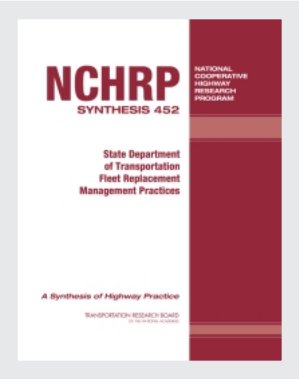

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP SYNTHESIS 452

State Department of Transportation Fleet Replacement Management Practices

A Synthesis of Highway Practice

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FOREWORD

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Tanya M. Zwahlen
Consultant
Transportation
Research Board

This report identifies the current state of the practice regarding fleet replacement management and financing methods by departments of transportation (DOTs). A primary objective of this study is to identify methods currently used to manage asset replacement, including the financing of replacement expenditures. The report also provides a discussion of the perceived strengths and weaknesses of different management and financing methods.

Information used in this study was acquired through a review of the literature and a survey of DOT representatives in all states.

Paul T. Lauria, Mercury Associates, Inc. and Donald T. Lauria, University of North Carolina at Chapel Hill, collected and synthesized the information and wrote the report. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable with the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

STATE DEPARTMENT OF TRANSPORTATION FLEET REPLACEMENT MANAGEMENT PRACTICES

SUMMARY

The goal of NCHRP Synthesis Topic 43-14 is to examine the fleet replacement management and financing practices currently employed by state departments of transportation (DOTs) and to summarize their perceived advantages and disadvantages. DOTs rely heavily on fleets of vehicles and equipment (hereinafter "assets") to fulfill their primary missions of building and maintaining roads. Accordingly, most of them spend large amounts of money on the acquisition, management, operation, and maintenance of fleet assets, and replacement management practices have a direct impact on fleet costs and performance attributes such as reliability, safety, and sustainability.

Fleet replacement management practices that consistently result in the replacement of assets at or near their optimal replacement cycles—the period of time over which their combined capital and operating costs are minimized—contribute to the fulfillment of a DOT's primary mission. Conversely, practices that result in assets consistently being retained longer than their optimal replacement cycles detract from this mission by diverting money to the fleet that could otherwise be spent on things such as highway maintenance. Simply put, the amount of money a DOT spends on the replacement of assets determines the age of its fleet, and the costs and performance of an old fleet are generally inferior to those of a young one.

This study gathered information on current fleet replacement management and financing practices and perceptions about them through a survey of state DOT fleet managers. The goal of the survey was to identify the methods currently used to manage asset replacement, including the financing of replacement expenditures and their relative advantages and disadvantages. Thirty-eight of the state DOTs (76%) responded to the survey. In addition, a literature review was conducted to supplement survey findings in order to identify effective methods for managing and financing fleet replacement costs.

The following summarizes the DOT fleet manager survey results.

- Replacement Costs
  - The average number of assets in the respondents' fleets is 10,000.
  - The average current replacement cost of an on-road vehicle or off-road equipment asset is $40,000.
  - The average replacement cost for small engine equipment and attachments is $8,500.
  - The estimated total replacement cost of all DOT fleets that participated in the study is $13 billion. The average fraction of on-road fleet value that was replaced with new assets in 2011 was 6% (it was 5% and 4%, respectively, for 2009 and 2010).
- Replacement Schedules
  - During the 3-year period from 2009 to 2011, 60% of the DOTs replaced less than 5% of their fleet value with new assets, and only 10% of the DOTs replaced more than 10% of fleet value.
  - Fifty percent of the DOTs have average replacement cycles longer than 20 years.
- Expenditures in Relation to Needed Replacements
  - The average expenditure per DOT for asset purchases in 2011 was $18.5 million; however, on average, the survey respondents indicated that they believe this amount should be increased by 40% to $25.7 million per year.

  - Conversely, nearly 20% of survey respondents indicated that replacement expenditures should be reduced instead of increased.
  - Half the respondents indicated that less than 20% of the assets currently in their fleets need to be replaced at this time. No correlation was found between DOT opinions regarding needed expenditures and needed replacements; the opinions were contradictory.
  - Similarly, there was no correlation between the reported ages of fleets and the percentage of assets that respondents reported needed replacing. Thus, the survey revealed inconsistencies regarding the interrelationships among fleet age, replacement backlogs, needed replacements, and needed expenditures.
- Fleet Replacement Decision Support Tools.

Following are six decision support methods DOTs use for planning asset replacements that were explored in the survey.

1. Replacement cycle policies based on formal analysis of life-cycle costs;
2. Replacement cycle policies based on judgment, experience, rules of thumb, etc.;
3. Multiyear fleet replacement plans showing future replacement dates and costs by asset;
4. Replacement lists that identify assets meeting pre-defined criteria (e.g., age or mileage);
5. Methods for prioritizing specific assets for replacement when funds are insufficient to replace every asset that should be replaced; and
6. Repair versus replace tools or policies that target specific assets needing expensive repairs.

Each of the six methods was considered by at least one DOT that responded to the survey to be either "the most important" or "second most important" method for guiding replacement decisions. The following is an overview of DOT responses.

Method 4 (age, mileage, cost, and similar criteria) was cited by more DOTs than any other as the most important method; however, fewer than half the respondents reported using it. There is no consensus among the DOTs about which decision support method is the most effective.

Half the DOTs (19) noted that if their methods were not used their fleets would be much older. The other DOTs noted that their methods provide only moderate confidence that they will be successful in obtaining needed replacement funds.

- Fleet Replacement Decision-Making Processes

A majority of the respondents (60%) reported that the timely replacement of fleet assets is not a high priority for their governor, state budget office, and/or legislature, and 30% that decision making is decentralized and beyond their control. Sixty percent of the survey respondents reported that no formal studies have been made of their departments' fleet replacement practices in the past ten years. Half of the studies that were made used consulting firms, one-quarter used academic or research institutions, and the remaining one-quarter used a state or DOT auditor.

Two-thirds of the DOTs reported that the agency that makes final decisions about asset replacement funding is a central fleet management organization or other unit within the DOT, and the other third that it is an executive branch agency (state budget office, governor's office, state legislature, etc.). More than 80% of the DOTs noted that decisions about the amount of funding made available for fleet replacement are either entirely or somewhat satisfactory. Most DOTs believe that they fare better in securing fleet replacement funding than do other agencies in their states that also use fleets of assets.

Seventy-five percent of DOTs reported that outright purchases using money obtained through the annual budget process is the primary method they use to finance asset replacements, with 20% reporting outright purchases using a revolving or similar fund where funds are accumulated over time to defray such purchase costs. Sixty percent of the DOTs use replacement financing programs managed by a central fleet management organization within

the DOT, and 20% have programs managed by another organizational unit within the DOT, including individual fleet user organizations.

- Financing Methods

Most DOTs use one primary method for financing the capital costs of their fleet. Eighty-five percent of the DOTs stated that their method is either somewhat or very effective in promoting the timely replacement of assets; only 10% said it is ineffective. The majority of DOTs that use a revolving fund said this financing approach is very effective. Securing replacement funds through the annual budget process was judged by some survey respondents to be ineffective, but no explanations were given for why.

Annual budgets were also reported to be the most ineffective in promoting understanding of the trade-offs between asset capital and operating costs and opportunities to optimize them.

The explanations respondents gave for this ineffectiveness were: (1) the highly defined separation of capital budget funds in the appropriation process makes it easy to target them for cuts; (2) there is mistaken belief that once assets have been purchased, it no longer costs anything to operate and maintain them; and (3) with centralized replacement budgeting, management, and purchasing fleet users have no incentive to minimize overall fleet size.

DOTs using revolving funds for financing fleet replacement costs reported that the source of monies is a system of charge-back rates. Half of these agencies noted that the monies collected through the charge-back system for fleet capital and operating costs are maintained in separate accounts, the other half that the monies are pooled. Most DOTs using charge-back rates reported that: (1) revenues cover all costs; (2) all rates have been updated within the past two years; (3) specific methods are used for setting charge-back rates; and (4) replacement reserves in the revolving fund are almost never raided to meet other spending needs.

Half of the DOTs that use revolving funds are completely satisfied with them, and the rest are fairly satisfied. No other financing method has such a high level of satisfaction. Only one DOT in five is completely satisfied with using funds secured through annual budgets for financing asset replacements. Some improvements DOTs would like to see in this particular financing method include: (1) more funding; (2) the return of used asset sale proceeds to the fleet budget; (3) restrictions on funds budgeted for vehicles and equipment being used solely for that purpose and not redirected elsewhere; (4) replacement with a revolving fund; and (5) a more level funding stream that allows the replacement of fleet assets on 8- to 10-year cycles.

Half the DOTs do not want to change the method they use for financing the capital cost of assets. All the DOTs presently using revolving funds prefer to keep them. Fewer than half the DOTs presently using annual budgeting processes want to keep them. Some want to switch to leasing, or borrowing, or a revolving fund.

Two-thirds of the DOTs reported that they use additional financing methods to periodically supplement their primary method. The methods used include short-term rentals (most common), leasing, and guaranteed buy-back programs. Thirty percent of DOTs said they occasionally buy used instead of new assets.

A literature review was also undertaken for this study. The state of California's DOT, Caltrans, recently published the results of a survey it commissioned of state DOT fleet management practices, including some related to asset replacement and fleet financial management. The study draws no conclusions about the advantages/disadvantages of fleet management practices nor does it make any recommendations for improvement. Nonetheless, it is the only one other than the present study that explores how state DOTs are managing and financing the costs of fleet replacements.

The AASHTO Standing Committee on Highways recently commissioned a report on future equipment fleet management research needs. The report includes recommendations regarding research that should be conducted on the development of asset replacement cycle guidelines, asset repair-rebuild versus replacement decision making, fleet replacement planning, and fleet replacement financing. The report sheds light on what a group of state DOT, FHWA, and consulting company officials that met to identify research needs deemed to be key elements of an effective fleet replacement program.

