Standard Title Page — Report on State Project

Report No.	Report Date	No. Pages	Type Report: Final	Project No. : 92-63-080-940 803
VTRC 92-R11	Sept. 1991	70 pages	Period Covered: March 1990–August 1991	Contract No. :

Title and Subtitle

Review of Travel Data Issues in VDOT's Transportation Planning Division

Author(s)

E. D. Arnold, Jr.

Performing Organization Name and Address:

Virginia Transportation Research Council
Box 3817, University Station
Charlottesville, Virginia 22903-0817

Sponsoring Agencies' Names and Addresses

Virginia Department of Transportation
1401 E. Broad Street
Richmond, Virginia 23219

University of Virginia
Charlottesville,
Virginia 22903

Key Words

transportation planning
data collection
O & D survey
occupancy counts
turning movements

Supplementary Notes

Abstract

The Transportation Planning Division (TPD) of the Virginia Department of Transportation uses an extensive amount of travel data in both its routine planning activities and its provision of data forecasts to other divisions. Travel data consist of such items as 24-hour and peak hour volume counts, turning movement counts, origin and destination surveys, occupancy counts, and vehicle classification counts. These data are expensive to obtain because of the personnel required and the cost of the data collection equipment.

Accordingly, TPD requested that a study be undertaken to inventory and review its use of travel data, review the method of data collection and their usage, identify issues regarding travel data, and recommend changes in data collection or usage. Changes were formulated in the context of reducing the amount or level of data needed, streamlining data collection, and utilizing data more efficiently.

The research was conducted in two phases. The first phase included three specific tasks: an inventory of TPD's travel data requirements, the categorization of the travel data, and the identification of issues for further investigation. Phase II consisted of an investigation of each of the identified issues.

Based on the findings of Phase I, 17 issues concerning travel data that had a potential for savings were identified. Primarily because of their scope, some issues were not investigated under this project; they will be investigated in an upcoming project scheduled for FY 1992. Results from the investigation of the other issues are described in this report.

FINAL REPORT

REVIEW OF TRAVEL DATA ISSUES IN VDOT'S TRANSPORTATION PLANNING DIVISION

E. D. Arnold, Jr.
Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by
the Virginia Department of Transportation and
the University of Virginia)

Charlottesville, Virginia

September 1991
VTRC 92-R11

TRAFFIC & PLANNING RESEARCH ADVISORY COMMITTEE

A. L. THOMAS, JR., Chairman, State Traffic Engineer, VDOT

E. D. ARNOLD, JR., Executive Secretary, Research Scientist, VTRC

M. G. ALDERMAN, Regional Sign Shop Coordinator, VDOT

W. S. BLACK, Fredericksburg District Traffic Engineer, VDOT

G. R. CONNER, Assistant Rail & Public Transportation Administrator, VDOT

J. C. DUFRESNE, Culpeper District Traffic Engineer, VDOT

D. L. FARMER, Chief Transportation Planner, Hampton Roads Planning District Commission

C. F. GEE, State Construction Engineer, VDOT

C. D. HALL, Assistant State Traffic Engineer, VDOT

T. A. JENNINGS, Safety/Technology Transfer Coordinator, Federal Highway Administration

P. L. KRUSE, Bristol District Traffic Engineer, VDOT

Y. LLORT, Northern Virginia District Planning & Operations Engineer, VDOT

C. E. MORRIS, District Tunnel & Toll Engineer, VDOT

T. W. NEAL, JR., Chemistry Lab Supervisor, VDOT

R. L. SAUVAGER, Assistant Urban Division Administrator, VDOT

80/

ACKNOWLEDGMENTS

Appreciation is extended to members of the task group for their assistance in guiding the direction of the research and their review and comments on the various documents produced. They include Chairperson Don Wells, Charlie Rasnick, Jim Robinson, and Phil Hopkins. Also, thanks go to the study engineers in TPD who completed the detailed travel data survey. They include Pete Bradley, Wayne Woodcock, Walter Johnson, Herman Hollis, Grady Ketron, Bob Chandler, Carol Valentine, Irene Shuman, Horace Welsh, Herbert Pegram, and George Pierce. Finally, the assistance of Cary Adkins, Ken Persons, and Charlie Hall in evaluating the data needs of ED, L & D, and TED, respectively, is acknowledged.

TABLE OF CONTENTS

ACKNOWLEDGMENTS iii

ABSTRACT vii

INTRODUCTION 1

PURPOSE 1

METHODS 2
- Phase I 2
- Phase II 2

RESULTS 2
- Phase I 2
  - Data Requirements by Function 2
  - Issues for Further Investigation 7
- Phase II 9
  - Issue 1: Data Needs for the 1994 Statewide Highway Plan 9
  - Issues 2, 3, and 4: Project Specific Data Requests from Other Divisions 10
  - Issue 5: Occupancy Count Data 12
  - Issue 6: Origin and Destination Surveys 17
  - Issue 7: Turning Movement Data 21
  - Issue 8: Census Year Updates of Urbanized Area Plans 22
  - Issue 9: Evaluation of the Urban Count Program 22
  - Issue 10: Traffic Volume Forecasting Methods 22
  - Issues 11 and 12: Permanent Count Stations and Average Annual Daily Traffic 23
  - Issue 13: Manual Vehicle Classification Counts 24
  - Issue 14: Count Data to Consultants 24
  - Issue 15: Primary Count Program Vehicle Classifications 25
  - Issue 16: Secondary Road System Counts 25
  - Issue 17: Count Data to Private Parties 26

CONCLUSIONS 26

RECOMMENDATIONS 29

REFERENCES 31

APPENDIX A: Travel Data Survey 33

APPENDIX B: Data Required for the 1994 State Highway Plan 43

APPENDIX C: Standard Data Request Forms 51

APPENDIX D: Information on TURNFLOW and TMOVES 59

ABSTRACT

The Transportation Planning Division (TPD) of the Virginia Department of Transportation uses an extensive amount of travel data in both its routine planning activities and its provision of data forecasts to other divisions. Travel data consist of such items as 24-hour and peak hour volume counts, turning movement counts, origin and destination surveys, occupancy counts, and vehicle classification counts. These data are expensive to obtain because of the personnel required and the cost of the data collection equipment.

Accordingly, TPD requested that a study be undertaken to inventory and review its use of travel data, review the method of data collection and their usage, identify issues regarding travel data, and recommend changes in data collection or usage. Changes were formulated in the context of reducing the amount or level of data needed, streamlining data collection, and utilizing data more efficiently.

The research was conducted in two phases. The first phase included three specific tasks: an inventory of TPD's travel data requirements, the categorization of the travel data, and the identification of issues for further investigation. Phase II consisted of an investigation of each of the identified issues.

Based on the findings of Phase I, 17 issues concerning travel data that have a potential for savings were identified. Primarily because of their scope, some issues were not investigated under this project; they will be investigated in an upcoming project scheduled for FY 1992. Results from the investigation of the other issues are described in this report.

FINAL REPORT

REVIEW OF TRAVEL DATA ISSUES IN VDOT'S TRANSPORTATION PLANNING DIVISION

E. D. Arnold, Jr.
Research Scientist

INTRODUCTION

The Transportation Planning Division (TPD) of the Virginia Department of Transportation (VDOT) is responsible at the state level for transportation planning in Virginia. Transportation planning activities are data intensive. In general, the data required can be categorized as socioeconomic data and travel data. The former are usually obtained from other sources, but travel data must usually be collected by VDOT. Travel data are obtained from such activities as 24-hour and peak hour volume counts, turning movement (TM) counts, origin and destination (O & D) surveys, home interview surveys, vehicle classification studies, occupancy rate studies, and bicycle counts.

TPD is the official source of all forecast data. Therefore, other VDOT divisions routinely request travel forecast data on a project-level basis.

Travel data are very expensive to collect because of the personnel required and the cost of the data collection equipment. Further, much of the data are collected for TPD by personnel in the Traffic Engineering Division (TED). TED also has its own travel data needs, and there are often conflicts resulting from limited personnel and equipment and, consequently, from conflicts in priorities. Finally, the cost of travel data collection—particularly volume counts—has escalated significantly within the past 2 years because of added safety requirements.

PURPOSE

The purposes of this study were (1) to inventory and review the use of travel data by TPD, (2) to review the method of collection and usage of the travel data, (3) to identify issues regarding travel data, and (4) to recommend changes that would increase efficiency. Changes increasing efficiency were formulated in the context of reducing the amount or level of data needed, streamlining data collection, and utilizing data more efficiently.

METHODS

The research was conducted in two phases.

Phase I

Phase I included three tasks:

1. *Inventory travel data usage*. A travel-data survey questionnaire was provided to each of the 12 urban area study engineers in TPD in order to inventory the travel data currently being utilized in the urban planning process. Data needs for the statewide planning effort were obtained directly from the planning engineer in charge of the activity. For each data item, the questionnaire requested information on why it is needed, how it is applied by the user, how and by whom it is collected, and how often it is needed. The questionnaire is included in Appendix A. The questionnaire was distributed to the engineers at an informational meeting at the outset of the inventory task.

2. *Review and categorize travel data*. The responses to the survey were reviewed and compiled. The data items were then categorized by TPD activity or function.

3. *Review information from the survey, and identify issues*. The survey information obtained for each data item was reviewed and, in conjunction with members of a task group consisting of TPD and TED personnel, issues needing further investigation were identified.

Phase II

Detailed investigations into each issue were undertaken. Some of the issues were resolved outside the context of the research. Because of budget and time constraints, and the magnitude of the issue, the investigation of some issues was deferred until a future research effort.

RESULTS

Phase I

Data Requirements by Function

TPD has five basic activities or functions:

1. statewide planning
2. regional planning
    - population group
    - level of effort
3. subarea planning
    - corridor studies
    - site plan review
4. project-specific (from outside TPD) activities
5. miscellaneous.

A *statewide highway plan* is developed every 5 years. This is an extensive and comprehensive effort in which urban area plans are combined with specific planning activities in rural areas to develop a list of prioritized highway projects throughout the state. The 2010 Statewide Highway Plan, dated October 1989, was released in July 1990. A detailed list of data proposed for the next statewide plan was developed by TPD and is included as Appendix B.

A *regional transportation plan* is developed for every urban area with a population of 3,500 or greater and for several smaller areas that maintain their own streets. Urban areas are categorized into three population groupings, each generally having a different level of planning effort. These groups are (1) less than 10,000, (2) between 10,000 and 50,000, and (3) 50,000 or greater. The level of effort, including the amount of data needed, increases as the population increases.

The most extensive and comprehensive effort is undertaken for "urbanized" areas (≥50,000), and a "3C" (cooperative, comprehensive, and continuous) planning process is mandated by the U.S. Department of Transportation. Complex mathematical models are developed and calibrated in the base year and then recalibrated and updated at the time of the official 10-year census in order to use the most current socioeconomic data. Interim years are devoted to monitoring the plan by comparing model predictions to actual data. There are 11 urbanized areas within the state, including 3 (Bristol, Kingsport, and Northern Virginia) for which TPD is not the lead state agency. (TPD has assumed a much greater role in recent years in Northern Virginia through the Subregional Planning Process.) Planning requirements for these areas are extensive and receive top priority because of the magnitude of the transportation requirements and the federal requirements for urbanized area planning.

For urban areas having a population of less than 50,000, the planning activities are also categorized into base year, monitoring, and updating. However, the level of effort varies in both the complexity of activity and the timing of the monitoring and updating activities. In general, areas having a population between 10,000 and 50,000 receive more effort than areas having a population less than 10,000.

There are currently 11 urban areas in the 10,000 to 50,000 population group and 36 in the <10,000 population group. Others will be added when results of the 1990 census are available.

Data requirements for the urban planning process (as categorized by base year, monitoring, and updating) are provided in Table 1. The specific data items are the same for all population categories. The difference is in the amount of data needed and how the data item is used or applied.

Subarea transportation planning is conducted for two specific activities: corridor studies and site plan review. TPD often undertakes detailed studies of needed improvements along a specific route or in a specific corridor. Likewise, TPD may be asked to review a consultant's traffic impact study for a proposed development. Specific data requirements for each of these activities are provided in Table 2.

Project-specific data items are often requested by other VDOT divisions, consultants, and others outside TPD. These requests generally require forecasts of traffic data items for specific highway projects, thus coming under the area of transportation planning. TPD is responsible for providing both current and forecast values. Specific data items are listed in Table 3. The Environmental Division (ED) and the Location and Design Division (L & D) have standard forms for these data requests (see Appendix C).

