in all cases where they could be determined. In all other cases, the split was estimated proportionally.

ing approximately 47 percent of the project cost. The labor cost for conducting the survey was approximately 33 percent, and expenses accounted for the remaining 20 percent. The labor cost for the data collection task was lower than design and planning labor cost because temporary agency employees working on an hourly basis were used to conduct the surveys.

The breakdown between mail-back postcard surveys and interview surveys was included to illustrate the difference in cost between the two techniques. The number of usable surveys included the mail-back postcards that were filled out correctly by the respondents and the interviews that were completed correctly. The cost per usable response, reflecting the costs incurred in order to get one usable postcard or one usable interview, was estimated to be \$13.35. The estimated cost per usable response for the mail-back postcard survey was \$14.21, compared with \$12.40 for the interview survey.

## STUDY FINDINGS

One of the most interesting parts of this study was the opportunity to compare the costs of the different survey techniques involved. Table 3 indicates that the cost per usable response for the mail-back postcard survey (\$14.21) is greater than that for the interview survey (\$12.40). However, much of this difference results from the fact that in this study interviews were conducted on low-volume roadways (less than 5,000 vehicles per day [vpd]). On the other hand, mail-back postcard surveys were conducted for all higher-volume roads (greater than 5,000 vpd) and lower-volume roads where interviews could not be conducted. As indicated earlier, the response rate was lowest for Canadian border sites where mail-back postcard surveys were conducted, which contributed to higher overall cost per usable postcard survey. The ferry site (VT 314), which was an interview site, did not require any traffic control because the motorists were interviewed while they were waiting in the holding area before

boarding the ferry. Fewer interviewers were required because more time was available for conducting interviews, further contributing to the lower costs for interview surveys.

It was considered more appropriate to compare costs for sites with similar traffic volumes and conditions. The first group of sites included traffic volumes from 2,000 to 3,000 vpd, and the second group included 4,500 to 6,500 vpd. The cost comparisons are presented in Table 4. Although data were not available to compare costs for higher-volume roads (over 6,500 vpd), mail-back postcard cost per usable response was estimated for a representative higher-volume road. This cost estimate is also presented in Table 4.

It is generally more cost-effective to conduct interview surveys on lower-volume roads (5,000 vpd or less). The comparison indicated that the cost per usable response for mail-back postcard surveys decreased as traffic volumes increased. Cost per usable response for higher-volume roads like I-91 were as low as \$8.50. This Interstate site required the largest number of crew members and police officers, and the traffic control plan was the most elaborate, resulting in a higher total cost for the site. However, the cost per usable response was much lower, indicating that the cost per usable mailback survey drops as traffic volume increases.

Additional study findings include the following:

- Interview sites generally required more traffic control, more training time, and more supervision of crew members than mail-back postcard sites;
- Interviews could generally be conducted in less than 1 min;
- Police assistance is desirable for all sites where traffic is stopped on the road for the survey;
  - The mail-back postcard technique is generally not appropriate for lower-volume roads because the lower response rate may affect sample size requirements;
  - Interview surveys were generally cost-effective for lower-volume (5,000 AADT or less) roadways.

TABLE 4 Comparison of Interview and Postcard Techniques for Selected Roadways in Vermont

Traffic Volume Range: 2,000-3,000 Vehicles per Day	Interview (VT 114)	Mail-back Postcard (NH 25)
Two-way Traffic Volume	2,974	2,322
One-way Traffic Volume	1,487	1,161
Usable Responses	600	167
Interviews Conducted or Postcards Distributed	612	769
Response Rate	98.0%	21.7%
Estimated Cost per Site	\$5,600.00	\$5,300.00
Estimated Cost per Usable Response	\$9.35	\$31.75
Traffic Volume Range: 4,500-6,500 Vehicles per Day	Interview (US 2 NY)	Mail-back Postcard (US 4 NY)
Two-way Traffic Volume	4,860	6,450
One-way Traffic Volume	2,430	3,230
Usable Responses	503	420
Interviews Conducted or Postcards Distributed	511	1,941
Response Rate	98.4%	21.6%
Estimated Cost per Site	\$5,600.00	\$6,150.00
Estimated Cost per Usable Response	\$11.15	\$14.65
Traffic Volume Range: 14,500 Vehicles per Day	Interview	Mail-back Postcard (I-91 MA)
Two-way Traffic Volume	N/A	14,500
One-way Traffic Volume	N/A	7,250
Usable Responses	N/A	1,000
Interviews Conducted or Postcards Distributed	N/A	4,304
Response Rate	N/A	23.2%
Estimated Cost per Site	N/A	\$8,500.00
Estimated Cost per Usable Response	N/A	\$8.50

The study provided an opportunity to compare two popular O-D data collection techniques—mail-back surveys and interview surveys. Each method has advantages and disadvantages and cost concerns. Transportation planners should evaluate study requirements and site restraints before selecting a survey method to suit their needs. In general, this study concludes that the interview technique is more cost-effective for lower-volume (less than 5,000 vpd) roadways.

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