A few reports by academicians describe decision support tools for determining when to replace specific assets in fleets so as to minimize total costs. All but one of these studies were made for state DOTs. The authors of some of these reports acknowledge that the content is highly technical and may require the help of experts in order to apply it. The reports have valuable discussions of underlying principles for effectively replacing fleet assets.

Consulting reports often use a standard methodology for evaluating the soundness of fleet replacement practices. The first step is a multi-year plan that estimates the future costs of replacing assets. The resulting forecasts show that replacement spending requirements often fluctuate from year to year, which causes too few assets to be replaced when DOTs are strapped for cash. An alternative approach for estimating future fleet replacement costs is to simply divide the current replacement cost of the entire fleet by a target average replacement cycle (e.g., seven years). Under both approaches, estimates of future costs provide a benchmark against which past replacement spending levels can be compared.

Much of the consulting literature analyzes the pros and cons of different types of capital financing that are used by government jurisdictions, including (1) outright purchase using funds secured through annual budgeting processes; (2) purchase using a revolving fund and charge-back system; (3) purchase using borrowed funds; and (4) leasing. The first is the most common and the last is the least common method used. Two key points made by a number of these studies are that old fleets cost more than younger fleets and that the choice of a replacement financing method can have a significant impact on the age and hence the costs of a fleet. The biggest challenge in making a fleet younger and more economically efficient is securing the funds for replacing obsolete assets that have been backlogged.

The literature shows that outright purchase of assets with cash is the least beneficial method for financing assets (despite its widespread use by governments). It has the biggest impact on an organization's budget in the near term, and it frequently incentivizes the repair and retention rather than the replacement of obsolete assets. Financing approaches that leverage cash (e.g., debt financing and leasing) are usually more viable, partly because they do not require fluctuating amounts from year-to-year.

In 2002, the TRB Standing Committee on Maintenance Equipment published a circular on capital financing methods used by state DOTs. The report is a primer, intended to provide information to fleet managers regarding the various financial acquisition choices and how each impacts budget, total costs, and fleet upgrade factors. It summarizes different acquisition methods, cost factors, and how life-cycle bids are used by state DOTs. The section on acquisition states that "cash purchase is the lowest cost method for owning, operating, and disposing of a piece of equipment." This statement does not align with other reports reviewed in the literature review.

Articles published in fleet industry periodicals occasionally cite the savings from downsizing fleets and reducing fleet age.

Although its primary readership is corporate fleet managers, Bobit's Fleet Financials has many articles on the characteristics, pros, and cons of various types of fleet lease agreements, offering a good source of introductory information.

CHAPTER ONE

INTRODUCTION

The goal of this synthesis report is to examine the fleet replacement management and financing practices currently employed by state departments of transportation (DOTs) and to summarize their advantages and disadvantages. The study acquired information on current practices and perceptions about them through a survey of state DOT fleet managers. The survey was designed to identify the range of methods used to manage asset replacement, including the financing of replacement expenditures and perceptions about their relative advantages and disadvantages. In addition, a literature review was conducted to supplement the survey findings and to attempt to identify effective methods for managing and financing fleet replacement costs.

DOTs rely heavily on fleets of vehicles and equipment to fulfill their primary missions of building and maintaining roads. Accordingly, most of them spend significant amounts of money on the acquisition, management, operation, and maintenance of fleet assets, and replacement management practices have a direct impact on fleet costs and performance attributes such as reliability, safety, and sustainability.

FLEET REPLACEMENT DECISION SUPPORT TOOLS

A key aspect of replacement management practices explored in this study is the use of decision support tools, the general objectives of which are to determine if and when to replace fleet assets and how much to spend on such replacements. Commonly used methods for determining when to replace vehicles include:

- Recommended replacement cycles for different types of assets in the fleet;
- Multiyear fleet replacement plans;
- Replacement eligibility lists identifying specific assets that meet or exceed pre-defined criteria for replacement;
- Replacement prioritization methodologies aimed at ranking assets for replacement from most to least important, particularly in instances in which available replacement funds are less than desired spending levels; and
- Repair versus replace decision tools.

The advantage of decision support tools is that, when properly designed and used, they provide a systematic means of developing fleet replacement budgets or funding requests. Generally speaking, structured replacement management methods that take into account such factors as the age and condition of individual assets and the operational needs of fleet user organizations produce better and more defensible (to budget and elected officials) funding requests than do methods based solely on past practice, subjective judgment, perceived but ill-defined priorities, and the relative influence on decision-making processes of the organizational units within a DOT that compete for budget dollars.

The disadvantage of such tools is that some of them require specialized skills in the codification and capture of data, the analysis of such data and the development of forecasts, cost and performance metrics, other pertinent management information, and the communication of such information to non-fleet management experts. Such skills are difficult to develop or apply to the management of fleet replacement without proper training and, in some cases, sophisticated analytical tools.

Regardless of the method, the amount of money a DOT spends on replacement assets each year determines the age of its fleet, and it is a well-established principle of fleet management that the costs and performance of an old fleet are generally inferior to those of a young one [e.g., see *Guidance Position Statement: Timely Replacement of Fleet Assets,* American Public Works Association, Washington, D.C. (n.d.), which is available at: http://www2.apwa.net//Documents/Advocacy/_FL_%20Timely%20Replacement%20of%20Fleet%20Assets-Guidance%281%29.pdf].

For these reasons, fleet replacement management practices that consistently result in the replacement of assets at or near their optimal replacement cycles—the period of time over which their combined capital and operating costs are minimized—contribute to the fulfillment of a DOT's primary mission. Conversely, practices that result in assets consistently being retained longer than their optimal replacement cycles detract from this mission by diverting money from the fleet that could otherwise be spent on things such as highway maintenance.

METHODS OF FINANCING

Another important dimension of fleet replacement management examined in this study is the methods used by DOTs to pay for or finance the purchase of fleet assets. The

most commonly used methods of financing new equipment include:

1. Outright purchase through the annual budget
2. Revolving fund
3. Borrowed funds
4. Leasing
5. Vendor buy-back
6. Surplus asset sales.

Different financing methods affect an organization's budget in different ways and these effects may help or hinder it in replacing its fleet assets in a timely manner. For instance, purchasing vehicles outright at the time they are acquired tends to result in fluctuating year-over-year replacement funding needs. In contrast, paying for the replacement of equipment with loans or leases results in relatively predictable annual funding requirements. This can reduce the likelihood that appropriations for fleet replacement will be inadequate in years in which spending needs spike, resulting in a replacement backlog as needed replacements are postponed. However, loans and leases are usually considered by administrators to be more expensive than outright cash purchase because of the interest charges associated with them. Fleet replacement reserve funds also make year-over-year replacement funding requirements fluctuate less, and thus tend to promote the timely replacement of assets. However, they are complicated to structure and manage properly; for example, to ensure that the right amount of money is contributed to the fund annually and fund balances are managed in a manner that ensures long-term solvency. In short, the choice of a capital financing approach can have a profound impact on the effectiveness of a DOT's fleet replacement practices.

CHAPTER TWO

METHODOLOGY

This study gathered information on current fleet replacement management and financing practices and perceptions about them through a survey of state DOT fleet managers. The goal of the survey was to identify the methods currently used to manage asset replacement, including the financing of replacement expenditures and their relative advantages and disadvantages. In addition, a literature review was conducted to supplement survey findings and identify effective methods for managing and financing fleet replacement costs.

FLEET MANAGER SURVEY

The types of information that were collected through the survey included:

- Fleet characteristics (size, composition, age, capital costs, desired and actual annual replacement spending levels, current replacement backlog, etc.);
- Fleet replacement management program characteristics and efficacy in promoting the timely replacement of fleet assets, including institutional structures, policies, procedures, decision support methods, and tools for making asset replacement decisions and funding requests;
- The existence of prior audits and studies of fleet replacement practices and the availability of associated reports for incorporation in the literature review;
- The location of responsibility and authority for fleet replacement budgeting and funding-related decision making and the perceived efficacy of such decision making;
- Details of the specific capital financing method(s) that are used and fleet managers' satisfaction with them; and
- Information on other strategies and techniques used to stretch fleet replacement budgets, including seasonal equipment rental practices, purchase of used instead of new assets, and the use of guaranteed buy-back programs.

A draft questionnaire was designed to collect information through a series of interrelated questions that enabled cross checking the consistency of responses. A survey distribution list of all 50 state DOT fleet managers, including agency names, manager names, titles, phone numbers, and e-mail addresses, was compiled using information from several sources. The survey was conducted by means of the Internet using an on-line survey tool. Respondents were alerted in the e-mail that certain quantitative information was requested and that they might want to assemble or be prepared to assemble this information before beginning to answer the questionnaire. An estimate of the time required to complete the questionnaire (40 to 45 minutes) was provided, and an electronic copy in PDF format was attached to the e-mail.

Owing to the low initial response rate (only eight completed surveys were received in the two weeks targeted for survey completion), the survey deadline was extended; however, after an additional four weeks, the initial survey response rate was only 48% (24 completed questionnaires). Consequently, the Topic Panel members and the Program Officer agreed to personally contact additional DOT fleet managers in an effort to persuade them to participate in the survey. As a result of these outreach efforts, survey responses were secured from 14 more DOTs over a period of eight more weeks, bringing the final tally of completed questionnaires to 38; a response rate of 76%.