Table 1

DATA REQUIREMENTS FOR TRANSPORTATION PLANNING
IN URBAN AREAS

Base Year and Update
Average daily traffic
Peak hour volumes
Turning movements
Origin and destination information
Travel times, speeds, delays
Parking information
Percent trucks
Signal timing and phasing
Roadway inventory
Accident data
Transit data (if applicable)
Monitoring
Average daily traffic
Peak hour volumes

Table 2

DATA REQUIREMENTS FOR SUBAREA TRANSPORTATION PLANNING

Data Item	Corridor Studies	Site Plan Development/Review
Average daily traffic	•	•
Peak hour volumes	•	•
Turning movements	•	•
Origin and destination information	•	
Travel times, speeds, delays	•	
Parking information	•	
Percent trucks	•	•
Through trucks	•	
Signal timing and phasing	•	•
Accident records	•	
Occupancy counts	•	
Roadway inventory	•	•
Distribution of traffic to and from site		•
Capture rates and % pass-by trips		•

Table 3

DATA REQUIREMENTS FOR SPECIFIC PROJECTS

		Source of Request		
Data Item	Environmental	Location & Design	Traffic Engineering	Consultants
Roadway inventory	•	•	•	
Signal timing and phasing	•	•	•	
Average daily traffic	•	•	•	•
Each hour 6 a.m.–9 p.m.				
% ADT	•			
Directional split	•			
Operating speed	•			
Peak hour volumes (by 15 min)	•	•	•	•
Peak hour directional split	•	•	•	•
Peak hour operating speed	•			
Percent trucks with:				
≥ 3 axles	•	•	•	
2 axles, 6 tires	•	•		
2 axles, 4 tires	•			
Between 9 a.m. and 3 p.m. (M–F)				
Max. hourly volume	•			
Operating speed	•			
Truck mix	•			
Between 9 a.m. and noon (Sun.)				
Max. hourly volume	•			
Operating speed	•			
Truck mix	•			
Through trucks (≥ 3 axles)	•			
Design hourly volume		•		
Turning movements		•	•	•
Lane volumes (ramp analysis)		•		
General classification counts				•

Note: Peak hour factor, level of service, and the directional distribution factor are not considered data items; i.e., specific data items are used to calculate these values. For example, signal timing and phasing is a specific data item required to calculate the level of service at an intersection (which is the information requested by others).

Finally, there are *miscellaneous* functions or activities that fall outside the scope of the major functions. These can be summarized as follows:

1. Available traffic volumes are provided to businesses, developers, etc. upon request.
2. A 24-hour volume may be used to aid in determining functional class.
3. The volume and distribution of trucks are required for conducting goods movement studies and evaluating the need for a truck lane.
4. Travel times, speeds, and delays are used for before and after studies, evaluations of high-occupancy vehicle (HOV) operations, and determination of congested locations.
5. O & D information (with or without trip purpose), including through truck movements, is used for bypass studies.
6. Pedestrian counts are required to evaluate the need for a pedestrian facility, sidewalk, or signal treatment.
7. Weave/merge counts by lane during peak hours are required to evaluate weaving areas.
8. Bicycle counts are needed to determine the need for or improvement to a bicycle facility.
9. Occupancy counts are required to evaluate the need for or effectiveness of an HOV facility.
10. Accident records are used for special studies of spot locations.
11. Videotaping is used to document or review roadway inventory information, review and analyze intersection operation and traffic flow conditions, and determine the percentage of no passing for two-lane roadway capacity analysis.
12. Photographs are sometimes used to document inventory information.
13. Various parking data are used for special studies.
14. Aerial photographs are used to develop functional plans.
15. Bus counts, ferry boat counts, railroad crossing counts, bridge openings, and flooding information are used for special requests.

Issues for Further Investigation

Based on a review of the survey and discussion with the task group, the following 17 issues relating to data needs, utilization, and collection were identified. Each appears to have the potential for savings.

1. A list of data needed for the 1994 Statewide Highway Plan was developed, and there is concern in TPD over the amount and detail of data required. A review and an evaluation of the method and resulting data needs for the statewide effort are needed.

2. Considerable time and effort is expended in responding to data requests from ED, L & D, and TED. Discussions with these divisions should be undertaken to verify their needs.

3. Requests from the aforementioned divisions require varying design year forecasts. It may be possible to standardize the forecast years needed.

4. Several respondents to the survey indicated that other divisions need O & D data. This is questionable and should be checked to determine if unnecessary data collection is being undertaken.

5. The collection of occupancy data, which is not done a great deal, is very expensive. The required occupancy counts in Northern Virginia seem to be especially comprehensive and detailed. A review of that activity, including a search for other data collection methods, is needed.

6. There are several techniques for collecting O & D data. A discussion of the various current methods, and possible guidelines on when to use each, may be of benefit.

7. The collection of TM data is very costly. The various uses should be reviewed to determine if alternative data can be utilized or whether a full 12 hours of data are needed.

8. There is some concern that the data collection effort for the 10-year, or census year, updates of the urbanized area plans is too comprehensive. This process should be checked, and possible guidelines developed for this effort.

9. The urban count program requires that a considerable number of 24-hour counts be made every other year in the urban areas. These counts are used for monitoring the transportation plan, establishing trends, and answering project-specific requests for projects that happen to be at or near a designated urban count station. There is a concern that these data are being underutilized. Apparently, the data are used to varying degrees by TPD staff for monitoring and trend development, and it is clearly not cost-effective to count a large number of locations just in case project-specific requests at those locations may be received. A review and evaluation of the urban count program should be undertaken to determine the extent of this underutilization (if in fact it exists).

10. Trendline, or historical-based, traffic projections are often made outside urban areas. The data required for this procedure are sometimes lacking, and the accuracy is sometimes questionable. A review of this procedure as well as a search for more efficient, less data-intensive procedures is needed.

11. A significant number of continuous count locations have been established in recent years. The location of and availability of data from these stations

may not be common knowledge in TPD. Greater utilization of these data might preclude count requests designed solely to develop factors to expand short-term counts.

12. It is recognized that daily traffic volumes vary from day to day, week to week, month to month, and even by season of the year. A true ADT, or an average annual daily traffic (AADT), should reflect this variation; in fact, the current primary count program incorporates this variation. Other count programs and count requests do not. To address this variability, some study engineers request 7-day, 5-day, or 2-day counts; others accept a single 24-hour count because of time and money constraints. An investigation of this issue is needed to determine if the longer counts can be eliminated. Obviously, one simple solution is better utilization of the continuous count station data mentioned previously. This issue is also related to the effectiveness of the urban count program since it consists of single 24-hour counts.

13. Several respondents to the survey indicated that vehicle classification counts are being done manually. This should be investigated to determine if maximum utilization is being made of current equipment technology.

14. Several respondents to the survey indicated that TPD provides count data to VDOT consultants to hold down contract costs. This is probably valid if these count data already exist; however, if special counts are required, this practice may cost more than letting the consultant obtain the data. This should be investigated.

15. Several respondents to the survey indicated that primary count data are no longer published in the truck classifications needed. There seems to be disagreement on this point, and a clarification should be obtained.

16. There are several concerns with the available counts on the secondary road system. Vehicle classification and historical data are needed both for project-specific requests and for the statewide and regional plans. Also, 15-minute or hourly counts are often needed. An investigation is needed to determine if changes should be considered.

17. Based on survey responses, there is some concern that special count requests are being made to supply businesses, developers, or other private citizens with data. Normally the practice is to provide only existing data. If the former situation does exist, TPD should clarify its policy on this issue.

Phase II

Issue 1: Data Needs for the 1994 Statewide Highway Plan

Preliminary work was undertaken by requesting copies of available statewide plans from the 49 other state departments of transportation. Because of the magnitude of the anticipated effort, however, the investigation will be conducted in continuing research scheduled for FY 1992.

Issues 2, 3, and 4: Project-Specific Data Requests from Other Divisions

Three divisions of VDOT request data for specific projects from TPD: L & D, ED, and TED. As necessary, TPD requests that TED undertake the necessary studies to obtain the data. TPD then develops forecasts of the data items for the year needed and responds to the requesting division. The investigation of this issue consisted of a review of the data requested from TPD by each division.

Data Requests by Division

The data requests by the three divisions are as follows:

1. *Location and Design Division.* Form LD-104 (Rev. 10-90) is used by L & D to request data from TPD (see Appendix C). The previous form (Rev. 9-87) was developed after a meeting between L & D and ED, which had the objective of combining the requests by the two divisions. Thus, on the current form, the ADT for 5, 10, 15, and 20 years after completion and the ADT and speed for the do-nothing design year are requested for use by other divisions, not by L & D. The other data items are needed for design. The request for TM data for intersections with cross streets having an ADT of 3,000 or more is based on judgment. There are no specific design principles that indicate an ADT of 3,000 as the criterion.

2. *Environmental Division.* ED has a standardized interdepartmental memorandum that is used for requesting data from TPD (see Appendix C). Every federally funded project requires one of three levels of environmental evaluations. An environmental impact statement (EIS) is the most comprehensive level of evaluation and includes analysis of air, noise, and energy impacts. An environmental assessment is less comprehensive, and the impact analyses to be undertaken are selected based on the type of project. A categorical exclusion is the least comprehensive and rarely requires any of the three types of analyses.

All of the data items requested by ED (Section VII of the aforementioned memorandum) are needed for one of these three impact analyses or by the document writer as background justification for the project. Table 4 relates the data item requested to the analysis for which it is needed. The data are needed for the present year, the design year (build and no-build), and an interim year (build and no-build). ED is flexible in setting these years, and generally, the year should coincide with L & D's present design and "after completion" years (Form LD-104, Rev. 10-90), respectively. The data are also needed for the main line, intersecting roadways with a certain volume, and ramps and loops within the project's limits. The volume established by ED for the intersecting roadway is based on judgment as to the volume that will contribute significantly to the impacts on the main line.

Finally, mesoscale traffic information is requested if the project is judged to have major impacts. Then, the area for which the data are needed is expanded beyond the project and intersecting roadways. Although this has been rarely requested in the past, the provisions of the new Clean Air Act will likely require much greater use of this option.

3. *Traffic Engineering Division.* TED needs TM data to evaluate the need for a signal. If signals already exist on a proposed project, it is assumed that they

Table 4

DATA REQUIREMENTS FOR ENVIRONMENTAL ANALYSES

Data Item	Air	Noise	Energy	Background
ADT	•	•	•	•
% ADT, directional split, operating speed for each hour 6 a.m.–9 p.m.	•	•[a]		
a.m. and p.m. peak hour volumes, operating speed, directional split	•	•		
% trucks ≥ 3 axles	•	•		
% trucks 2 axles, 6 tires	•	•		
% trucks 2 axles, 4 tires	•	•[a]		
LOS for design hour traffic periods				•
Schools—max. hourly volume, weekday, 9 a.m.–3 p.m. and operating speed and truck mix		•		
Churches—max. hourly volume, Sunday, 9 a.m.–noon, and operating speed and truck mix		•		
% through trucks (≥3 axles)		•		

[a] Only if already available from air analysis.

will be replaced. However, TED wants to avoid the situation whereby a proposed project needs a signal as soon as or shortly after it is completed. Thus, the division requests TM data for a forecast year of 5 years beyond the expected completion date of the project at all intersections where signalization is judged to be potentially needed. A copy of L & D's data request form (LD-104) usually alerts TED to an upcoming project and results in the request to TPD.

TED also requests design year ADT and percent commercial trucks (≥ 2 axle, 6 tires) for the so-called Kip study. This study is undertaken by TED at the request of the Materials Division for a pavement design analysis and requires a forecast of the data for 30 years into the future.

Possible Revisions

Ideally, the most efficient way to address the issues of inconsistency in and duplication of the data requests would be to develop a single request form that contained all data needed by the three divisions. This, however, is not practical. L & D requires the data at the earliest stages of a project to establish the basic design features. ED's data needs are dependent on which environmental analyses (air, noise, or energy) are required, and this decision is based on the design of the project. Thus, ED must wait until the design is established by L & D before determining its data needs, and the time between the initial request for data and the development of the design can range from 2 months to 2 years. Further, because of the magnitude of data needs for the various environmental analyses, it is not efficient to collect routinely all the data that could potentially be used. Rather, only the data actually needed should be collected.

Since this practical limitation precludes a single data request form, each division's current requesting procedure should be made as efficient as possible. With this in mind, a joint meeting of personnel from each of the three divisions and TPD was held to evaluate the current data forms, with the goal of eliminating duplicative data requests, agreeing on consistency where possible, and clarifying specific needs. Based on discussions at that meeting, revisions are currently being considered in the data request forms and procedures.

Another factor to consider is the level of accuracy required of a data item in the analysis in which it is being used by the requesting division. The level of accuracy of the data item as provided by the data collection method used need not be more than that required in the analysis. Further investigation is needed to determine if there are cases of mismatched levels of accuracy in the provision of data to other divisions. Once any final revisions are made to the data request forms and procedures, a continuing dialogue among the four divisions should address this factor. It may be appropriate to include this investigation in the FY 1992 continuing research effort.

With regard to Issue 4, it is noted that O & D data are not requested by any of the three divisions for specific projects. Such requests result from special study needs.

Issue 5: Occupancy Count Data

Overview

Vehicle occupancy data are used in transportation planning to monitor travel trends and measure the impacts of plans, policies, and procedures at both the regional and local levels. Three occupancy studies conducted by VDOT prompted the inclusion of occupancy counting as a data collection issue in this study:

1. Metropolitan Washington Council of Governments' (MWCOG) occupancy studies to measure regional travel (collected by VDOT)
2. VDOT's occupancy studies on the I-66 and I-395 HOV lanes to monitor their utilization
3. special occupancy studies (e.g., studies of major arterials parallel to I-66 and I-395).