LITERATURE REVIEW

A search of U.S.-based literature was conducted to assemble background information on the range of practices used by public-sector entities in the areas of fleet replacement management, financing, and funding, including their strengths and weaknesses. Several sources of information were explored, including:

- The publications of selected publishers of commercial fleet management-related journals such as Bobit Business Media;
- TRID, TRB's database that combines the records of TRB's Transportation Research Information Services (TRIS) database and the OECD's Joint Transport Research Centre's International Transport Research Documentation database;
- Consultant reports, known to the principal investigators as a result of their consulting work with several state and local governments, including state DOTs, or identified by the Topic Panel members or by DOT fleet managers in the questionnaire;
- The Internet; and
- The resources of selected fleet management trade associations such as NAFA Fleet Management Association and American Public Works Association.

CHAPTER THREE

SURVEY RESULTS

This chapter contains the analysis of survey response data. The chapter is divided into four subsections: Survey Response, Fleet Costs and Expenditures, Replacement Management Practices, and Replacement Financing Methods.

SURVEY RESPONSE

Seventy-six percent (38) of the state DOTs in the United States responded to this study's survey. The 2010 state populations represented by the respondents ranged from fewer than 1 million up to 37 million, with an average of 6.9 million. The median population was 4.5 million; half of the responses were from states with fewer than 4.5 million individuals. Both the average and median populations for the responding states are about the same as the average and median populations for all 50 U.S. states.

Respondents were asked to report the current number of assets in their DOT fleets separated into three categories: On-Road assets, Off-Road assets, and Other assets. (The term asset is used herein to represent vehicles and other types of equipment that commonly comprise the fleets of state DOTs.) The average number of assets per state in these categories was approximately 3,800, 1,800, and 4,300, respectively, as shown in Table 1. The average total number of assets per state was about 9,700. The minimum and maximum values in Table 1 indicate substantial variation in the numbers of different kinds of assets from one state to another. Figure 1 shows the relationship between the number of On-Road assets compared to 2010 U.S. Census populations for the states that responded to the survey. Generally, the higher the state's population, the more On-Road assets they have.

FLEET COSTS AND EXPENDITURES

This section (1) describes the fleets of the DOTs that responded to the survey in terms of their original costs and replacement values, (2) analyzes the effects of capital expenditures in 2009, 2010, and 2011 on asset replacement, and (3) compares information from DOTs on their preferences and concerns about fleet age, replacement backlogs, and replacement cycles with their recommendations for changes in annual expenditures for new assets.

Respondents were asked to report the original capital costs of the assets in their fleets and to indicate the level of confidence they have in their estimates. Such estimates can be difficult to make, because assets are not acquired all at one time but necessarily over several years. Sixty percent of the DOTs stated that they had ample confidence in their estimates, and most of the rest said they had some confidence. Correlations between estimated original fleet costs and the number of assets in the different types of fleets were reasonably strong, which lends confidence to the estimates reported. All correlation coefficients were greater than 0.7, as shown in Table 2.

Table 2 shows the average original acquisition cost per asset by type (On-Road, Off-Road, Other) of fleet based on data from the DOTs. The estimate for On-Road assets may be slightly more accurate than the others because those cost data do not reflect economies of scale. Cost estimates for Off-Road and Other assets, on the other hand, reflect small economies of scale, which means that the average cost per asset may vary depending on fleet size. The results in this table are considered to be reasonably accurate and consistent with the quality of the survey responses.

Original capital cost estimates are only rough indicators of fleet value because there is no common basis for them, given that assets are acquired over several years. Consequently, respondents were asked to estimate the current replacement costs of their fleets, which should be more accurate indicators of current fleet values; costs are assumed to be in 2011 dollars. Levels of confidence in estimates were requested; 34% of respondents had a lot of confidence, 55% had some confidence, and 11% did not have very much confidence. For the three types of assets (On-Road, Off-Road, Other), the correlation coefficients between the numbers of assets and respondents' estimates of replacement costs were high, all greater than 0.7. This implies that the replacement costs shown in Table 3 are reasonably good indicators of current asset values.

The data in Table 1 on the average number of assets per state and in Table 3 on the average replacement cost per asset provide a basis for estimating the average replacement costs per state of the different types of fleets and the total replacement cost for all of the responding DOTs. The results are shown in Table 4. The estimated total replacement value for all of the DOT fleets that responded to the survey is approximately $13 billion.

Respondents were asked to report the amount spent by their departments on the purchase of fleet assets of each type

TABLE 1
NUMBERS OF ON-ROAD, OFF-ROAD, AND OTHER FLEET ASSETS PER STATE

	On-Road	Off-Road	Other	Total
Minimum	477	120	0	637
Maximum	15,000	15,100	24,024	32,501
Average	3,839	1,761	4,319	9,692
Median	2,706	900	2,109	6,817

(On-Road, Off-Road, Other) in 2011, 2010, and 2009. (It is possible that portions of expenditures were made for additions to the fleet and not just for replacement purchases, but this is not known. The survey did not ask respondents to distinguish between these two types of purchases. Asking about three years of purchases instead of only the last year was designed to determine the variability and trends in annual fleet acquisition expenditures. Nearly 25% of the DOTs did not respond.

If the total expenditure in 2011 for acquiring On-Road assets by all DOTs is divided by the total replacement value of those assets, the result is an indicator of the fraction of total On-Road asset value that was replaced in 2011 for the United States as a whole, which can be expressed as a percentage. The results are shown in Table 5. For all the states that provided usable data, 6% of the value of their On-Road fleets was replaced in 2011; the percentages are a little lower (5% and 4%) for 2009 and 2010, respectively. (Strictly speaking, the percentages for 2009 and 2010 should use the fleet replacement values for those years. By using the fleet replacement values for 2011, because fleet replacement values are unavailable for 2009 and 2010, the percentages in Table 5 may be slightly too low.) The average percentages of asset values replaced for all types of fleets in 2009–2011 ranged from 3% to 6%. In the 3-year period 2009–2011, only three of the 38 DOTs of this study reported that they replaced 10% or more each year of their On-Road fleet value with new assets. The other 35 DOTs either replaced less than 10% each year or did not provide data. Only five of the DOTs reported that they replaced at least 10% each year of their Off-Road fleet value with new assets. More than half the DOTs replaced less than 5% of fleet value each year with new assets.

Table 5 shows estimates of the percentages of fleet values that were spent on asset acquisitions. For simplicity's sake, assume that these expenditures were entirely for replacement assets and not for additions to the fleet. If a fleet is fairly homogeneous and comprised of assets that are not very different from each other, which most likely pertains to On-Road assets more than the other two types of fleet assets, then annual expenditures as a percentage of total asset *value* would be approximately equivalent to annual replacements in terms of *numbers* of assets. Replacing, say, 7% of a fleet's value (or assets) each year on a sustained basis would be equivalent to a replacement cycle of about 15 years. Thus, it would take about 15 years to replace all the assets in a fleet if expenditures each year on acquisitions equal 7% of replacement value. Although the equivalence between value- and number-of-assets arguably applies to On-Road fleets, it may be less applicable to Off-Road and Other asset types because those fleets are probably not homogeneous.

The average percentages of the number of assets in the DOT's fleet replaced each year for different types of fleet assets were estimated from the response data used for Table 6. For each of the three different types of assets, the average rate of asset replacement is the same, 6% per year, which implies an average replacement cycle of about 16 years. The median values are slightly lower than the averages: 5%, 4%, and 3%, respectively, for On-Road, Off-Road, and Other fleet assets. This means that 50% of the DOTs have average asset replacement cycles of more than 20 years.

The respondents were asked how much they think annual fleet asset acquisition expenditures for their DOTs vary from one year to the next. Thirty-seven percent believe the annual

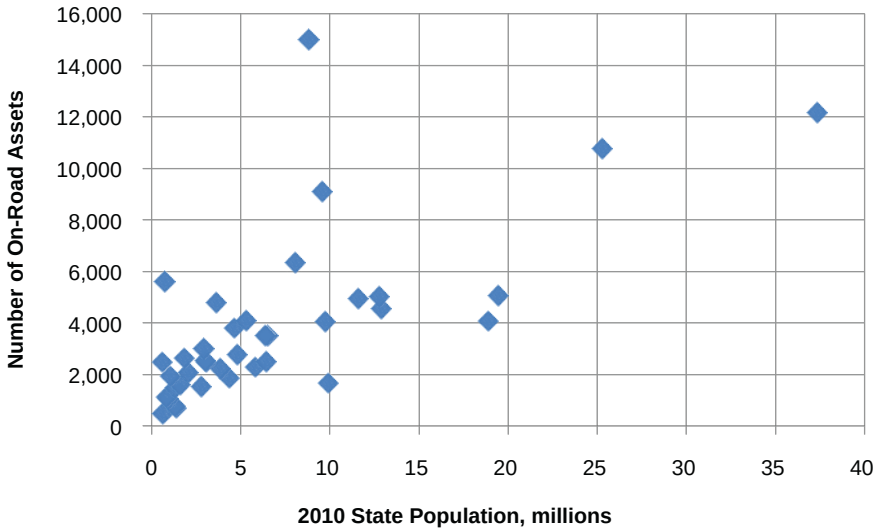

FIGURE 1 Scatter plot of On-Road assets vs. population for the states of this survey.

TABLE 2
ORIGINAL CAPITAL COST ESTIMATES BY TYPE OF FLEET ASSET

Asset Type	Correlation (original fleet cost and no. of assets)	Average Original Cost per Asset, $
On-Road	0.74	35,000
Off-Road	0.77	33,000
Other	0.86	6,000

TABLE 3
CURRENT REPLACEMENT COST ESTIMATES BY TYPE OF FLEET ASSET

Asset Type	Correlation Between Replacement Cost and No. of Assets	Average Replacement Cost per Asset, $
On-Road	0.70	41,100
Off-Road	0.71	38,600
Other	0.84	8,500

TABLE 4
DOT REPLACEMENT COST ESTIMATES BY TYPE OF FLEET ASSET

Asset Type	Average DOT Replacement Cost per State, $M	Total U.S. DOT Fleet Replacement Cost, $B
On-Road	156	7.8
Off-Road	70	3.5
Other	36	1.8
Total	262	13.1

variation is very little, 47% that there is some variation from year to year, and 16% that the variation is large. These opinions were compared with the amounts the respondents gave for the total expenditures on their fleets in 2009, 2010, and 2011.

The coefficient of variation (COV) is a measure of variation in data (e.g., the COV for the numbers 2–3–5 is 0.46 and the COV for 2–3–12 is 0.97. Small COVs indicate small variation). For each DOT, COV was calculated for the annual expenditures in the three-year period 2009–2011 for the three types of fleet assets. The coefficients were then collected into three groups according to whether respondents think the variation is "A Little," "A Lot," or "Somewhat." The COVs were then averaged for each group. Larger coefficient values indicate more variation in data. Table 6 shows that those departments whose fleet managers think the variation is "A Lot" had the highest COV in annual expenditures on acquisitions during this period. However, there was less variation for those whose opinion is "Somewhat" than for those whose opinion is "A Little." Thus, some respondents' opinions are not supported by the expenditure data they actually provided.

The respondents were asked how much in dollars should be spent on fleet acquisitions annually. The average expenditure in 2011 for all assets was $18.5 million per DOT; however, respondents as a group said it should be increased to an average of $25.7 million, an increase of about 40%. Not all DOTs, however, said that expenditures on new acquisitions needed to be increased. As shown in Table 7, 17% of the DOTs gave amounts indicating that annual expenditures on new assets should be reduced. Twenty percent of the DOTs indicated that annual expenditures on new assets should be increased from 0% to 20%, 23% of DOTs favored expenditure increases on new assets from 20% to 50%, 26% of DOTs favored expenditure increases in the range from 50% to 100%, and 14% of DOTs favored increases for new assets of more than 100% per year.

Respondents were then asked about the current size of backlogs in their fleets (in $millions) that need replacing,

TABLE 5
ASSET ACQUISITION EXPENDITURES IN 2009–2011 AS A PERCENTAGE OF 2011 FLEET VALUES FOR ALL RESPONDING DOTs

Asset Type	2011	2010	2009
On-Road Assets	6	4	5
Off-Road Assets	5	4	5
Other Assets	5	3	4

TABLE 6
THREE-YEAR COEFFICIENTS OF VARIATION (COV) VS. OPINIONS ABOUT HOW MUCH DOT ACQUISITION EXPENDITURES CHANGE EACH YEAR

Respondent's Opinion:	A Little	A Lot	Somewhat
Average COV	0.34	0.82	0.26

TABLE 7
RECOMMENDED INCREASES IN ANNUAL EXPENDITURES FOR NEW ACQUISITIONS

Recommended Percentage Increase in Annual Expenditures	<0	0–20	20–50	50–100	>100
Percentage of DOTs wanting recommended increase	17	20	23	26	14

TABLE 8
BACKLOGS IN CURRENT FLEET ASSETS NEEDING REPLACING

Percentage of Current Assets Backlogged	0–10	10–20	20–30	30–50	>50
Percentage of DOTs with indicated backlogs	31	28	21	10	10

where backlog means today's cost of replacing those assets that are believed to be due or overdue for replacement. Twenty percent of the respondents either gave no information or erroneous data. For the useable responses, the average estimated backlog per DOT is $70 million, which implies that approximately 20% on average of all fleet assets currently need to be replaced (the average replacement value of a DOT fleet is $360 million). Table 8 shows that 31% of the DOTs indicated that from 0% to 10% of their fleet assets currently need to be replaced, 10% to 20% of all assets need to be replaced in 28% of the DOTs, 20% to 30% of all assets need replacing in 21% of the DOTs, 30% to 50% of fleet assets need replacing in 10% of the DOTs, and more than 50% of assets need replacing in 10% of the DOTs.

Approximately 40% of the DOTs (see the three right-hand columns of Table 8) reported that at least 20% of their total assets need replacing. These replacement backlog sizes were compared with respondents' recommendations for increases in annual capital expenditures for their fleets. The correlation coefficient relating backlog sizes with desired increases in expenditures is –0.1, which means that the recommendations by the respondents for increases in expenditures have no association with their opinions about the sizes of their current backlogs.

Respondents were asked to report the average age of assets in their fleets. Their answers are plotted in Figure 2 against the fraction (percent/100) of assets the respondents said need replacing. For example, two DOTs reported that the average age of their fleets was about 7 years, and indicated that about 10% to 12% of their assets need to be replaced. Older fleets with higher age would be expected to need a larger fraction of their assets replaced. That is, the data in Figure 2 would be expected to show an upward trend to the right for older fleets. However, the chart shows no such association; in fact there is no trend between fleet age and the fraction of assets that DOTs said need replacing. This implies a general difficulty in relating the notion of fleet age to needs for asset replacement.

REPLACEMENT MANAGEMENT PRACTICES

This section (1) identifies the primary and secondary decision support tools that DOTs use for managing fleet asset replacements and how they are used; (2) reports DOT opinions on how effective they believe their tools are for securing sufficient funds to replace their assets in a timely manner; and (3) presents information from DOTs on the perceived strengths and weaknesses of these tools. In addition, this section summarizes the findings of the survey regarding the use by DOTs

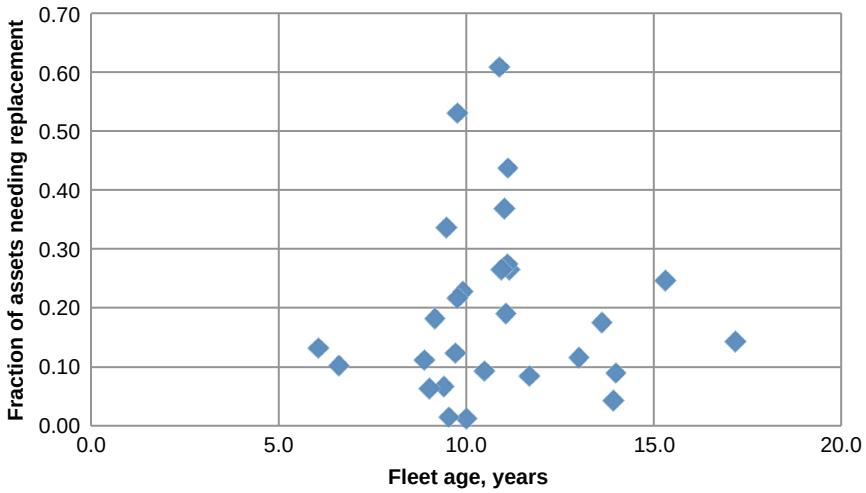

FIGURE 2 Fraction of DOT assets needing replacement vs. fleet age.

TABLE 9
METHODS USED FOR SECURING REPLACEMENT APPROVALS AND FUNDS

Method	Description
A	Replacement cycle policies or guidelines for specific types of assets based on formal analysis of the life-cycle costs of those assets in your fleet
B	Replacement cycle policies or guidelines for specific types of assets based on subjective judgment, professional experience, past practice, industry rules of thumb, etc.
C	Multiyear fleet replacement plans showing future replacement dates and costs by asset and for the fleet as a whole
D	Replacement eligibility lists or reports identifying specific assets that meet or exceed predefined criteria (e.g., age, mileage, LTD maintenance and repair costs) for replacement
E	A methodology for prioritizing specific assets for replacement in the next budget year when total fleet replacement spending requirements are expected to exceed available replacement funds
F	A repair versus replace policy or decision-making tool that is applied to specific assets requiring expensive repairs to remain operational

of audit, consulting, and other reports aimed at improving fleet management practices.

Respondents were asked to check all the methods (i.e., decision support tools) listed in Table 9 used by their DOTs for making fleet replacement decisions. They were then asked to indicate which were the most important and the second most important methods. For the most important method, they were asked how often it is used. Then they were asked what positive impacts all the methods they use have on securing the approvals and funds needed to replace their fleet assets in a timely manner, and what is the single most important deficiency of their methods. For ease of reference, the methods are labeled A through F.

Table 10 shows the first and second most important methods used by the respondents for making replacement decisions. First consider the row totals, which show that each of the six methods is considered by at least one DOT to be "the most important method." Similarly, the column totals show that each of the six methods is considered by at least three DOTs to be the "second most important method." The row totals of Table 10 show wide differences among the DOTs regarding which method they think is "most important." The column totals show similar disagreement about what is the second most important method for replacing assets. Although Method D (use of age, mileage, and similar criteria) is used by more DOTs for guiding replacement decisions than any other method, fewer than half the DOTs use it, and there is no unanimity about which method is most effective.

The diversity in using so many different methods has a downside. It makes it essentially impossible to determine their relative effectiveness; that is, impossible to assess which methods work most effectively for deciding how to replace assets. The fraction of fleet value replaced in 2011 by the 38 DOTs was regressed against the number of DOTs using each of the six most important methods so as to determine which methods were statistically significant. None was found to play a significant role in replacing fleet value. It is expected that this same result would have

TABLE 10
FIRST AND SECOND MOST IMPORTANT METHODS FOR MAKING ASSET REPLACEMENT DECISIONS

Most Important	Second Most Important						Total
	A	B	C	D	E	F	
A—Replacement cycle policies based on analysis of asset life-cycle costs		1	1	2	1		5
B—Replacement cycle guidelines based on past practice, judgment, thumb rules	1		1	4	2	1	9
C—Multiyear replacement plans	1			1			2
D—Decision criteria-based (e.g., age, mileage) replacement eligibility lists	2	6		1	5	3	17
E—Prioritized replacement lists if aggregate replacement costs exceed expected available funds	1		1	2			4
F—Repair vs. replace, especially if repair expensive					1		1
Total	5	7	3	10	9	4	38

Table entries are the number of respondents that use the row and column methods as their "most important" and "second most important" methods for obtaining fleet replacement funds.

been obtained even if all 50 DOTs had responded to the questionnaire. Only if a few methods had been used by the respondents for guiding replacement decisions might it be possible to say with any confidence which ones are the most effective for deciding how to replace assets.