The collection of occupancy data is very labor intensive and time-consuming. An attempt is made to record manually the occupancy of every vehicle passing the count station, and counts can be taken for up to 13 hours in the case of MWCOG studies. The HOV lane monitoring by VDOT begins 1 hour before the HOV restrictions and ends 1 hour afterward. Another problem is visibility. Since occupancy must be observed during daylight hours, there is only a limited time in the spring and fall when the data can be collected during the morning and evening peak commuting periods. Occupancy data are generally not collected during the summer because of bias in the results introduced by school being out of session and summer vacations.

Data Collection

An investigation of occupancy counting methodologies was undertaken. Generally, there are two ways to reduce the effort now being undertaken to collect occupancy data: the use of sampling procedures and the use of automated equipment.

Sampling Procedures. In 1981, the Federal Highway Administration (FHWA) published a comprehensive study of occupancy sampling entitled *Guide for Estimating Urban Vehicle Classification and Occupancy.*[1] The guide provides sampling and data collection procedures based on sound statistical sampling techniques. By use of these procedures, the number of days of field data collection needed for both regional (areawide) and focused (corridor, destination area, or individual location) surveys can be determined. The study report includes two case studies, which are described in more detail in Transportation Research Record 779.[2,3]

More specifically, the sampling approach is designed around the "link day" as the sampling unit. Occupancy is estimated for a particular link on a particular day. Regional surveys require the random selection of links in the network and the random selection of days on which data will be collected on these links. Focused surveys involve the judgmental selection of links and random selection of the days on which data will be collected.

The study report also recognized that it may not be practical to record the occupancy of all vehicles traversing a link during the selected day. The term "short-count" data collection technique is used to describe a procedure to sample the vehicles. Since vehicle occupancy may vary during the day, a systematic procedure of collecting data during each hour of the day offers the best potential for producing relatively accurate estimates while conserving personnel resources. Three types of short-count procedures were described:

1. Monitor all vehicles passing a location during a fixed interval within each hour (e.g., counting for 45 minutes and resting for 15 minutes during each hour—a 75% systematic sample).

2. Monitor a sample of vehicles passing a location by observing each lane during a fixed interval within each hour (e.g., counting each of these lanes during successive 15-minute periods within each hour and resting for the last 15 minutes—a 25% systematic sample).

3. Monitor two or more locations concurrently by counting all vehicles passing a particular location during the same time interval within each hour (e.g., counting vehicles at one location from 7:00 to 7:15, 8:00 to 8:15, etc. and at a second location from 7:30 to 7:45, 8:30 to 8:45, etc.—a 25% systematic sample).

Automated Equipment. Even with the technology available today, manual occupancy counting appears to be the most practical way of collecting data. A recent report from the Washington State Transportation Center at the University of Washington in Seattle summarized four possibilities for mechanical data collection, as well as likely disadvantages[4]:

1. photographs or videotape:
   - several angles needed to record interior
   - analysis as time-consuming as manual counting
2. infrared radiation sensors to detect people: inaccurate because of heat from engine and other sources
3. computer-aided figure recognition techniques in conjunction with photoelectric cells:
   - logistics of placing photoelectric cells on highways
   - cost of developing and using sophisticated computer programs
   - requirement that vehicle occupants be silhouetted against windows
4. weigh-in-motion to compare empty and occupied vehicles: data interpretation very difficult.

The most promising of the methods appears to be videotaping. A recent study of the use of videotape for HOV lane surveillance and enforcement in California used a three-camera set up to observe vehicles.[5] Evidence suggested that occupancy data could be collected more accurately with this setup than with manual observations. The cameras provided more views than with manual observation and enabled the viewer to slow down or even rewind the tape to clarify counts. In addition to improved accuracy, videotape provided a permanent and verifiable record of traffic activity, information on vehicle mix, and license plate numbers.

However, the costs of videotaping and data reduction are considerably more than the costs of manual observation and data reduction. In the California study, two experienced operators were required to set up and operate the video equipment, at an approximate time of 8 hours for each to tape a 4-hour peak period. Data reduction was estimated to take 2 to 4 hours per hour of videotape to identify violators only and twice that amount to identify violators and record occupancy. Based on the cost of personnel at $30 per hour, and the midpoint of the data reduction times, personnel costs amounted to $840 for 4 peak hours of HOV lane data for violations only and $1,200 for violations and occupancy. Additionally, the cost of the equipment, which amounted to approximately $108,000 (see Figure 1), must be considered in any cost analysis.

Item Description		Qty	Cost	Extended
01	Motor Van with Toilet and Cab-bed	1	$36,000.00	$36,000.00
02	Air Conditioner	1	1,500.00	1,500.00
03	Motor Generator (4Kw)	1	2,500.00	2,500.00
04	Awning	1	2,000.00	2,000.00
05	Trailer Hitch	1	350.00	350.00
06	Custom Equipment Racks	1	2,000.00	2,000.00
07	Mobile Phone	1	1,500.00	1,500.00
08	Emergency Light/Generator	1	800.00	800.00
09	Fire Extinguishers (2)	2	100.00	200.00
10	Battery Powered Work Lights	3	50.00	150.00
11	Portable Lantern	1	25.00	25.00
12	Safety Cones	24	25.00	600.00
13	Safety Signs, Stands and Flags	2	100.00	200.00
14	Walkie/Talkie Radio	2	300.00	600.00
15	Sand Bags	12	25.00	300.00
16	Tool Kit	1	300.00	300.00
17	Hard Hats	4	50.00	200.00
18	Safety Vests	4	25.00	100.00
19	Equipment Storage Case	4	200.00	800.00
20	Hi Speed Color Camera	4	1,500.00	6,000.00
21	Telephoto Zoom Lens	4	1,200.00	4,800.00
22	CCU with Genlock	1	600.00	600.00
23	Heavy Duty Tripod with Arm	4	450.00	1,800.00
24	Fluid Pan/Tilt Head	4	300.00	1,200.00
25	Quick Release Plates	4	25.00	100.00
26	Portable Viewfinder (4")	2	300.00	600.00
27	U-Matic "B" VCR	2	4,000.00	8,000.00
28	U-Matic "B" Edit VCR	1	6,500.00	6,500.00
29	Edit Controller	1	1,900.00	1,900.00
30	13" Hi Res monitor, Color	3	500.00	1,500.00
31	Quad B/W Monitor	1	950.00	950.00
32	Quad Split Device, Color	1	2,900.00	2,900.00
33	Special Effects with Dual TBC	1	10,000.00	10,000.00
34	Video Cable Reels (150')	5	150.00	750.00
35	Video Cable Reels (300')	5	300.00	1,500.00
36	Power Cable Reels (50')	3	25.00	75.00
37	Power Cable Reels (150')	3	50.00	150.00
38	Video Cam-Corder with Case	1	1,500.00	1,500.00
39	Mounting Clamp Set	1	100.00	100.00
40	Wheel Chocks and Ramps	2	50.00	100.00
	Total Mobile Vehicle Price			$101,150.00
	California State Sales Tax			6,827.62
	TOTAL COST OF VAN AND EQUIPMENT			$107,977.62

Figure 1. Estimate of Cost of HOV Video Van. *Source*: Billheimer, John W.; Kaylor, Ken; and Shade, Charles. 1990. *Use of videotape in HOV lane surveillance and enforcement*. A Technology Sharing Reprint. Report No. DOT-T-91-02. Washington, D.C.: Department of Transportation.

On the other hand, it was estimated that manual observations during a 4-hour peak period would require two persons for 6 hours each and data reduction would require one person for 2 hours. Thus, using the figure of $30 per hour, personnel costs amounted to $420 for 4 peak hours of HOV lane data.

It was noted in the report, however, that the costs of videotaping and reducing HOV data appeared to be justified if the data could be used as an enforcement tool in citing violators. That is, the videotaping procedure became more cost-effective if a reduction in enforcement personnel costs was considered a benefit. An investigation of the enforcement potential of videotaping is beyond the scope of this research effort; however, it may be worthy of further evaluation and joint use with monitoring.

Although the use of automated equipment for actually observing occupancy has drawbacks, the report from Seattle described the use of portable computers to collect data in the field directly. The computers caused very few problems, and observers quickly learned how to operate them. Keys not used for counting were disabled. Several advantages were noted:

- ease of data reduction and analysis
- capability of data transmittal over telephone lines
- quick feedback on performance of observers (substitution for some aspects of field supervision)
- decrease in the chance for errors in transcription of the data
- quick feedback on reasonableness and accuracy of data collected.

Another state-of-the-art data collection tool is voice recognition computer hardware and accompanying software. Rather than manually recording occupancy data on a counter board and then transferring it onto a field data form, an observer records his or her observations on a portable tape recorder. The audio tape is then played, and a special "speech" board and software installed on a standard microcomputer translate the voice information into digital data and store it in a data base. This system has advantages similar to those for portable computers; however, a portable tape recorder is less cumbersome and easier to use than a portable computer. However, based on discussions with a researcher at the Texas Transportation Institute who had used such a system recently, two disadvantages were noted:

1. Such a system must be "trained" to recognize key words spoken by a specific individual. It does not operate if another person tries to use it.
2. Roadside noises, such as wind and traffic, distort the audio to the extent that the voice recognition system does not work well.[6]

Further, the system is expensive, in the range of $5,000 to $6,000 just for the voice recognition hardware and supporting software. Generally, it appears that this technology is not yet developed to the level needed; however, it may warrant future consideration.

Issue 6: Origin and Destination Surveys

Information on travelers' origins and destinations is a vital component of the transportation planning process in urban areas. Traditionally, the travel patterns depicted in a base-year O & D trip table are forecast to a future year based on socioeconomic data forecasts. The future-year trip table is then used to determine future transportation needs for the area.

Types of O & D Surveys

The base-year trip table has been traditionally developed from O & D surveys, which are a sampling of existing trip making in an area. Following is a discussion of the six types of O & D surveys.

1. *Roadside interview.* In this method, drivers are stopped and asked their origin and destination and, possibly, a limited amount of other trip data (particularly the purpose of the trip).

- *Advantages:*

  —Complete and accurate information is obtained because of the personal contact.

  —The rate of response is very high.

  —Samples can be chosen to match the desired statistical standards.

- *Disadvantages:*

  —The technique is expensive because of personnel requirements.

  —Traffic delays may result if volumes are high.

  —There are clearly hazards associated with stopping traffic.

2. *Driver post cards.* In this method, traffic is stopped and the drivers are handed post cards to complete and return. The questions are generally the same as described previously. If possible, the post cards could be distributed at natural points of stopping, such as at signals and toll booths.

- *Advantages:*

  —It is less expensive than the roadside interview since fewer people are required.

  —Untrained personnel can be utilized to hand out post cards.

  —The operation of handing out post cards is faster than interviewing; therefore, the work is accomplished more quickly and there is less chance of traffic delays.

- *Disadvantages:*

  —Since personal contact is lost, the response rate drops to, typically, 25 to 35 percent.

830

—There is a greater risk of a bias because of the low response rate.

—The response rates for out-of-state and through traffic are particularly low.

—There is still some inconvenience to motorists since traffic must be stopped.

—There is a greater chance of missing, incomplete, or incorrect information.

—There are hazards associated with stopping traffic and having personnel distribute the post cards.

3. *License plate survey (mail-out).* This method is similar to the previous method (driver post card) except that vehicle license numbers are recorded. The owners are then identified, and a mail-back questionnaire is sent.

- *Advantages:*

  —Untrained personnel can be utilized to record license plate numbers.

  —Traffic is not stopped; therefore, the survey is safer and there is no delay to motorists.

  —If a camera is used to record licenses, even fewer personnel are required.

  —Although based on limited information, there is some indication that the response rate is higher than that obtained using the driver post card method.

  —Since the owner's address is known, follow-up contact can be initiated if a response is not received.

- *Disadvantages:*

  —There is still a nonresponse bias since the response rate is low.

  —Immediate access to driver records is required in order to process the questionnaire quickly.

  —Out-of-state vehicles cannot be surveyed efficiently.

  —Night operation is generally not feasible.

  —Considerable in-house personnel may be required to process the questionnaires in a timely matter (typically within 24 hours).

  —There is a greater chance of missing, incomplete, or incorrect information.

—It is difficult to read fast-moving and distant license plate numbers.

4. *License plate survey (moving vehicle).* In this method, observers record license plate numbers (or several of the digits) of vehicles and the time when observed. Analysis involves matching the numbers at the various stations such that the vehicle's movement can be traced through the study area.

- *Advantages:*

  —There is no interference with traffic.

  —Information is gathered without the necessity of relying on driver cooperation in responding to questions.

  —There is no bias introduced by a lack of response.

  —The method is particularly applicable to studies of single routes or facilities.

- *Disadvantages:*

  —The method is not applicable in a large area because of the extensive number of stations required, the resulting personnel, and the need to operate all stations simultaneously.

  —Information on only origins and destinations (usually for just through trips) is obtained.

  —Recording errors have serious impacts on results; i.e., vehicles are traced incorrectly or not at all.