Although regression analysis was unable to indicate the "best" methods for making decisions about replacing assets, the DOTs provided opinions about which ones they believe are most effective. Approximately 25% of the DOTs reported that they use their most important method all the time, and about 70% noted that they use it most of the time. Nearly half of the DOTs (46%) reported that all the methods they use are essential; without them their fleets would be significantly older. Most of the rest (49%) noted that their methods are somewhat helpful but only provide moderate confidence that their DOTs will be successful in obtaining replacement funds.

About half of the respondents (55%) answered question 22 (Q22) about why their decision support tools are not more effective; 30% stated that the timely replacement of fleet assets is not a high priority of their governor, state budget office, and/or legislature. Fourteen percent reported that replacement decision making is decentralized and beyond the control of their office, and 2% that they have a revolving fund and do not need additional funding. A variety of reasons was given by the remaining DOTs for why their methods are not more effective, including: (1) top decision makers in DOTs do not believe in using decision support tools; (2) their offices cannot produce convincing reports on replacement needs because they lack the resources to do so; (3) timely replacement of fleet assets is not a high priority in their department; and (4) the peculiarities of funding replacements make it difficult to use decision support systems.

Respondents were asked a series of questions about formal studies that have been made of their fleet replacement practices. Q24 asked: Has your DOT commissioned or been the subject of any formal studies of its fleet replacement practices in the last 10 years, and Q25 and Q26 asked who conducted the studies. Q27 asked if study reports are available to the public, and Q28 requested their descriptions. Q29 asked: How would you describe the positive impact of formal studies on the timeliness with which the DOT replaces its fleet assets?

Nearly 60% of the respondents stated that no formal studies had been made in the past ten years. Among those that undertook studies, 70% conducted a single study during the past 10 years, 25% two studies, and 5% three studies. Half of the studies were made by consulting firms, one-quarter by academic or research institutions, and the remaining one-quarter either by the state auditor's office or an auditor within the DOT.

Because only 40% of the DOTs reported that they had such "outside" studies in the past ten years, 60% of the DOTs that participated in the study obtained no information from outsiders that could help them benchmark their replacement practices and learn from their peers. Nearly 70% of the states that had had studies noted that their positive impacts on the timeliness of fleet replacements were either high or moderate; only 30% said the impact was low. Half the states that had studies knew that the reports were available to the public, the others were either unsure or said they were unavailable.

REPLACEMENT FINANCING METHODS

This section describes: (1) the process and methods DOTs use for financing the purchasing of fleet assets; (2) the sources of funds for replacements; (3) how well the DOTs say they understand the financing process; (4) the opinions of survey respondents about the effectiveness of their financing methods; and (5) the opinions of respondents about preferences for changes and improvements in the finance methods they use. Most survey responses are reported as the fraction or percentage of the 38 DOTs that participated in the study. The same response that was made by, say, 50% of the DOTs implies that 19 DOTs gave the same answer to the survey question.

Respondents were asked (Q30) to identify the state agencies where final decision making takes place for the funds allocated for asset replacements. Two-thirds reported that the agency was a central fleet management organization or some other unit within the DOT. Eighteen percent mentioned it was an executive branch agency such as the state budget office or the governor's office, 13% that it was the state legislature, and 3% that it was a district or division office of the DOT.

A follow-up question (Q32) asked: How would you rate the overall effectiveness of fleet replacement decision making as it relates to the DOT's fleet? The responses are in Table 11, which shows that 84% of the DOTs say decision making about funding effectiveness is either entirely or somewhat satisfactory; and only 16% say it is unsatisfactory. Two different types of agencies are correlated with the unsatisfactory opinions: a unit within the DOT other than the central fleet management organization and an agency in the executive branch of state government. DOT satisfaction with funding effectiveness decisions far outweighed dissatisfaction.

The DOTs were then asked (Q33) How do you think the effectiveness of the DOT's fleet replacement practices compares with that of other major fleet-using departments in your state? The responses, which are related to the type of agency responsible for DOT fleet funding decisions, are shown in Table 12; table entries are the percentage of DOTs responding to the question. The bottom row of this table shows that 58% of the respondents (more than half) believe that DOTs fare better with fleet funding than other state departments; approximately 30% of the respondents believe that DOTs fare about the same or worse. Thus, "Better" outweighs "Same or Worse" 2 to 1.

TABLE 11
SATISFACTION WITH THE EFFECTIVENESS OF DECISION MAKING ABOUT FLEET REPLACEMENT FUNDING

Degree of Satisfaction	A Central Fleet Management Organization Within the DOT	Another Unit Within the DOT or Commission Governing the DOT	Individual DOT Districts or Divisions	An Executive Branch Agency (state budget office, governor's office)	The Legislature	Total
Entirely Satisfactory	13	3			3	18
Somewhat Satisfactory	18	24	3	11	11	66
Not Satisfactory		8		8		16
Total	31	35	3	19	14	100

Table entries are percentage of DOTs.

The first row of Table 12 suggests that when funding decisions are made by central fleet management organizations within a DOT, DOTs fare at least as well as other units of state government that require fleet funding. The same is true when the decision agency for funding is the legislature. The data show that when funding decisions are in the hands of individual DOT districts or divisions, the respondents believe they are always better served than other state departments; however, the caveat is that the percentage of DOTs having such end-user organizations in charge of replacement funding decisions is small; therefore, this result is inconclusive. The second and fourth rows of data in the table present mixed results: the data suggest that when an organizational unit within the DOT or a commission governing the DOT *other than* a central DOT fleet management organization handles funding decisions, some DOTs fare better than other state departments and others worse; the same applies when funding is handled by the state budget office or a similar unit in the executive branch.

When asked which of four different methods was the *primary* one used for financing replacements (Q35), approximately 75% of the DOTs said outright purchase using money obtained through the annual budget process, 20% outright purchase using money from a revolving or similar fund, and 5% using borrowed funds. None of the DOTs reported that leasing is the primary method for replacing assets. The data show no association between the primary financing method used and the fraction of fleet value that was replaced in 2011 as a result of using it.

The respondents were asked (Q37): Who manages the primary method used to finance the capital costs of DOT fleet assets? The results are in Table 13, which shows that a central fleet management organization within the DOT is by far the most common arrangement. Some other organizational unit within the DOT is a distant second. This implies that DOT fleet managers generally have a great deal of influence over the fleet replacement financing methods used by their departments.

DOTs were asked (Q40) to identify the sources of funds used by the primary method to replace fleet assets; their responses are summarized in Table 14. Approximately 60% of the DOTs receive their funds from the central DOT fleet management organization, 18% receive funds from both a central DOT organization and individual user organizations (which typically signifies the use of a cost charge-back system), and 13% receive

TABLE 12
COMPARISON OF DOT's SUCCESS IN FLEET FUNDING WITH THE SUCCESS OF OTHER FLEET-USING DEPARTMENTS DEPENDING ON THE UNIT THAT MAKES FUNDING DECISIONS

Deciding Unit	Worse	About the Same	Better	Don't Know	Total %
A central fleet management organization within the DOT		11	21		32
Another unit within the DOT or a commission governing the DOT	5	8	16	5	34
Individual DOT districts or divisions			3		3
Another executive branch agency (e.g., the budget office, the governor's office)	3	4	8	3	18
Legislature		3	10		13
Total %	8	26	58	8	100

Table entries are percentage of DOTs.

TABLE 13
ORGANIZATIONS THAT MANAGE THE PRIMARY METHOD USED TO FINANCE DOT FLEET REPLACEMENTS

Type of Organization	% of DOTs
A central fleet management organization within the DOT	63
Another organizational unit within the DOT or a commission governing the DOT	21
Individual DOT districts or divisions	3
Other	5
A fleet management organization in a state agency other than the DOT	8
Total	100

TABLE 14
SOURCES OF FUNDS FOR REPLACING FLEET ASSETS USING PRIMARY FINANCING METHOD

Sources of Funds	% of DOTs
Budget of the central DOT fleet management organization	61
Budgets of both a central DOT fleet organization and individual fleet user organizations	18
Budgets of individual fleet user organizations within DOT	13
Budget of another organizational unit within DOT	8
Total	100

their funds from individual fleet user organizations within the DOT. Eighty-four percent of the DOTs reported that budgets for fleet asset acquisition have their own distinct accounting code(s); 11% that the funds are from a budget that combines fleet and non-fleet capital asset costs in a single line item or accounting code; and 3% that the funds are from a budget that combines fleet capital, operating, and maintenance costs.

Respondents were asked a series of questions about levels of understanding of the budgeting and financing process for replacing fleet assets and how well these processes work. Table 15 shows that 90% of both DOT directors (including their key employees) and the organizations that use fleet assets understand the finance process either completely or reasonably well.

When asked how effective they believe the primary method used to finance the capital costs of fleet assets is in promoting the timely replacement of those assets (Q47), 26% of the DOTs said "Very Effective," 61% "Somewhat Effective," 11% "Ineffective," and 3% did not know, as shown in Table 16. The vast majority of respondents reporting "Very Effective" use revolving funds as the primary financing method; no respondent mentioned that revolving funds are "Ineffective." Financing using funds secured through an annual budget process were judged to be more than twice as ineffective as borrowed funds, which were the only two financing methods viewed as "Ineffective" by any of the survey respondents. The vast majority of DOTs that use annual budgets as the primary method stated that it is "Somewhat Effective." When respondents were asked to explain why their primary methods are ineffective, no explanations were given.