  —It is difficult to read fast-moving and distant license plate numbers.

5. *Tag-on vehicle/Lights-on survey.* In this method, a coded card is handed to the driver or fastened to the vehicle as it enters the route or study area. The card is then picked up as the vehicle leaves the survey area, and the time, location, and other readily observed information can be recorded. Through traffic can thus be traced as it traverses the study area from one external station to another. A variation of this calls for drivers to turn on their headlights as they enter a study area and then turn them off when they leave the area. Counts are made of vehicles exiting the area with headlights on. An estimate of only through trips is obtained; no information is available on the route of travel.

- *Advantages:*

  —Most drivers tend to cooperate when directly confronted; therefore, the response rate is good and a no response bias is not applicable.

  —The method is particularly applicable to small areas for obtaining information on external (through) trips.

- *Disadvantages:*

  —Only limited information can be obtained, specifically on external to external (through) trips.

  —It is too personnel intensive to be feasible in a large study area.

  —Drivers sometimes object to having a card fixed to their vehicle.

6. *Home interview survey.* The previously described surveys are generally designed to collect information on trips that have one end outside the study area. That is, the data collection stations are on the cordon of the area. Accordingly, a home interview survey is generally necessary to obtain information on trips staying within an area. Information is also obtained on trips having one end of the trip inside the area. Only trips passing through the area are not recorded in this survey. This type of survey is typically associated with transportation planning studies of an entire urban area rather than just a single route or corridor. Variations include an in-home personal interview, a self-administered mail survey, a telephone interview, and a combination telephone and mail survey. The specific questionnaire may request information on "yesterday's" trips or may request that a "diary" of trips on a future day be kept.

- *Advantage:* The method provides the most comprehensive information on travel within an area.
- *Disadvantages:*

  —In a large area, a significant number of interviews must be obtained in order to obtain even a small, statistically valid sample.

  —Personal interviews in the home or by telephone are very costly to conduct.

Modeling Techniques

In recent years, transportation planners have focused their attention on developing O & D trip tables from existing data, primarily ground counts. This interest arose mainly because of the expense in collecting even a sample of O & D information and because of potential sampling errors. Essentially two different approaches exist for estimating trip tables from ground counts. The first involves regression analysis to estimate parameters of a demand model; the second involves mathematical programming techniques to obtain the most likely trip table consistent with a given set of observed data.

A detailed study of the modeling techniques is beyond the scope of this project; however, researchers at the University Center for Transportation Research at Virginia Polytechnic Institute and State University (VPI & SU) have developed expertise in this area.

Issue 7: Turning Movement Data

Knowledge of the traffic volume of through and turning movements at intersections is fundamental to most intersection analyses. TM data, and forecasts thereof, are used by TPD as well as TED and L & D. TM data are generally collected manually, and manual data collection is expensive. There are basically two ways to reduce the TM data collection effort: the use of automated equipment and reduction in the amount of data collected. Following is discussion of these two ways.

1. *Automated equipment.* Electronic counter boards are typically being used now to collect TM data, often in conjunction with laptop computers that expand the storage capability for field data on multi-intersection studies. Because they have the same advantages previously described for portable computers, these tools should continue to be used for all TM studies, even if additional equipment needs to be obtained.

Videotaping is also a potential tool for collecting TM data. If a single camcorder can cover the intersection, it is likely that fewer personnel will be required to videotape than to count the traffic manually. On the negative side, however, data reduction is time-consuming, especially when compared to electronic data transfer from counter board to computer. Also, it may be difficult to find a camera location from which the entire intersection can be filmed. Thus, videotaping appears to have only limited applications.

The voice recognition system is also a tool applicable to collecting TM data. Because the previously described disadvantages are also applicable, however, the system is, at best, a tool to consider in the future.

2. *Reduction in amount of data.* Currently, up to 13 hours of TM data (i.e., 6:00 a.m.–7:00 p.m.) are being collected, depending on who requests the study and how the data will be used. In some cases, all 13 hours of data are not used in the analysis for which the data were requested. In the majority of cases, only peak hour data are used. In these cases, only 2 to 3 hours of data in the morning and afternoon peak periods (e.g., 6:00 a.m. to 9:00 a.m. and 3:30 p.m. to 6:30 p.m.) are required to determine the actual peak hour in each period. Thus, at least 7 hours of data collection can feasibly be eliminated from a 13-hour count. The use of only peak period data is even more feasible when the data are combined with other data collected with automatic traffic recorders (ATR) either at the intersection being counted or from nearby permanent count stations.

Although the elimination of 7 hours of data collection appears to offer significant savings, there are logistical problems with such a count schedule. Primarily, the question arises as to what to do with the personnel between counting periods. In some cases, other data collection, such as collecting inventory or geometric data, can be undertaken during the "off" period. Also, if the afternoon peak period is counted one day and the morning peak the next day, then the "off" time can be used in traveling to or from the job site or relocating to another intersection in the area. Potentially, one night of lodging and some overtime could be eliminated. Also, a "relief" person would likely not be needed in peak period only counts.

There are cases, however, where traditional peak period TM data are not sufficient. For example, the actual peak hour on some roadways may occur at lunch time. Also, roadways that are significantly affected by special generators may experience peak traffic during hours coincident with the generator's schedule. For example, a factory may have a 7:00 a.m. to 3:00 p.m. shift. In many instances, these peculiarities are known and a reduced TM count can still be scheduled to ensure coverage of the peak hour.

Finally, for a limited number of analyses, 12 to 13 hours of TM data are needed. For example, signal design and timing typically require at least that much data. Signal warrant evaluations require approach volumes, which may be collected with ATRs rather than manual TM counts.

Another way to reduce TM data collection, primarily for planning applications, is to use available computer software to generate estimates of TMs when only approach and discharge volumes at an intersection are known. Two such computer programs, which are both public domain software available through the Center for Microcomputers in Transportation (McTrans) at the University of Florida, are TURNFLOW[7] and TMOVES.[8] In addition to the approach and discharge volumes, either a "best guess" estimate of turning proportions for each approach or a "seed matrix" of turning flows must be input. Either estimate can be based on an old count, a count taken at a different time, or a count taken for a short interval. One of the programs contains a Propensity Model that generates its own seed matrix. Further information on these programs is presented in Appendix D.

Issue 8: Census Year Updates of Urbanized Area Plans

This issue is no longer pertinent because TPD developed and initiated the data collection and analysis procedures for the census year updates. The draft procedures were reviewed under the auspices of this research project.

Issue 9: Evaluation of the Urban Count Program

Because of the magnitude of the anticipated research effort, this issue will be investigated either in continuing research scheduled for FY 1992 or in coordination with potential research recommended by another researcher. (See discussion of Issues 11 and 12.)

Issue 10: Traffic Volume Forecasting Methods

At least four methods of projecting future traffic are used by TPD: urban area growth rates, direct generation, trendline, and modeling. Modeling, which involves the formulation of a relationship between traffic and explanatory factors, is a well-established practice in urban areas. Therefore, this issue is primarily related to small urban, rural, and statewide traffic projections. Accordingly, it is logical to investigate this issue in conjunction with Issue 1, which concerns statewide planning. Specifically, the statewide plans already obtained from other departments of transportation may include information on applicable methods for traffic volume forecasting. This investigation will, therefore, be conducted in continuing research scheduled for FY 1992.

Issues 11 and 12: Permanent Count Stations and Average Annual Daily Traffic

Both of these issues should be resolved by the implementation of VDOT's Highway and Traffic Records Information System (HTRIS). The system is scheduled for implementation in the fall of 1991; however, it will likely be much later before all the data input and analyses are readily available. The most recent proposal for utilizing data from the permanent count stations includes the following user-selected menu items[9]:

- detailed locations of permanent count stations
- ADT for permanent count stations—historical data
- monthly variations of permanent count stations—% of ADT
- station grouping by range of monthly factors (ADT/weekday)
- monthly factors (weekday traffic)
- daily variation (% of yearly traffic)
- daily variation (% of ADT)
- 30th highest hour
- % of daily traffic (hourly distribution/weekday)
- seasonal distribution of travel (%)
- variation of traffic flow by day, by month, and by station
- variation of traffic flow by day, by month, and by district
- variation of traffic flow by day, by month, and by functional classification.

Once HTRIS is fully operational, users will be able to obtain these data either on line or via periodic summary reports. Thus, the location of and data from the permanent stations will be readily accessible (Issue 11). Further, the factors developed from the data by HTRIS will enable the user to modify 24-hour counts to AADTs (Issue 12). The user will have to select a permanent station that has similar characteristics to the location being counted as the source of adjustment factors. The closest permanent station with similar characteristics will likely be the most logical selection. Current interstate, arterial, and primary count locations are already related to a permanent station, and counts within close proximity to these locations can logically use the same permanent station.

It is important to note that the permanent stations were established to develop factors for short counts in the interstate, arterial, and primary count program. Thus, there are no locations on local urban streets or the secondary system. Some of the locations are in urban areas, and factors from these stations may be applicable to nearby local urban streets. It is questionable, however, whether factors from rural stations are applicable to nearby secondary roads. The researcher at VTRC who developed the current interstate, arterial, and primary count program recommended that similar efforts be undertaken for local urban streets and the secondary system.[10]

Issue 13: Manual Vehicle Classification Counts

The investigation revealed that, in fact, maximum utilization is being made of current equipment technology. There are instances where manual classification counts are conducted; however, it is because of practical limitations, not the lack of equipment. For example, it is generally not practical to stretch and tie down road tubes on high-volume, multilane roadways. However, TED is experiencing significant problems with the classification counters and is in the process of correcting them. Sometimes, this may result in a shortage of counters for other count needs.

Issue 14: Count Data to Consultants

In order to reduce the cost of a study being conducted by a consultant, TPD sometimes agrees to provide the traffic counts. The premise is that TED can obtain the data at less cost than that normally charged by a consultant for counts. Further, the counts may be more reliable than the consultant's. This premise has been questioned, and the answer to the question is not simple.

If the data already exist or are readily available, then it is clearly cost-effective simply to collect and compile it rather than having the consultant collect new data. An obvious example is the need for traffic counts already available from or to be collected under any of the three formal VDOT count programs.

If additional data are required, and it can be collected by existing personnel and equipment, then it is probably cost-effective for TED to collect the data. Logically, if salaried personnel are available to collect the data, and they are being paid regardless, then it represents a more efficient utilization of resources if they are kept busy. However, if salary, overhead, travel expenses, equipment costs, and transportation are considered, then the actual cost may not be that much lower than a consultant's fee.

Finally, if large-scale data collection is required, then the premise of cost-effectiveness is definitely questionable. The underlying question in this case is whether TED should set its staff and equipment requirements to accommodate these peaks of demand. Although this is ultimately a management decision, it would not seem to be cost-effective. The answer is less clear, however, if it were decided to use temporary help or pool VDOT personnel from other divisions (e.g., TPD) to accommodate these peaks.

Regardless of which of the situations described is being considered, the final answer must be obtained from a cost-effectiveness evaluation. The consultant's fees, which could be obtained from past contracts, must be compared with VDOT's cost of collecting specific data items. These costs are more than salaries and expenses, and preliminary inquiries have determined that there are no existing estimates of the total cost of collecting specific data items. Thus, a detailed and time-consuming evaluation is envisioned.

Given the fact that the use of consultants is currently being discouraged due to the state's financial situation, it is suggested that such a cost-effectiveness evaluation not be undertaken at this time. Should the situation change (i.e., the state's financial situation improves and considerable work is let to consultants), then such an evaluation might be appropriate.

Issue 15: Primary Count Program Vehicle Classifications

In 1987, VDOT began fully automating its traffic volume counting on the interstate, arterial, and primary routes. The ATRs, when operating in a mode that relies on loop detectors for data collection, produce only four classifications of vehicles, not the seven classifications previously recorded manually. Thus, the interstate, arterial, and primary counts, which rely solely on permanently installed loop detectors, can no longer be used as the source of vehicle classification data for those applications or analyses requiring more or different categories than those collected. For example, ED needs certain classifications of truck data for input to its air and noise models, and these data are no longer available from the count program.

There are generally three solutions to this problem. The first is to estimate the number of vehicles in each needed classification based on current counts of total vehicles and historical counts in the required classifications. This is likely to be the most inaccurate. The second is to conduct a special classification count. The ATRs used by VDOT can produce more than four classifications if the data input includes axle counts; i.e., the data are obtained from either piezo cables or road tubes. Special counts are preferable if accurate and current data input is critical in the analysis. VDOT's ATRs have the capability of accepting axle counts from a combination of loops and road tubes or piezo sensors. Thus, the special count effort may be reduced if the count location coincides with permanently installed count program loops; i.e., a single road tube can be used in conjunction with dual loops to obtain the necessary axle counts. The third solution, which in fact has been discussed in VDOT, is to install piezo sensors at some or all of the count stations. This will enable the collection of axle counts and thus the classifications required.

Issue 16: Secondary Road System Counts

Since the implementation of this project and the identification of this issue, the secondary road count program has been reviewed by VDOT management and modified to address some of TPD's concerns. TPD staff is still concerned about the conversion of 24-hour counts to AADTs and the accuracy of the counts being collected. Although these concerns are valid (e.g., the AADT issue was addressed earlier in this report), it would seem that the final decision on the program has been made, at least for the present time.