TABLE 15
UNDERSTANDING OF THE FINANCING METHOD USED FOR REPLACING FLEET ASSETS BY . . .

Degree of Understanding	You and Your Employees	Users of Fleet Assets
Completely	50	50
Reasonably Well	40	40
Not Well	10	10
Total	100	100

Table entries are percent of DOTs.

When asked how effective the primary financing methods are in promoting understanding of asset costs (e.g., trade-offs between capital and operating costs), and opportunities to optimize these costs (e.g., by reducing fixed fleet costs through proactive fleet utilization management and rightsizing) (Q49), there was more uncertainty in the answers than for Q47, and a slightly higher percentage that said "Ineffective," as shown in Table 17. Again, revolving funds were judged to be most effective with this question, and annual budgets were the least effective. The five DOTs that reported that their primary method is "Ineffective" in promoting understanding provided the following explanations for their answers:

- The financing method we use is new to the DOT and we are just starting to learn how to use it effectively. Lots of details remain to be clarified.
- The highly defined separation of capital budget funds in the appropriation process makes it easy to target them for cuts. Decision makers don't realize that those cuts result in higher operational costs.

TABLE 16
OPINIONS ABOUT EFFECTIVENESS OF THE PRIMARY METHOD USED TO FINANCE THE CAPITAL COSTS OF FLEET ASSETS IN PROMOTING TIMELY ASSET REPLACEMENT

	Annual Budget	Revolving Fund	Borrowed Funds	Total
Very Effective	5	18	3	26
Somewhat Effective	58	3	0	61
Ineffective	8	0	3	11
Don't Know/Not Sure	3	0	0	3
Total	74	21	5	100

Table entries are percent of DOTs.

- There is the mistaken belief that once assets have been purchased, it no longer costs anything to operate and maintain them.
- With centralized management and purchasing, the user districts have no incentive to minimize overall fleet size; the current method encourages "hoarding." A revolving fund or (internal) service fund would create incentives to minimize overall fleet size.
- Programs are not budgeted for fleet acquisition or maintenance so there is little incentive to promoting efficiency within the program. Fleet pays for all of fleet operations; e.g., fuel, tolls, accident damage, etc.

The DOTs were asked (Q51) to indicate whether they use a secondary method in addition to the primary method for financing acquisitions of new assets; the results are provided in Table 18. As shown in the bottom row, 79% of the DOTs do not use a secondary method. Six different secondary methods are used by the other DOTs, which are identified in the titles of the second row of the table. As shown in the bottom row, each of the six secondary methods is used by only one or two DOTs (i.e., by 3% or 5% of the DOTs). The DOTs using them indicated that between 0% and 50% of new assets were acquired with funds using the secondary methods; however, the differences were large. The median percentage of new assets in individual DOT fleets acquired using secondary methods was only 2%.

The eight DOTs using revolving funds as the primary financing method were asked to indicate the sources of those funds. In all cases, the source was a system of charge-back rates intended to recover both capital and operating costs. These DOTs answered additional questions, including: Q56—Are monies in the revolving fund kept in separate accounts for replacement and operating costs?; Q57—Are charge-back rates sufficient to cover costs?; Q59—What year were charge-back rates last updated?; Q60—Is there a documented methodology for calculating charge-back rates?; Q61—Do you understand the methodology used to calculate charge-back rates?; Q62—Are those methods sound?; Q65—What was the approximate unrestricted balance in the revolving fund at the end of FY 2011?; Q66—How often have monies in the revolving fund *not* been used for the fund's purposes. The responses are in Table 19.

Consider Q56: four DOTs said "Yes," monies for capital and operating costs are kept in separate accounts, and the other four DOTs said "No," the monies are pooled. The other responses can be similarly interpreted; for example, most DOTs reported that revenues cover costs; all DOTs had updated their rates within the past two years; all DOTs have methods for setting charge-back rates, they understand them, and they work; revolving fund balances at the end of 2011 ranged from $0 to $30 million, with an average of $11 million and a median of $6 million; these funds are almost never used for other purposes.

The two DOTs whose states use *borrowed funds* as the primary financing method for replacements answered several

TABLE 17
OPINIONS ABOUT EFFECTIVENESS OF THE PRIMARY METHOD USED TO FINANCE THE CAPITAL COSTS OF FLEET ASSETS IN PROMOTING UNDERSTANDING OF ASSET COSTS AND OPPORTUNITIES TO OPTIMIZE THEM

	Annual Budget	Revolving Fund	Borrowed Funds	Total
Very Effective	5	13		18
Somewhat Effective	47	5	5	58
Ineffective	11	3		13
Don't Know/Not Sure	11			11
Total	74	21	5	100

Table entries are percent of DOTs.

TABLE 18
PRIMARY AND SECONDARY METHODS USED TO FINANCE ASSET ACQUISITIONS

Primary Method	Secondary Method							
	None	Annual Budget	Revolving Fund	Borrowed Funds	Leasing	Vendor Buy-back	Surplus Asset Sales	Total %
Borrowed Funds	3		3					5
Revolving Fund	18	3						21
Annual Budget	58		3	3	5	3	3	74
Total %	79	3	5	3	5	3	3	100

Table entries are percent of DOTs.

questions about these funds, including: Q67—What is the primary method of borrowing?; Q69—How often have statutory limits (caps) on the amount of debt restricted the DOT's ability to replace assets in a timely manner?; Q70—Is there bureaucratic, political, or other opposition to using debt (borrowed funds) to finance the acquisition of fleet assets for the DOT?; Q71—Has opposition to using debt financing (borrowed funds) restricted the ability of the DOT to replace fleet assets in a timely manner?; Q72—Are the costs of servicing the debt (principal and interest) passed on to users through a charge-back system?; Q73—Are these costs charged separately or are they recovered in the charge-back rates that combine fleet asset capital and operating costs (in which case, debt service costs would be included in some fashion in the rates). The responses are in Table 20.

Respondents were asked several questions about their satisfaction with the primary methods their DOTs use for financing the acquisition of fleet assets and the changes they would like to see. The responses to Q81 that asked: How satisfied are you with the ability of your state's primary financing method to ensure the timely replacement of fleet assets? are shown in Table 21. Note that half of the DOTs that use revolving funds are "Completely Satisfied," and the remainder is "Fairly Satisfied." No other financing method performs this well. Although 13% of all DOTs reported that they are "Completely Satisfied" with their annual budget method, this figure represented less than one DOT out of five that use the method. All DOTs that use borrowing are only "Fairly Satisfied." Thus, use of annual budgeting for funding new assets, which has the most users by far, has a mixed record of user satisfaction.

The following list includes improvements that survey respondents reported they would like to see in the annual budget method of financing asset acquisitions:

- Continued increased funding as needed along with a renewed commitment to preventive maintenance.
- Limited funding means limited equipment to be replaced, thereby increasing the repair costs of equipment that is beyond its useful life.
- When assets are surplused, no money is returned to the fleet budget; I believe the money should return to the fleet budget.
- (1) Revision of the fleet replacement methodology; (2) Leasing part of the fleet, if not all; (3) An internal revolving fund dedicated to the fleet replacement that collects rental fees from the users for renewal of the fleet; (4) Auction proceeds to be dedicated to the replacement of the fleet; and (5) A national fleet management system.
- More funding.

TABLE 19
RESPONSES TO Q56–Q66 FROM EIGHT DOTs USING REVOLVING FUNDS WITH CHARGE-BACK RATES AS PRIMARY ASSET ACQUISITION FINANCING METHOD

Question	Response 1	Count 1	Response 2	Count 2
Q56—Separate accounts?	Yes	4	No	4
Q57—Rates cover costs?	Yes	6	No	2
Q59—When last updated?	2011	3	2012	5
Q60—Methodology for setting rates?	Yes	8	No	0
Q61—Understand the methodology?	Yes, completely	7	Yes, mostly	1
Q62—Methodology OK?	Yes, completely	7	Yes, mostly	1
Q65—Fund balance end 2011?	$6 million	Median	$11 million	Average
Q66—Use fund for other purposes?	Never	3	Seldom	4

TABLE 20
RESPONSES TO Q67–73 FROM DOTs USING *BORROWING* AS PRIMARY ASSET ACQUISITION FINANCING METHOD

Question	Response 1	Count 1	Response 2	Count 2
67—Primary method?	Loans from banks	2	—	—
69—Caps restrictive?	Frequently	1	Seldom	1
70—Is there opposition?	Yes	1	No	1
71—Does the opposition work?	Yes	1	No	1
72—Debt service cost incl. rates?	Yes	2	—	—
73—How is debt service recovered?	Charge back rates combine capital & operating costs	2	—	—

- Would like to see funds budgeted for vehicles/equipment used solely for that purpose and not have funds redirected to other projects. We can't continue to build without having proper maintenance (not having adequate vehicles and equipment prolongs proper maintenance of state highways).
- A revolving fund/service fund in lieu of appropriation would be better.
- A more level funding stream that allowed replacement of the fleet on 8- to 10-year cycle would be ideal.
- There is no indexing to inflation or rising equipment/vehicles costs. The amount of money is fixed.
- Perhaps a two-tier rental rate/charge-back system whereby there would be a flat rate and mileage rate.
- The current method requires that the equipment fund be spent down to zero each biennium and no purchases can be made again until after the allotments are loaded and distributed downwards. Given the ability to roll over funds in an internal service fund would eliminate the need for frantic purchasing at the end of budget cycles and allow the agency to purchase vehicles as needed as opposed to when funds are available.
- Need to increase our funding.
- Adequate appropriations for replacement based on need shown in the data.
- The state should look at some form of low interest capital loans to stretch our capital outlay dollars over time and increase our buying power.
- Funding or cash distributions from DOB need to be timely with defined allocations. Restrictions on leasing; lease purchase and alternative procurement options need to be made available to maximize efficient and effective procurement.
- Buy back and seasonal rental options. Financing acquisition costs and fuels hedging.
- A higher level of funding. We have yet to be funded at an optimum level meeting or exceeding our actual need. Like many other DOTs we direct the funding to support our primary mission while allowing other equipment to age.
- Implement a vehicle and equipment replacement revolving fund that encourages units to possess only the equipment they need; to use the equipment they have; to use shared pools; to take better care of the equipment; and to replace vehicles and equipment on a regular schedule. Model after Alabama DOT's program.
- Requests from the legislative budget body for operational cost analysis of the fleet assets for every budget period. This would document in the legislative budget process the lack of pro-active cost avoidance measures through reduced repair expense.
- More funding is needed to replace older equipment.
- It would be nice to have a "depreciation" account so there are always funds to replace equipment. Also, we would like to see funds collected from online equipment sales go in this type of account and monies collected from insurance.