Issue 17: Count Data to Private Parties

It is acceptable to supply private parties (e.g., businesses and developers) with available data. It is not acceptable to request special counts or other data collection for this purpose. This is a matter of policy, and no further investigation is required. If there is confusion on this policy among TPD staff, then the policy needs to be clarified by the division administrator.

CONCLUSIONS

The following conclusions apply to the 17 issues identified in this research, respectively.

1. *Data needs for the 1994 statewide highway plan.* Because of the magnitude of this issue, an investigation will be conducted in an FY 1992 research project.

2. *Project-specific data requests from other divisions.* Because of the particular time the data are needed, it is not practical to combine all requests for data for specific projects on a single request form. Thus, each division must request the data it needs. Efficiency is achieved if all information requested by a division is actually needed in its operation. Further, efficiency is achieved if all forecast year data are consistent. Revisions to the data request forms and procedures are being considered by the divisions to eliminate unnecessary data and avoid inconsistency. Once any revisions are made, an investigation of the levels of accuracy needed in the analysis versus the levels of accuracy provided by the data collection method should be undertaken, either by the group or by inclusion in continuing FY 1992 research.

3. *Inconsistency in forecast years.* See 2.

4. *Use of O & D data by other divisions.* O & D information is not routinely requested by other divisions; however, it is sometimes requested for special studies. There appear to be no changes necessary.

5. *Occupancy count data.* Efficiency can be achieved through the use of sampling techniques and portable computers. FHWA's *Guide for Estimating Urban Vehicle Classification and Occupancy*[1] recommends sampling plans and procedures for regional and areawide surveys and focused surveys at the corridor, destination area, or individual location level. Simple formulas enable the user to determine the number of days of data collection needed for a statistically valid sample. Input to the formulas depends on both the type of survey and user judgments; therefore, it is important that the formulas be applied on a case-by-case basis. Further, the guide

discusses several short-count data collection techniques to statistically sample the vehicles at a given location. The use of automated equipment for observing occupancy (e.g., videotaping) and recording occupancy (e.g., voice recognition systems) has potential; however, manual data collection is the most cost-effective. The use of portable or laptop computers by the observer to tally the occupancy observation is very beneficial in facilitating data reduction and analysis.

6. *O & D surveys*. Efficiency is achieved by utilizing the least costly method that provides the amount and type of data required for the particular study effort. This decision must be made on a case-by-case basis. Computer-generated O & D data may have application in some study efforts. Trip tables are produced from ground counts, and significant savings in personnel are accrued.

7. *TM data*. Efficiency is achieved through a reduction in the amount of data collected and the use of automated equipment. For the majority of applications, only peak hour data are required. Thus, the amount of data collected can be reduced by limiting the counts to 2- to 3-hour periods around the a.m. and p.m. peak hours. It may be necessary to count periods outside the typical 6:00 a.m. to 9:00 a.m. and 3:30 p.m. to 6:30 p.m. periods; however, these anomalies are often known, and the counts can be scheduled accordingly. For some planning applications, computer-generated TMs based on intersection input and output volumes may be substituted for actual field counts. These volumes are often already available or can be obtained more easily than TM data. Significant savings can result if computer-generated TM data can be used in place of actual field counts. Evaluation of the use of this software is needed. The use of automated equipment (with the exception of electronic counter boards and portable computers) has little potential for collecting TM data. VDOT personnel should always use electronic counter boards and portable computers.

8. *Census year updates of urbanized area plans*. The data collection and analysis procedures developed by TPD have been implemented. Further investigation would be irrelevant at this time.

9. *Evaluation of the urban count program*. Because of the magnitude of this issue, an investigation will be conducted either in an FY 1992 research project or in conjunction with recommendations resulting from other research at VTRC. (See 12.)

10. *Traffic volume forecasting methods*. Because of the relationship of this issue with statewide transportation planning (Issue 1), an investigation will be conducted in an FY 1992 research project.

11. *Utilization of data from permanent count stations*. Currently, little use is being made of data from VDOT's permanent count stations. Implementation of VDOT's HTRIS in the fall of 1991 will resolve this issue.

12. *Modification of 24-hour counts to AADTs*. Efficiency is achieved by taking 24-hour counts and factoring them to AADTs. HTRIS will provide these factors in the near future for the permanent count stations in the interstate, arterial, and

8410

primary count program. Factors from these stations may be applicable to nearby local urban streets and, to a lesser degree, to nearby secondary roads. Research to develop similar count programs for urban areas and secondary roads has been recommended.

13. *Manual vehicle classification counts*. Manual counts are being conducted only in cases where VDOT's classification counters cannot be used for practical reasons. VDOT is maximizing its utilization of current equipment technology, and there appear to be no changes necessary. Hardware problems exist; however, VDOT is addressing these.

14. *Count data to consultants*. Currently, TPD sometimes provides data to consultants to reduce the contract's cost. This practice is efficient if it is, in fact, cost-effective. It is clearly cost-effective to provide data to consultants in lieu of paying them to collect them if valid data already exist. If minimal data collection is required, and the effort can be handled with existing resources, it is most likely cost-effective for TED to collect the data. If the data collection effort requires additional resources, then the question of cost-effectiveness must be addressed by an economic analysis. The consultant's fees must be compared to VDOT's costs for collecting specific data, which are currently not known. What is known, however, is that VDOT's costs are more than salary and expenses. Overhead, additional equipment and personnel, and office space are examples of other costs to consider. Once all costs are considered, the apparent savings that occur when just consultant's fees and VDOT salaries are compared are significantly diminished. Given this fact, and the fact that consultant contracts are being held to a minimum at this time, a comprehensive and detailed cost-effectiveness evaluation of this issue is not warranted. Such an evaluation may be appropriate at a later time.

15. *Primary count program vehicle classifications*. The current method of collecting data in the interstate, arterial, and primary count program allows the classification of vehicles into only four categories. If additional categories are needed, they must be estimated from historical data, which were collected manually, or obtained from special classification counts. A potential solution to the problem is to install piezo sensors at some or all of the count stations. This will allow axle counts to be obtained, and thus more categories of vehicle classification can be determined.

16. *Secondary road system counts*. This program has recently been modified to address some of TPD's concerns. Further investigation would seem irrelevant at this time; however, consideration of AADTs for secondary roads and the accuracy of the counters may be appropriate in the future.

17. *Count data to private parties*. Current policy does not allow special counts or studies to be undertaken for private parties. If confusion exists among TPD staff, this policy should be clarified.

RECOMMENDATIONS

1. *TPD, L & D, ED, and TED should continue their efforts to revise the project-specific data request forms and procedures.* These efforts (which were initiated under the auspices of this research project) have the goal of eliminating duplication, inconsistencies, and inefficiencies. Further, the divisions should meet periodically to discuss ongoing data issues, especially the consideration of levels of accuracy required in the analysis versus that obtained from the method of data collection.

2. *When planning for vehicle occupancy studies, TPD staff should use the sampling techniques recommended by the FHWA*[1] *to select the locations and times to count. Also, the use of "short-count" techniques, as described by the FHWA,*[1] *should be used to sample the vehicles at the selected locations.*

3. *The advantages and disadvantages of various techniques for obtaining O & D information that are presented in this report should be used as guidelines to TPD staff when formulating O & D data collection plans.*

4. *TPD should investigate the validity of and applications for computer models that develop trip tables (O & D information) from ground counts.* Considerable cost savings are possible if ground counts can be used instead of O & D surveys. The University Center for Transportation Research at VPI & SU should be contacted for assistance.

5. *TM data should routinely be collected during peak periods only.* Peak-period TM data are sufficient for the majority of uses; requirements for longer periods of data are the exception. Obviously, TM data should be obtained for longer periods if they are absolutely needed.

6. *TPD should investigate the feasibility of using computer-generated TMs in some of its transportation planning applications.* Significant savings can result if these TMs can be substituted for those obtained from actual field counts. The investigation should focus on whether the accuracy of the computer-generated data is satisfactory for the particular analysis or application being undertaken.

7. *Maximum utilization should be made of electronic counter boards and portable or laptop computers in the collection of vehicle occupancy and TM data.* The primary benefit is the efficiency gained by computer analysis and the direct field input of data. Videotaping is not recommended on a routine basis.

8. *TPD should continue to monitor the implementation of HTRIS to ensure that the data from the permanent count stations will be available and in the proper format to enable the development of AADTs from 24-hour counts.* Once this system is fully implemented, TPD staff should routinely use factors from the permanent count stations to convert 24-hour counts to AADTs at locations on the interstate, arterial, and primary systems and, to the extent possible, on local urban streets and secondary roads. TPD should keep abreast of research efforts to develop similar count programs for these latter two categories of roads.

842

9. *If consultant contracts become more numerous in the future, TPD staff, in conjunction with TED staff, should undertake an economic analysis to determine if it is cost-effective to collect large amounts of data to provide to the consultant rather than requiring the consultant to collect it.*

10. *VDOT should consider the economics of installing piezo sensors at some or all of the count stations in the interstate, arterial, and primary count program to enable the collection of more categories of vehicle classifications than are currently collected.*

REFERENCES

1. Ferlis, R. A. 1981. *Guide for estimating urban vehicle classification and occupancy*. Publication No. DOT-FH-11-9249. Washington, D.C.: Federal Highway Administration.

2. Hupp, R. Craig, and Palombo, Carmine. 1980. *Evaluation of the FHWA vehicle classification and automobile-occupancy sampling manual.* Report No. TRR 779. Washington, D.C.: Transportation Research Board.

3. Fisher, R. Fred; Williams, G. Jack; and Boyd, J. Phillip. 1980. *Atlanta vehicle occupancy monitoring.* Report No. TRR 779. Washington, D.C.: Transportation Research Board.

4. Ulberg, Cy, and McCormack, Edward. 1987. *Auto occupancy monitoring study.* Draft Report. Seattle: Washington State Transportation Center, University of Washington.

5. Billheimer, John W.; Kaylor, Ken; and Shade, Charles. 1990. *Use of videotape in HOV lane surveillance and enforcement.* A Technology Sharing Reprint. Report No. DOT-T-91-02. Washington, D.C.: Department of Transportation.

6. Christiansen, Dennis L. Texas Transportation Institute. Telephone call, April 17, 1991.

7. Schaefer, Mark C. 1988. *TURNFLOW-estimating intersection turning movements from approach volumes using LOTUS 1-2-3(tm).* Gainesville: Center for Microcomputers in Transportation, University of Florida.

8. Furth, Peter G. 1990. *TMOVES: A model of turning movement propensity.* Publication No. DOT-FH-11-9249. Washington, D.C.: Federal Highway Administration.

9. National Con-Serv, Inc. 1991. *Design for the Traffic Court Analysis Subsystem of the Highway and Traffic Records Information System (HTRIS) of the Virginia Department of Transportation.* Rockville, Md.

10. Garber, Nicholas J. University of Virginia/Virginia Transportation Research Council. Telephone call, August 5, 1991.

APPENDIX A

Travel Data Survey

DEPARTMENT OF TRANSPORTATION
RAY D PETHTEL, COMMISSIONER

OSCAR K. MABRY
DEPUTY COMMISSIONER

GARY R. ALLEN, PH. D
RESEARCH DIRECTOR

UNIVERSITY OF VIRGINIA
ROBERT M O'NEIL, PRESIDENT

SCHOOL OF ENGINEERING & APPLIED SCIENCE
EDGAR A STARKE, JR., DEAN

DEPARTMENT OF CIVIL ENGINEERING
FURMAN W BARTON, CHAIRMAN

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
TRANSPORTATION RESEARCH COUNCIL
BOX 3817 UNIVERSITY STATION
CHARLOTTESVILLE, 22903

RAY D. PETHTEL
COMMISSIONER

IN REPLY PLEASE REFER TO FILE NO 30.2.51

April 26, 1990

TO: Urban Area Study Engineers

FROM: E. D. Arnold, Jr. Gene

SUBJECT: Travel Data Survey

At the request of Mr. Lockwood, the Research Council has undertaken a study to inventory and review TPD's travel data needs. Travel data are very expensive to obtain because of the manpower required and the cost of the data collection equipment. Further, much of the data are collected for TPD by personnel in the Traffic Engineering Division. Other divisions also request travel data directly from TED, and there are often conflicts resulting from limited personnel and equipment, and consequently, from conflicts in priorities. Finally, the expense of travel data collection--particularly volume counts--will escalate significantly within the year because of added safety requirements. Accordingly, TPD requested that a study be made of its travel data needs.

As a first step, it is necessary for me to learn as much about the division's data needs and utilization as I can. Therefore, I am requesting that you and the other study engineers complete the attached survey. I need to know as much as possible about every need you may have for every specific data item. This includes data needed routinely for project level planning (i.e. requests from outside TPD) and urban area planning as well as miscellaneous special data needs. Data items needed exclusively for the statewide planning effort <u>should</u> <u>not</u> <u>be</u> <u>included</u>.

In view of the aforementioned costs and conflicts in collecting data, it is hoped that ways to streamline data collection, to reduce the amount or level of data needed, and to utilize data more efficiently can be found. However, it is <u>not</u> a foregone conclusion that this is the case. Accordingly, I <u>will</u> need complete and precise descriptions of data usage to accurately evaluate your travel data needs.

In completing the survey, I suggest that you closely review the instructions before starting. If any questions arise, please do not hesitate to call me at SCATS 745-1931.

Thank you in advance for your help; I am looking forward to working with you on this timely project. If at all possible, I would like to have your completed survey by May 11, 1990.

EDA/tao

Attachment

cc: R. C. Lockwood
D. H. Wells
G. R. Allen
R. N. Robertson

TRAVEL DATA SURVEY

Instructions

General

Please complete an attached data sheet for every case requiring the collection of a data item. Following are specific instructions for each question on the data sheet.

Data Item

List the specific data item needed. A specific data item should have a data sheet for each different application if it is used in more than one way. Later examples will clarify this point. Include data items needed for project level planning, urban area planning, and miscellaneous analyses. A comprehensive (but not necessarily all inclusive) list of data items is attached to these instructions to help you think of all your needs.

Usage

Describe, as precisely as possible, why the data item is needed and how it is applied by the user. Be sure to list the user. A data sheet is needed for each application. For example, a peak hour turning movement count may be needed by TPD staff to evaluate the need for an intersection improvement due to a proposed shopping center. Likewise, the same data item might be needed by TED for signal timing. Another example is ADT, which may be needed by TPD staff to project to a future year in order to evaluate the need for improvements. The same data item might be needed by EQD in preparing an EIS.

Data collection - how?

Describe, in detail, how the data item is obtained; i.e., the method of collection. For example, an ADT might be obtained by collecting three weekdays of machine counts and averaging, or by simply a one day count for a Tuesday, Wednesday, or Thursday, or by expanding a 12-hour manual count. A turning movement count might be obtained by two people counting 100% of the vehicles between 4 p.m. and 6 p.m. or by only one person using a sampling technique. Be sure to list all data collection methods that are used, especially noting if you specify a particular method.

Data collection - who?

Define who actually collects the data item; for example, TPD personnel, TED personnel, etc. Note all those that might collect the data item and an estimate of what percentage of the time. For example, TPD and TED might each collect peak hour turning movement counts for site plan review, with TPD collecting it 75% of the time and TED 25%.

Data collection - how often?

Estimate how often the data item is needed. If the usage is in the context of urban area planning activities, list how often it is collected. If its usage is project-related, provide an estimate of how often the data item is needed, either on a monthly or yearly basis.

POTENTIAL DATA NEEDS

Project Level (generally requested by others for specific projects)

ADT (weekday, Saturday, or Sunday)
24-hour count by hour
Peak hour volumes
Turning movements
Vehicle classification (% trucks)
Speeds
Travel times
Pedestrian counts
Bicycle counts
Occupancy counts
Through trucks
Terrain type

Urban Area Planning - model calibration

ADT
Peak hour volumes
48-hour volumes
7-day volumes
Turning movements
Vehicle classification
Speeds
Travel times
Occupancy counts
O & D data

Urban Area Planning - routine

ADT
Peak hour volumes

Miscellaneous Activities

ADT
Peak hour volumes
Turning movements
Vehicle classification
VMT
Speeds
Travel time
Pedestrian counts
Bicycle counts
Occupancy counts
Parking information
O & D data

85

DATA SHEET

DATA ITEM: ______________________ NAME: ______________________

1. Describe precisely how the data item is used, and by whom.

2. Describe how the data item is collected.

3. Who collects the data item? (Include approximate percentage of time if more than one collector.)

4. How often is the data item collected? (Estimate number of times per month or per year if not routinely collected.)

5. Please use this sheet to describe any ideas, comments, suggestions, etc., you might have regarding the collection and utilization of travel data.

APPENDIX B

Data Required for the 1994 State Highway Plan

STATEWIDE PLAN - EVERY 5-YEARS

FILE: SHP_DATA.WK1 DISK: LCC-5 14-Mar-89

STATEWIDE HIGHWAY PLAN UPDATE

USE	DATA ITEM	FIELD LENGTH	ALPHA. NUMERIC	SOURCE	OFFICE/ FIELD	DEFAULT
	SCREEN 2					
B1	LENGTH (MILES) XXX.XX	6	N	INPUT	FIELD	REQUIRED
B2	TYPE TERRAIN L-LEVEL R - ROLLING M - MOUNTAINOUS	1	A	INPUT	FIELD	R
B3	ACCESS CONTROL F-FULL P-PARTIAL N-NO CONTROL	1	A	INPUT	FIELD	N
B4	TYPE OF OPERATION 1W-ONE WAY 2W-TWO WAY R1-REVERSIBLE LANE (1 LANE) RX-REVERSIBLE LANES (X LANES)	2	A	INPUT	FIELD	2W
B5	NUMBER OF THROUGH LANES XX	2	N	INPUT	FIELD	2
B6	TOTAL PAVEMENT WIDTH (FT)- THROUGH LANES XXX	3	N	INPUT	FIELD	24
B7	AVERAGE LANE WIDTH (FT)- THROUGH LANES XX	2	N	INPUT	FIELD	12
B8	PAVEMENT TYPE P-PAVED U-UNPAVED	1	A	INPUT	FIELD	P
B9	PAVEMENT CONDITION VG - VERY GOOD G - GOOD F - FAIR P - POOR VP - VERY POOR	2	A	INPUT	FIELD	G
B10	CURB & GUTTER L - LEFT R - RIGHT B - BOTH N - NONE	1	A	INPUT	FIELD	N
B11	TYPICAL SECTION ADEQUACY A - ADEQUATE I - INADEQUATE	1	A	INPUT	FIELD	A
B12	DRAINAGE G-GOOD F-FAIR P-POOR U-UNKNOWN	1	A	INPUT	FIELD	G
B13	MEDIAN WIDTH (FT) XXX	3	N	INPUT	FIELD	0
B14	MEDIAN TYPE R-RAISED	1	A	INPUT	FIELD	N

STATEWIDE HIGHWAY PLAN UPDATE

USE	DATA ITEM	FIELD LENGTH	ALPHA. NUMERIC	SOURCE	OFFICE/ FIELD	DEFAULT
	D-DEPRESSED/DIVIDED					
	F-FLUSH;NO TURN LANES					
	C-CENTER TURN LANES;CONTINUOUS					
	L-LEFT TURN LANES;ALTERNATING					
	N-NONE					
B15	GEOMETRICS-VERTICAL ALIGNMENT	2	A	INPUT	FIELD	G
	VG - VERY GOOD					
	G - GOOD					
	P - POOR					
	VP - VERY POOR					
B16	GEOMETRICS-HORIZONTZAL ALIGNMENT	2	A	INPUT	FIELD	G
	VG - VERY GOOD					
	G - GOOD					
	P - POOR					
	VP - VERY POOR					
B17	% GRADE	2	N	INPUT	FIELD	5
	XX					
B18	DIRECTION RIDDEN	1	A	INPUT	FIELD	BLANK
	E - EASTBOUND					
	W - WESTBOUND					
	N - NORTHBOUND					
	S - SOUTHBOUND					
B19	PARKING IN PEAK HOUR	1	A	INPUT	FIELD	N
	L - LEFT SIDE					
	R - RIGHT SIDE					
	B - BOTH SIDES					
	N - NOT PERMITTED OR EXISTING					
B20	SHOULDER TYPE ON RIGHT SIDE	1	A	INPUT	FIELD	E
	P-PAVED					
	G-GRAVEL					
	E-EARTH					
	C-CURB					
	N-NONE					
B21	SHOULDER WIDTH ON RIGHT SIDE -AVERAGE(FT)	2	N	INPUT	FIELD	2
	XX					
B22	DISTANCE TO OBSTRUCTION ON RIGHT SIDE (FT)	1	N	INPUT	FIELD	6
	X USE 9 IF >9					
B23	SHOULDER TYPE ON LEFT SIDE	1	A	INPUT	FIELD	E
	P-PAVED					
	G-GRAVEL					
	E-EARTH					
	C-CURB					
	N-NONE					
B24	SHOULDER WIDTH ON LEFT SIDE-AVERAGE (FT)	2	N	INPUT	FIELD	2
	XX					
B25	DISTANCE TO OBSTRUCTION ON LEFT SIDE (FT)	1	N	INPUT	FIELD	6
	X USE 9 IF >9					

STATEWIDE HIGHWAY PLAN UPDATE

USE DATA ITEM	FIELD LENGTH	ALPHA. NUMERIC	SOURCE	OFFICE/ FIELD	DEFAULT
SCREEN 3					
B26 RIGHT-OF-WAY EXISTING (FT) XXX	3	N	INPUT	OFFICE	BLANK
B27 WIDENING FEASIBLE? Y/N	1	A	INPUT	FIELD	Y
B28 WIDENING FEASIBLE WIDTH? (FT) XX	2	N	INPUT	FIELD	BLANK
B29 % NO PASSING ZONE XXX	3	N	INPUT	FIELD	60
B30 NUMBER OF SIGNALS XX	2	N	INPUT	FIELD	0
B31 TYPICAL GREEN TIME / CYCLE LENGTH (%) XX	2	N	INPUT	FIELD	50
B32 NUMBER OF STRUCTURES XX	2	N	INPUT	FIELD	0
B33 DRIVER POPULATION C - COMMUTER R - RECREATIONAL	1	A	INPUT	FIELD	C
B34 ENVIRONMENT (LAND USE) CBD - CENTRAL BUSINESS DISTRICT OBD - OUTLYING BUSINESS DISTRICT SUB - SUBURBAN (>10 INTER/DRWY PER MILE) RES - RESIDENTIAL RUR - RURAL	3	A	INPUT	FIELD	RUR
B35 NUMBER OF RR CROSSINGS XX	2	N	INPUT	FIELD	0
B36 SIDEWALK L-LEFT SIDE R-RIGHT SIDE B-BOTH SIDES N-NONE	1	A	INPUT	FIELD	N
B37 BICYCLE FACILITY L-LEFT SIDE R-RIGHT SIDE B-BOTH SIDES N-NONE	1	A	INPUT	FIELD	N
B38 BICYCLE FACILITY TYPE S-SHARED ROADWAY L-BICYCLE LANE P-BICYCLE PATH	1	A	INPUT	FIELD	BLANK
B39 BICYCLE FACILITY MAINTENANCE RESPONSIBILITY V-VDOT O-OTHER	1	A	INPUT	OFFICE	BLANK
B40 # CURVES: 20 MPH XX	2	N	INPUT	FIELD	0
B41 # CURVES: 30 MPH XX	2	N	INPUT	FIELD	0
B42 # CURVES: 40 MPH	2	N	INPUT	FIELD	0

STATEWIDE HIGHWAY PLAN UPDATE

USE	DATA ITEM	FIELD LENGTH	ALPHA. NUMERIC	SOURCE	OFFICE/ FIELD	DEFAULT
	XX					
843	# CURVES: 50 MPH	2	N	INPUT	FIELD	0
	XX					
844	# CURVES: 60 MPH	2	N	INPUT	FIELD	0
	XX					
845	FHWA ESTIMATED AHS (MPH)	2	N	COMPUTE	COMPUTE	60
	XX					
846	POSTED SPEED LIMIT	2	N	INPUT	FIELD	55
	XX					
847	OPERATING SPEED:TRAVEL/TIME (MIN)	2	N	INPUT	FIELD	BLANK
	XX					
848	OPERATING SPEED: TRAVEL/TIME (SEC)	2	N	INPUT	FIELD	BLANK
	XX					
848	OPERATING SPEED:LENGTH (MILES)	5	N	INPUT	FIELD	BLANK
	XX.XX					
850	AVG. TRAVEL SPEED (MPH)	2	N	COMPUTE	COMPUTE	BLANK
	XX					
851	VDOT ESTIMATED AHS (MPH)	2	N	INPUT	OFFICE	60
	XX					