Respondents made suggestions for changes they would like to see in the revolving fund method of financing asset acquisitions: "Our DOT's ability to accept new equipment is constrained by its ability to make depreciation payments. Thus, operating constraints are limiting capital investments." "We need a more aggressive replacement schedule." "The charge-back structure should be changed to include all capital costs, not just the depreciation component, and it should provide for carry-over of unspent funds."

TABLE 21
SATISFACTION WITH THE ABILITY OF THE PRIMARY ASSET ACQUISITION FINANCING METHOD TO ENSURE THE TIMELY REPLACEMENT OF FLEET ASSETS

	Completely Satisfied	Fairly Satisfied	Dissatisfied	Total %
Annual Budget	13	55	5	74
Revolving Fund	11	11	0	21
Borrowed Funds	0	5	0	5
Total %	24	71	5	100

Table entries are percent of DOTs.

TABLE 22
PREFERENCES FOR USING A DIFFERENT PRIMARY METHOD FOR FUNDING REPLACEMENT ASSETS

	Preferred New Method						
Present Method	No Change	Leasing	Borrowed Funds	Annual Budget	Special Fund for Acquisitions	Revolving Fund	Total %
Borrowed Funds	0	0	0	3	3	0	7
Revolving Fund	14	0	0	0	0	0	14
Annual Budget	34	7	3	0	28	7	79
Total %	48	7	3	3	31	7	100

Table entries are percent of DOTs.

Respondents were asked in Q84: If you could choose any method for financing the capital costs of the assets in the DOT's fleet other than the primary method used today, which method would you choose? The responses are in Table 22, where table entries indicate the percentage of DOTs that favor the *preferred new method.* About half of the DOTs do not want change. All of the DOTs presently using revolving funds prefer to keep them. Fewer than half of the DOTs presently using annual budgets, however, want to keep them. Some want to switch to leasing, borrowing, or a revolving fund, but the majority that wants to switch prefers a new "special fund" whose monies are dedicated solely to acquisition of new assets.

Respondents were asked in Q86 a follow-up question: Please explain why you feel that the alternative financing method you identified in Table 22 would be better than the method currently used. The responses for DOTs that presently use annual budgets as the primary method for funding are described here.

- With a special fund dedicated to acquisition of new assets, funds earmarked for replacing assets will not be used for other types of expenditures.
- Leasing could be used as another method for fleet replacement. Some items are costly to purchase and maintain. Leasing would allow the budget to replace more units without a full initial buy-in.
- Debt financing appears to be the most promising alternative for our DOT. This of course is predicated on our DOT's ability to incur long-term debt. Present state fleet policies provide for long-term payment plans that include interest; therefore, we assume that the legislation and policies are in place to allow this type of financing. Like a revolving fund, debt financing allows organizations to spread the capital costs of fleet replacement purchases over the service lives of the vehicles in the fleet. Debt financing is similar to a reserve fund in that it eliminates most of the year-to-year volatility in replacement funding requirements. Rather than accumulating cash in a reserve fund to pay for replacement purchases, this approach involves borrowing money from the capital markets and repaying it after vehicles have been placed in service. Pay as you go, instead of pay before you go.
- A special fund would enable DOTs to have funds just for equipment.
- With a special fund we would probably not lose any funding, and vehicle and equipment purchases would be better catered to the end users.
- Not only would a special fund create incentives amongst users to minimize assets, but purchasing and operational funding can be combined in order to make more timely decisions. Our current (annual budget) method of funding has separate unique budgets for acquisition and operating. A unit that should be replaced due to a major repair is often repaired instead of sold.
- Annual budgets are unstable.
- The fleet in essence would be self-funded if a revolving fund were used.
- The current (annual budget) method requires the equipment fund to be spent down to zero each biennium, and no purchases can be made again until after the allotments are loaded and distributed downwards. The ability to roll over funds in an internal service fund would eliminate the need for frantic purchasing at the end of budget cycle and allow the agency to purchase vehicles as needed as opposed to as funds are available.
- Possession rates are currently charged for the use of the units and include acquisition and depreciation. The amount charged should be placed in a revolving fund to be used only for fleet-specific purposes.
- I believe that, depending on the equipment class, some units should be purchased outright and others could be financed. Leasing and rental may also be used to offset skyrocketing replacement prices.
- Operating as an internal/external service organization with programs paying for the services utilized would generate greater efficiencies in utilization, operating costs, and fleet replacement alternatives.
- A special fund dedicated to acquiring new assets could be a combination of "leasing" and "outright purchase."
- A revolving fund would include an internal charge-back system to provide a steady revenue stream.
- A dedicated revolving fund similar to Alabama DOT's has a proven track record.
- A good portion of our light fleet is used in an application that would be well suited to the use of leasing (construction inspector vehicles).

The survey ended with a series of questions about different topics. Q87 asked: In addition to the financing methods already discussed, does your DOT use any other acquisition methods such as short-term rental of seasonal equipment? and Q88 asked for their descriptions. Q89 asked how often the respondent's DOT buys used instead of new assets in order to stretch budgets, and Q90 asked for examples. Q91 asked if manufacturers' guaranteed buy-back programs were used in order to save money and/or improve the predictability of asset acquisition costs, and Q92 asked for examples. The questionnaire ended with an invitation for respondents to provide any other information they think would be helpful to DOT fleet managers.

Sixty-three percent of the DOTs said their departments use additional finance methods, mainly to supplement the primary and secondary methods, which are described here. The most common methods include short-term rentals, leases, and buy-back arrangements. In most cases, the items that are the subject of these arrangements are specialty equipment or items for special purposes.

- Our DOT uses short-term rentals on federal projects instead of owned vehicles. This allows full rental fees to be covered by the project.
- Short-term (daily, weekly, and monthly) equipment rentals are used for unique and project-specific equipment; e.g., backhoes, crack sealing machines, water trucks, mowing equipment, etc.
- We do not have sufficient funding to replace all vehicles that are beyond their economic life. Thus, we lease vehicles when needed.
- We use short-term rental for items that are not needed on a regular basis. This allows for funding from projects and other sources rather than from the fleet replacement budget.
- We sometimes use short-term rentals.
- Sometimes we rent equipment that we need only for short durations.
- We rent some equipment when the need arrives, such as excavators, additional trucks, etc. None of our rentals are for seasonal equipment.
- We lease agricultural tractors used for mowing.
- We use rental agreements for low utilization pieces of equipment. We also use a buy-back program.
- We rent specialty equipment such as loader backhoes, excavators, etc.
- We sometimes rent equipment as needed.
- We have an agreement to lease tractor mowers and tractor loaders from the major manufactures at an extremely favorable rate.
- We lease tractors for our mowing season, thus reducing the number of tractors that are purchased.
- We use rental equipment for items that are desperately needed but for which funding to purchase has not been secured. We rent units that are "under-utilized" and not worth purchasing/maintaining.
- The state is issuing its first statewide price agreement for heavy duty equipment rentals in 2012.
- We use short-term rental of vehicles and equipment to augment seasonal needs like sweepers, excavators, milling machines, etc.
- Short-term statewide rental equipment is handled on a regional basis
- We rent high-cost specialty equipment that has limited use.
- We use short-term rentals to supplement equipment needs instead of purchasing when necessary.
- We lease mower tractors and equipment needed for one-time jobs.
- We use a construction equipment rental contract for equipment that is only used for a few weeks or months.
- We have annual leases of farm tractors and backhoes, and we use a one-year buy-back program on wheel loaders and skid steers; three-year rental on motor graders.
- We have developed short-term contracts to cover most of the incidental seasonal and intermittent needs.
- Guaranteed buy-back works very well: three-quarters of our loaders are now buy-backs, with three-year full warranty. The cost of ownership is low.

Only about 30% of the DOTs noted that they occasionally buy used instead of new assets (Q89), the remaining rarely or never buy used assets. Examples of buying used equipment are listed here.

- Various heavy equipment items; often show models with low hours.
- Semi-tractors and federal surplus items.
- Under-bridge inspection units and construction equipment.
- Light duty items for maintenance and construction as well as construction type equipment for maintenance purposes.
- Dozers from GSA, milling machine, heavy trucks.
- Tankers and tractors.
- Demo excavators, sign and electrical bucket trucks. End users get to select optional equipment on a used piece versus the DOT ordering custom, expensive equipment.
- Water trucks, rollers for full-depth reclamation, 80T crane.
- Motor graders, motorized rollers.
- Construction equipment and trailers mostly.
- Mainly heavy equipment.

Twenty-four percent of respondents reported they use buy-back programs. Examples of equipment acquired through buy-back programs are cited here.