SHP - Cont

FILE: SHP_DATA.WK1 DISK: LCC-5 14-Mar-89

861

STATEWIDE HIGHWAY PLAN UPDATE

USE	DATA ITEM	FIELD LENGTH	ALPHA. NUMERIC	SOURCE	OFFICE/ FIELD	DEFAULT
	SCREEN 4					
C1	PRESENT DAY: VPD (PV) XXXXXX	6	N	INPUT	OFFICE	CAPACITY,V
C2	PRESENT DAY: YEAR XXXX	4	N	INPUT	OFFICE	INVENTORY
C3	PRESENT DAY: % TRUCKS XX	2	N	INPUT	OFFICE	10
C4	PRESENT DAY: % BUSES XX	2	N	INPUT	OFFICE	0
C5	PRESENT DAY: % RECREATIONAL VEHICLES XX	2	N	INPUT	OFFICE	0
C6	PRESENT DAY: % TOTAL HEAVY VEHICLES (> 6 TIRES) XX	2	N	COMPUTE	COMPUTE	10
C7	PRESENT DAY: % DIRECTIONAL SPLIT XXX	3	N	INPUT	OFFICE	60
C8	PRESENT DAY: % PEAK HOUR OF VPD XX	2	N	INPUT	OFFICE	10
C9	PRESENT DAY: PEAK HOUR FACTOR X.XX	4	N	INPUT	OFFICE	0.9
C10	FUTURE NO BUILD: VPD (FV) XXXXXX	6	N	INPUT	OFFICE	BLANK
C11	FUTURE NO BUILD: YEAR XXXX	4	N	INPUT	OFFICE	BLANK
C12	FUTURE NO BUILD: % TRUCKS XX	2	N	INPUT	OFFICE	10
C13	FUTURE NO BUILD: % BUSES XX	2	N	INPUT	OFFICE	0
C14	FUTURE NO BUILD: % RECREATIONAL VEHICLES XX	2	N	INPUT	OFFICE	0
C15	FUTURE NO BUILD: % TOTAL HEAVY VEHICLES (> 6 TIRES) XX	2	N	COMPUTE		10
16	FUTURE NO BUILD: % DIRECTIONAL SPLIT XXX	3	N	INPUT		60
17	FUTURE NO BUILD: % PEAK HOUR OF VPD XX	2	N	INPUT		10
18	FUTURE NO BUILD: PEAK HOUR FACTOR X.XX	4	N	INPUT		0.9
19	FUTURE BUILD: VPD (FV) XXXXXX	6	N	INPUT		BLANK
20	FUTURE BUILD: YEAR XXXX	4	N	INPUT		BLANK
21	FUTURE BUILD: % TRUCKS XX	2	N	INPUT		10
22	FUTURE BUILD: % BUSES XX	2	N	INPUT	OFFICE	0
23	FUTURE BUILD: % RECREATIONAL VEHICLES XX	2	N	INPUT	OFFICE	0
4	FUTURE BUILD: % TOTAL HEAVY VEHICLES (> 6 TIRES)	2	N	COMPUTE	COMPUTE	10

862

STATEWIDE HIGHWAY PLAN UPDATE

USE	DATA ITEM	FIELD LENGTH	ALPHA. NUMERIC	SOURCE	OFFICE/ FIELD	DEFAULT
	XX					
C25	FUTURE BUILD: % DIRECTIONAL SPLIT	3	N	INPUT	OFFICE	60
	XXX					
C26	FUTURE BUILD: % PEAK HOUR OF VPD	2	N	INPUT	OFFICE	10
	XX					
C27	FUTURE BUILD: PEAK HOUR FACTOR	4	N	INPUT	OFFICE	0.9
	X.XX					

APPENDIX C

Standard Data Request Forms

LD-104 (Rev. 10-90)

DEPARTMENT OF TRANSPORTATION
INTER-DEPARTMENTAL MEMORANDUM

, Virginia

MEMORANDUM

Route ________ Proj. ______________________________

To - Mr. R. C. Lockwood

County ________________________

From -

P/PMS # ______________

From:

SUBJECT: TRAFFIC DATA FOR DESIGN PURPOSES

To:

Ad Date _____________ Design Year _________________

Min. Design Speed _________ Operating Speed _________

Please furnish us with the following traffic data on the above captioned project as checked:

☐ * Present ADT (For information purposes only)

☐ * ADT After Completion (Ad Date + 1 Year)

☐ * Design Year ADT - - - - - - - -
☐ Secondaries - Ad Date + 11 years
☐ All other systems and selected Urban Secondaries-Ad Date + 22 Years

☐ * Design Hourly Volume

☐ * Directional Distribution Factor

☐ * % Trucks (Total). (2 Axle with 6 Tires and 3 Axle or more)

☐ Plan Design Year Level of Service

☐ Peak Hour Traffic A.M. & P.M.

☐ Peak Hour Factor

☐ ADT ( ) Five, ( ) Ten, ( ) Fifteen and ( ) Twenty years after completion of the project. (Completion date ____________________________).

☐ Turning movements at all intersecting routes with a traffic count of 3000 V.P.D. or over.

☐ Do-nothing Design Year ADT and speed (i.e. design year traffic on existing roadway assuming project is not built).

If additional information is needed, please contact ______________________________

____________________, Extension ___________.

* Request this Data for all systems

CC: Environmental Engineer
Assistant Location and Design Engineer
Resident Engineer
District Design Engineer
State Traffic Engineer

DEPARTMENT OF HIGHWAYS AND TRANSPORTATION
INTER-DEPARTMENTAL MEMORANDUM
January 26, 1990

TO: Mr. R. C. Lockwood	ROUTE: ___ COUNTY/CITY: ________
ATTENTION: Mr.	PROJECT: ________________
FROM: Mr. R. L. Hundley	FROM: ________________
SUBJECT: Request for Environmental Traffic and Transportation Data	TO: ________________

ENVIRONMENTAL TRAFFIC AND TRANSPORTATION DATA REQUEST

I. INTRODUCTION(TPD)
Briefly discuss the planning history of the proposed action. Cite the significant basis for inclusion of the proposed facility in the transportation plan, the date of plan adoption, and the characteristics of the network that support the need for the proposed action. Jurisdictional comments on the proposed action in subsequent plan adoptions should also be provided.

II. EXISTING ROADWAY NETWORK (TPD)
(Briefly, for the study window, describe existing roadways, in terms of: (1) roadway termini; (2)roadway geometrics; (3) current traffic volumes and levels of service, and ; (4) areas served by existing roadways (travel desires). This chapter should also include figures presenting both the existing highway network and proposed improvements to the existing roadway system.)

III. EXISTING PUBLIC TRANSPORTATION
This section should address the following:

A. RPTD - Current transit-oriented facilities within the study window: i.e., commuter rail, buses, etc., and include figures depicting existing routes.

B. TPD - A description of current and proposed Transportation Systems Management (TSM) measures; i.e., HOV lanes, fringe parking lots, etc., should be included.

IV. TRAVEL FORECASTING (TPD)
(Discussion of the traffic methodology utilized for the technical report, if other than or in addition to normal procedures.)

V. PUBLIC TRANSPORTATION/TRANSPORTATION SYSTEMS MANAGEMENT ALTERNATIVES (RPT
(This section should discuss public transportation/TSM alternates to the Build Alternatives, i.e., public transportation, transit, TSM, etc. The coordination with local or regional transit agency regarding routes, increased or decreased service plans, ridership, etc. A summary of the information presented in this section should be included.)

VI. ANALYSIS OF NO-BUILD ALTERNATIVES (TPD)
A. No-build (All elements of the adopted regional transportation plan with the exception of proposed action.)

B. ________________ C. ________ D. ______________

For the above alternatives, please provide:

1. A generalized evaluation of each alternative (including figures depicting traffic volumes and levels of service):i.e., the ability of each alternative to fulfill transportation service in terms of both positive and adverse affects upon the network and areas within the network.

VII. <u>TRAFFIC DATA REQUIRED FOR AIR, NOISE AND ENERGY ANALYSES</u> (TPD)
<u>In reference to the technical studies associated with the subject</u> project, we request the following traffic information <u>in a map form:</u>

1. Project Specific Information

A. - ADT
- The breakdown on percent ADT, directional split and operating speeds for each of the hours between 6 a.m. and 9 p.m.
- Peak hour volumes, operating speed, and directional split**
- Percent of trucks with three or more axles**
- Percent of trucks with two axles and six tires**
- Percent of trucks with two axles and four tires
- Level of service during design hour traffic periods

B. - The above information should be developed for the following years:
- Present Year
- Design Year (   ) build and no-build*
- Interim Year (   ) build and no-build*

C. - and for the following facilities:
- Main Line(s)
- All crossing or intersecting roadways with   veh/day or more in the design year.
- All ramps and loops at interchanges within the project limits.

D. - Comments:

2. Special Information

A. - Schools - Maximum hourly volume(For the Design Year; Monday through Friday) operating speed, truck mix and level of service between 9 a.m. and 3 p.m. on the following roadway(s).

ROUTE	FROM	TO
________________	________________	________________
________________	________________	________________
________________	________________	________________

*If the project is on new location, the no-build traffic information should account for the distribution of vehicles over existing roadways in the the absence of the proposed facility.

**Please furnish design hour data also if different than peak hour data. The design hour data <u>must</u> reflect the actual design hour Level of Service or LOS C, whichever is better.

B. Churches - maximum hourly volume (For the Design Year: on Sunday) operating speed, truck mix and level of service between 9 a.m. and 12 noon on the following roadway(s).

ROUTE	FROM	TO

C. Trucks (Three axles or more only)
(a) Percentage of truck volume which can be considered through trucks
(b) Is it feasible or desirable to divert through trucks to other roadways? If not, why? If yes, which routes?
(c) Is it feasible or desirable to divert local trucks to other roadways? If not, why? If yes, which routes?

D. Conformity - Does the project qualify for conformity:
(a) As a TCM (or other project) specifically included in the State Implementation Plan (SIP).
(b) As from a conforming Transportation Improvement Program (TIP)
(c) As exempt from TIP requirements (A-95 review) without adversely affecting the TCM's of the SIP.
(d) Other - provide comments if the above criteria do not apply.

E. Mesoscale Traffic Information - See attachment

VIII. APPENDICES (TPD & RPTD)

(Include various materials utilized in the conduct of the traffic analyses and drafting of the report, i.e. level of service, references traffic data supportive of study.)

IX. NOTES
(1) Please provide information by ( ), which is the current PPMS date for "Traffic Data Furnished." This is necessary to complete the technical studies for inclusion in the environmental document. If you will be unable to meet this deadline, please contact us immediately and revise the PPMS accordingly.
(2) Please send a copy of your reply to the Location and Design Division.
(3) Should you have any questions regarding this request, please contact Mr. C. B. Adkins of this division.

R. L. Hundley
Environmental Engineer

A. C. Anday
Environmental Programs Manager

cc: Mr. R. G. Corder
Mr. E. C. Cochran, Jr.
Mr. J. M. Allen
Mr. C. B. Adkins
Mr. S. F. Curling, Jr.

ATTACHMENT

III. Mesoscale Traffic Information

Because of magnitute of this project, it will have an influence on traffic patterns on the surrounding network. Therefore, the following information is requested for all roadways whose build and no-build ADT differ by 5% or more. It is preferred that this information be provided in a map form.

- ☐ Present ADT, operating Speed, Truck Mix*
- ☐ Interim Year (   ) ADT, Operating Speed and Truck Mix* for build and no-build conditions
- ☐ Interim Year (   ) ADT, Operating Speed and Truck Mix* for build and no-build conditions.
- ☐ Design Year (   ) ADT, Operating Speed and Truck Mix* for build and no-build conditions.

*The truck mix should be broken down in terms of two axles and four tires, two axles and six tires, and three or more axles.

APPENDIX D

Information on TURNFLOW and TMOVES

TURNFLOW

Estimating Intersection Turning Movements From Approach Volumes Using LOTUS 1-2-3(tm)

by

Mark C. Schaefer, P.E.
Aurora, Colorado

May 1988

TURNFLOW

Estimating Intersection Turning Movements From Approach Volumes Using LOTUS 1-2-3(tm)

1.0 INTRODUCTION

For most intersection traffic analyses, a complete set of vehicle turning movements are required. Yet, there are circumstances wherein only intersection approach volume counts have been documented or obtained. These circumstances may include results of traffic field studies where only mechanical counting equipment was used (e.g., road tubes) and data from traffic forecasting models (where link volumes, rather than full intersection turning movements are output).

There has been considerable research on the development of intersection turning movement estimates based on approach counts. The TURNFLOW spreadsheet template is based on the algorithm and technique described by Hauer, Pagitsas and Shin ("Estimation of Turning Flows from Automatic Counts," Transportation Research Record 795, 1981). The algorithm and technique, based on "Kruithof's algorithm," provides a balanced set of intersection turning flows from a set of pre-specified inbound and outbound intersection flows and the user's "first guess" estimate of the probable turning proportions at each approach. Please review the referenced article and Appendix II for additional detail.

2.0 THE "TURNFLOW" PROGRAM

TURNFLOW was written as a template program for use with LOTUS 1-2-3(tm) Release 2 (herein after called "1-2-3"). "LOTUS" and "1-2-3" are registered trademarks of Lotus Development Corporation.

The spreadsheet is divided into five parts:

- Rows 1 through 16 contain some introductory material to the spreadsheet.
- Rows 17 through 44 contain brief instructions on operating the spreadsheet.

- Rows 46 through 109 contain a step-wise process for inputting the problem data.

- Rows 112 through 154 contain the one-page summary of results.

- Rows 155 through 252 contain the equations for the program's calculations, the macros, and error checking routines.

3.0 NEEDED INFORMATION

The program requires the user to input the following:

- Inbound link volume from each approach

- Outbound link volume to each approach

- "Best guess" estimate of turning proportions from each approach

- Closure of the iterations (default of the template is 0.01)

Some requirements and hints:

1) The total inbound and outbound volumes must be equal.

2) The algorithm is sensitive to the "best guess" estimate of turning proportions (since a wide range of actual turning proportions will balance a given set of inbounds and outbounds). Refer to Appendix II for some hints on selecting appropriate initial estimates of the turning proportions. Since there is not a unique solution to the problem, some sensitivity analysis is recommended prior to using the results.

3) Due to their relative infrequency, U-turns are not supported in this version of spreadsheet. Thus, the spreadsheet will not operate for combinations of inbound and outbound link volumes which require U-turns to make the interchange balance (specifically, the mode indicator in the upper right corner of the screen will light "UTURN" after invoking the macro \F and calculations will cease; hit any key to continue).

4) Initial turning estimates of "0.0" (for example, turns which cannot be made, such as at a T-intersection) will remain zero after balancing.

5) Although choosing a small value for closure increases the computation time of the spreadsheet (since an iterative process is used to solve the problem), the resulting turning movement estimates will better balance the inbound and outbound flows. View the range A222..E236 to ensure a balanced solution has been reached if you have used a large value for closure.

6) To prevent inadvertent changes or erasure of spreadsheet equations, cells not used for data entry have been "protected." One exception -- the range C167..C170 in the calculations section of the spreadsheet must remain "unprotected" for the proper functioning of the macros.

USER DOCUMENTATION OF PROGRAM *TMOVES*

Author: Prof. Peter G. Furth, Room 420 SN, Northeastern Univ., Boston, MA 02115.

Date: Jan. 1, 1990.

For background information, see P. G. Furth, "A Model of Turning Movement Propensity", presented at the Transportation Research Board annual meeting (January, 1990) and forthcoming in *Transportation Research Record.* (TRR 1287)

Purpose

This program estimates turning movements at a 4-way intersection to match user-supplied approach inflows and outflows based on a "seed matrix" of turning flows. The seed can be generated by the program using a Propensity Model, or it can be supplied directly by the user. To have the program generate a seed, map-based information such as approach angles must be supplied. If the user supplies the seed, it may be an actual turning movement count from this intersection. This "seed" count may be an old count, a count taken in a different time period, a count taken for a short interval such as a 15-min period, or a "split count" in which different movements were observed at different times. The user-supplied seed may also be a subjective guess of turning proportions or propensities.

If the approach inflow / outflow data is incomplete, missing inflow and outflow values will be estimated. Users are cautioned, however, that some seed options expect a full set of inflow and outflow totals, and will not perform well when more than one total is missing. U-turns are always assumed to be prohibited. Other turning movements may be prohibited at the user's option. Zero flows in the seed matrix can be treated either a structural zeroes, implying that they will yield zero-flow estimates, or as non-structural zeroes, in which case they are adjusted using a Bayesian procedure to permit non-zero estimates of the corresponding flow.

Analysis Preparation - General

1. The approaches must be numbered *counterclockwise.* It is advisable to standardize one direction (e.g. north) as always being approach 1.

2. *Caution when approach inflow / outflow data is incomplete.* The Propensity Model is not intended for making estimates when approach inflows or outflows are missing. (Of course, if seven of the eight inflows and outflows are given, the eighth is not really missing, since it is uniquely determined by equating total inflow to outflow.) An estimate made using an actual count as a seed will be valid, although care must be exercised if the count is a split count to be sure that all movements are weighted equally, i.e., are adjusted to a common interval of time. An estimate made based on a

subjective guess of inflow or outflow proportions will usually not be valid, unless the subjective guess tries to replicate a raw count.

3. When all four inflow and outflow totals are supplied, their respective grand totals should agree. If they do not, the program will automatically adjust them proportionately to match the average of the conflicting grand totals. (One way to avoid conflicting grand totals is to only enter seven of the eight inflow / outflow totals, and let the program calculate the eighth internally. However, this does not provide any check on the consistency of your input data.)

4. Three-way intersections can be modeled. Simply establish a dummy approach and make the target inflow and outflow for that approach 0.

Analysis Preparation When Using the Propensity Model

Use a worksheet such as shown in Figure 1 to prepare the input data.

1. *Measuring approach angles.* Three angles must be measured: 1-2 (i.e., the angle between approach 1 and approach 2), 2-3, 3-4. (The fourth angle will be calculated internally.) Angles are measured in degrees. When an approach is curved, treat it as a straight line going through the intersection of interest and the nearest intersection with a through street.

2. *Diversion levels.* A diversion level must be selected for both the right and the left turn movement at each corner, reflecting the tendency of competing short-cuts to divert turns than would have been expected. Level 0 implies that there are no short-cuts, as is expected in a pure grid network. Level 1 implies weak competition from a short-cut. Level 2 implies significant competition. Level 3 implies strong competition. Level 4 implies very strong competition, i.e., that nearly all expected turns are diverted away from the intersection. Level 5 indicates a prohibition on turns. In selecting a level of diversion for a movement, the following factors should be considered:

    1) *The distance of the short-cut from the intersection.* The closer the short-cut, the stronger the competition.

    2) *The land use between the short-cut and the intersection.* The greater the development, the weaker the competition since trips generated between the short-cut and the intersection won't be able to use the short-cut. A level 4 diversion should have very little development between the short-cut and the intersection.

    3) *How well know the short-cut is.* Maps may reveal a wonderful short-cut which may turn out to be a dirt road, or a narrow road connecting two broad roads that carry mostly long-distance travelers unacquainted

with local side streets.

Diversion levels are usually, but not always, the same for the right and left turns at a given corner.

When the angle at a corner is small (60 degrees or less), there will often be a preferable short-cut in the road network. However, because angle is also a factor in estimating flows, avoid double counting by not considering short-cuts to small angle corners unless they are particularly close to the intersection, i.e. closer than the prevailing spacing of through streets.

3. *Note dead end approaches.* "Dead end" here includes any approach not used by through traffic. Level 0 means it is a through street. Level 0.5 is a no-thru-street with more than one outlet, such as most entrances to shopping centers, entrances to subdivisions that have another outlet but are not amenable to through traffic, and horseshoe-shaped roads that serve as local access to developments. Level 1 is for pure dead ends, including streets that lead into subdivisions with no other outlet.

4. *Determine grid density level.* Three levels of grid density are allowed: outer suburb (level 1), inner suburb (level 2), and CBD (level 3). The two suburban levels correspond roughly to prevailing spacing of through streets being greater or less than 1.5 miles.

Analysis Preparation When an Actual Count is Supplied as Seed

1. The seed count may be from any length of time (15 min, 60 min, all day, etc.) and from any time of day. It may be a split count in which, for example, two approaches were observed for 15 min and the other two approaches were observed the next 15 minutes. Of course, the accuracy of the resulting estimate depends on the quality of the seed and how similar it is (in its underlying turning propensities) to the situation being estimated. In general, the longer a time period over which the seed was counted, the better its quality, and the closer the time period of the seed to the time period of the estimate, the more similar their underlying propensities. Research has shown, however, that good accuracy can still be expected if a seed comes from a different time period, or from a short time interval. The seed may be in raw numbers, or may be expressed as hourly flows, or may be converted to proportions of inflows or of outflows or to proportions of the grand total intersection volume.

2. If you are not going to supply a complete set of inflow and outflow totals for the estimate, the seed should be given in the form of either raw counts or hourly volumes.

3. To avoid input error, you may find it helpful to arrange your seed flows on a diagram as in Figure 2. In this way, the movements will be input in order as one reads counterclockwise around the intersection, beginning with left turns from approach 1.

8̃50

4. *Special treatment of zero flows*. The program contains an option allowing for special treatment of non-structural zero flows in the seed data. A *structural zero* is a flow that must be zero due to, say, a turning restriction or a one-way street. A *non-structural zero* occurs when a movement is permitted, but no vehicles made that particular movement when the seed count was made. If the seed count was made during a short time interval, non-structural zeroes are likely. The default option in the program is to apply a Bayesian adjustment to enable a non-zero estimate of the corresponding flow. Without this Bayesian adjustment, flows that are zero in the seed will remain zero in the estimate. The user may choose to not apply the Bayesian adjustment.

   If your seed data contains structural zeroes, the input data must be modified to distinguish structural zeroes from non-structural zeroes. *Structural zeroes should be entered as -1;* non-structural zeroes should be left as 0 (zero). If you intend to suppress the use of the Bayesian adjustment, you may leave all zeroes as 0 (zero).

   Please note that the program has no means for entering U-turn flows, so there is no need to specify zero flows for U-turns. The program assumes zero U-turn flows, and is not equipped to estimate non-zero U-turn flows.

Analysis Preparation When Using a Subjective Seed

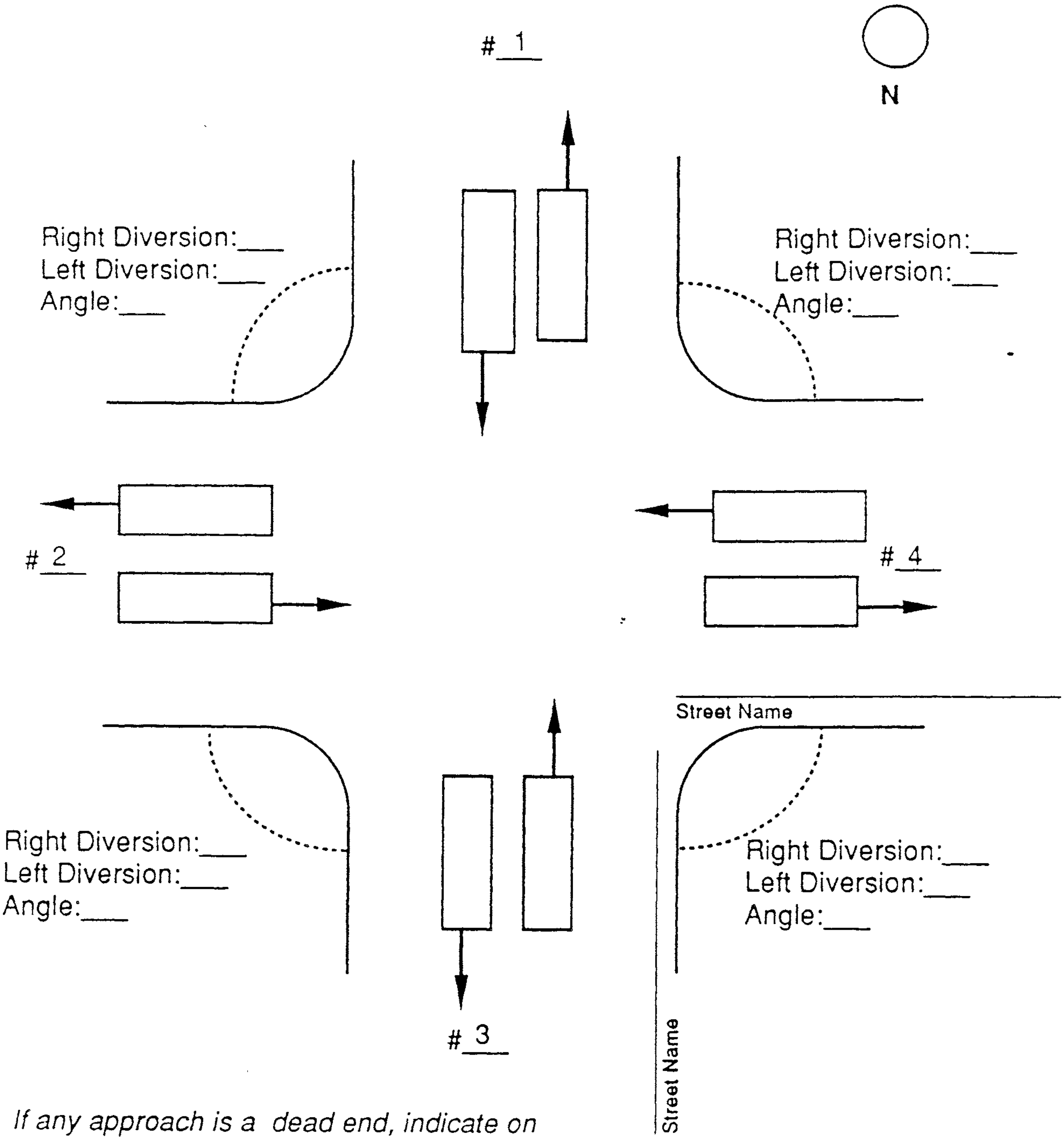
A subjective seed essentially tries to simulate a set of turning flows based on intuition. The seed can be in the form of simulated raw counts, but mentally simulating counts that properly balance inflows and outflows is difficult (that's part of the reason why this program was created!). More commonly, subjective seeds take the form of percentages of inflows, in which the three movements from a given entering approach are assigned percentages that sum to 100. It is also possible instead to use percentage of outflows. The use of inflow or outflow percentages will not yield a valid estimate unless a full set of inflows and outflows for the estimation are given.

The guidelines for using actual an actual counts as seed apply for this option as well.

Figure 1
Data Sheet When Using Propensity Model

Intersection name:____

Further title:____



If any approach is a dead end, indicate on the diagram with 1 for a true dead end, and 0.5 for a no-thru-street with another outlet

Grid Density (circle one):	1	Outer suburbs
	2	Inner suburbs
	3	CBD

FIGURE 2
Data Sheet When Supplying a Seed

Intersection Name:____

Further title:____