- Loaders, graders, backhoes, dozers, rollers. . . . The benefits include (1) a contractual known cost of maintenance, and (2) guaranteed re-purchase prices, thereby allowing for more accurate future budget projections. If this method is 100% implemented for, say, loaders, it ensures that the age of loaders in the fleet will be no

greater than that specified in the terms of the buy-back contract (e.g., 7 years/6,000 hours).
- Loaders and graders.
- Tractor trucks, backhoes, 3 & 4 CY loaders, motor graders.
- Highway sweepers are acquired under a guaranteed buy-back program.
- Wheel loaders, motor graders, dozers, backhoes. We will be trying out a transport tractor purchased with a buy-back contract this year.

A few final respondent comments by the DOTs are provided here.

- Buy-back programs are not always the most economical if you consider the time value of money. Without a dedicated equipment fund that is funded by capital cost recovery usage fees, fleet funding has to compete with road and bridge maintenance, construction, engineering, multimodal, and administration funding. Multimodal is generally funded via dedicated funding sources. The others are seen as mission critical. Fleet and facility replacement would generally have a low priority when compared to everything else. Recovering from a large backlog is do-able, but expensive. We get into these situations because we become cash poor and cannot afford large expenditures to purchase many assets. The additional operating costs and reduced sales value are spread out over many years, so they become less obvious. With the large discounts state DOTs get on new equipment, if assets were replaced at their economic life expectancy, the equipment replacement account is almost self-supporting. Inflation and unanticipated equipment replacements will cause it to not be self-supporting. Consequently, capital rental rates would be low, operational expenses and downtime would be as low as they can get, and more DOT money would be available for DOTs to spend more money in other areas. Economics supports DOTs operating fleets of new vehicles and equipment and replacing them at their economic lives, but will public and political perception support the DOT having all new vehicles and equipment when the many of state's residents do not have new vehicles and equipment?
- We began a concerted effort to focus on our "mission critical" core fleet a few years ago. Since then we have reduced our average age of the core equipment while sustaining a maintenance cost that has been increasing at a far lower rate than the inflationary factors driving our business.
- Use of performance metrics assist in ensuring overall fleet health and evaluation. It provides objective information to management for fleet decision making.

CHAPTER FOUR

LITERATURE REVIEW

The literature review found a considerable body of published information on equipment fleet management in the form of text books, trade association how-to guides, compendia of annual conference papers and educational presentations, and magazine articles from both trade and professional associations and independent publishers. However, very little *industry* research on equipment fleet management appears to have been undertaken (i.e., studies of the practices of multiple organizations within the transportation industry as opposed to studies of *individual* states' or localities' fleet management practices) or, if it has, to have had its results published in a manner that permits public access.

Searching the Internet and the databases of TRID, Bobit, NAFA Fleet Management Association, and American Public Works Association (APWA) yielded the following findings. Publication details of specific documents mentioned in the text may be found in the References at the end of this report.

REPORTS ON INDUSTRY PRACTICE

In June 2012, the state of California's Department of Transportation, Caltrans, published the results of a survey it commissioned of state DOT fleet management practices in a number of different areas, including equipment replacement and fleet financial management (*1*). Twenty-six DOTs participated in this survey. Several of the questions in that survey touched on topics related to fleet replacement and financing, including the percentage of fleet assets replaced each year, the size of current replacement backlogs, recent changes in replacement funding levels, the types of capital financing methods used, and factors taken into consideration in making equipment acquisition decisions (including alternative financing methods). No conclusions are drawn by the authors of this survey concerning the advantages or disadvantages of fleet management practices, nor do they make recommendations for improving practices. The report is noteworthy as the only one other than the present study that explores how state DOTs are managing and financing the costs of replacements for their fleets.

Another recent report, prepared at the request of the AASHTO Standing Committee on Highways, presents the results of a two-day workshop attended by representatives of TRB, FHWA, several state DOTs, and selected consulting firms in 2011 (*2*). The goal of the workshop was to develop recommendations for future equipment management research.

The workshop considered approximately 50 functional areas of equipment fleet management that might be candidates for research studies whose results would assist DOTs in improving their fleet management practices. Workshop participants selected 17 of the 50 functional areas for consideration, grouped into five broad areas. One of these areas, ranked as the fourth most important of the five areas meriting future research, was Equipment Replacement Management. Within this area, the workshop report describes four sub-areas for which future research is recommended: Equipment Replacement Cycle Guideline Development, Equipment Repair/Rebuild Versus Replacement Decision Making, Fleet Replacement Planning, and Equipment Replacement Financing.

Although the workshop did not prioritize these four components, their inclusion sheds light on what the participants viewed to be some of the key elements of an effective fleet replacement program. The report (1) discusses the fleet management challenge that each component is intended to address—for instance, determining when it is more cost-effective to repair or rebuild than to replace an asset; (2) provides background discussion on the challenges facing DOTs that make the particular facet of fleet replacement management important and worthy of research; (3) recommends what type of research should be conducted; and (4) identifies expected outcomes of the research and benchmarks that could be used to assess its effectiveness in improving actual DOT fleet management practices. It provides some useful context on the aspects of fleet replacement management that are the focus of this synthesis report, both by identifying them as part of a larger set of activities that are required to manage fleet replacement, some of which—such as the development of asset-specific replacement cycle guidelines—are not explored in any detail in this study; and by ranking the importance of fleet replacement management activities relative to that of other fleet management activities in which state DOTs engage.

DECISION SUPPORT TOOLS

A handful of academicians have published reports describing decision support tools they have developed to assist DOTs and other fleet owners in determining when to replace specific assets in fleets so as to minimize total asset and/or fleet costs. All but one of these studies was undertaken for state DOTs in Oregon, Texas, and Virginia (*3*–*5*). The reports use rigorous, structured methodologies for making and defending decisions regarding when to replace fleet

assets and which assets to replace each year given finite replacement funds.

With the exception of one report on the development of a decision support tool for making transit bus rebuild versus replacement decisions, no evidence was found that other state or local government agencies have undertaken similar research efforts.

Without exception, these reports and the tools they describe are of a highly technical nature, employing cost forecasting and optimization techniques such as linear regression analysis and mixed-integer programming, with which many fleet managers have limited familiarity (*6–10*). However, the reports do provide valuable discussions of the underlying principles of effective asset replacement decision making [see, e.g., Gillespie and Hyde (*4,* p. 2)]; reviews of methodologies and tools that other researchers have developed to support such decision making [e.g., Fan et al. (*3,* p. 6)]; and, in most cases, literature reviews and bibliographies that DOT fleet managers can peruse if they wish to learn more about these subjects.

The level of complexity of the tools presented in these reports is such that their potential usefulness to other DOT fleet managers is difficult to gauge. Indeed, two of the three departments that commissioned these studies do not use the methodologies that resulted from them. As reported in the survey for this project, the most important method used by the survey respondents to support fleet replacement decisions are user-defined criteria, which are much simpler than the optimization techniques proposed in these studies. Moreover, almost half the respondents in the survey of this present study have only limited confidence in the ability of support tools to improve the effectiveness of such decision making.

INDIVIDUAL ORGANIZATIONS' FLEET REPLACEMENT PRACTICES

Consulting reports for specific government jurisdictions (states, cities, etc.) or agencies (DOTs, departments of general services, public works, etc.) are another source of information on the fleet replacement practices of state DOTs and other public entities and, in terms of sheer volume, far exceed other types of literature on the topic of fleet replacement that we uncovered. The literature review identified reports prepared by MAXIMUS, Inc. (*11*); Mercury Associates, Inc. (*12*); and TransTech Management, Inc. (*13*). MAXIMUS, Inc. (www.maximus.com) and the firm David M. Griffith & Associates that it acquired in 1997 are management consulting firms that operated a fleet management consulting practice, since disbanded, from the late 1980s until approximately 2005; Mercury Associates (www.mercury-assoc.com) is a fleet management consulting firm; and TransTech Management (www.transtechmanagement.com) is a transportation management consulting firm. No other consulting studies were found during a targeted search of the Internet or through the survey of DOT fleet managers.

Most consulting studies are performed for organizations that believe their business practices or other conditions affecting the performance of their fleets are not as good as they should be. They are not representative of all organizations. Consequently, consulting reports, even for a large number of organizations, may not present a balanced picture of industry practices. That said, these studies shed light on the ways specific organizations have managed the replacement of their fleets; the strategies recommended for overcoming deficiencies; and the rationale for such recommendations.

Many of the consulting reports cited in the References share certain concerns in common, although the approaches to addressing them may differ. Most start from the premise that the client wants to improve its current fleet replacement practices. This motivation typically derives from conditions such as the following: fleets are old, they are increasingly unreliable and costly to maintain, and assets need to be replaced; current vehicle replacement cycles are too long, and better or "optimal" cycles need to be identified; current replacement financing and funding methods do not provide sufficient funds to replace assets that should be replaced each year; and the benefits of renting or leasing vehicles need to be explored.

The majority of the consulting reports by MAXIMUS and Mercury Associates cited in the References reflect a common approach to evaluating an organization's fleet replacement practices. They indicate that the most important step is to develop a multiyear plan (i.e., a forecast) that estimates the future costs of replacing current assets. (Among the reports by these two firms, the only exceptions to this are those prepared for the states of Iowa and Michigan and the Province of Ontario, studies that focused on aspects of fleet replacement or financing, but did not include the development of multiyear replacement plans.) These plans forecast the future replacement dates and costs of each asset in the fleet. This allows for detailed estimates of future costs, which often fluctuate from year to year. Such fluctuations are frequently cited in these reports as one of the principal reasons for replacing too few assets. Fleet owners that purchase vehicles outright with cash often struggle to obtain sufficient funds when annual replacement costs occasionally spike, which is common. This problem can be exacerbated because repairing an old asset is usually "cheaper" (in annual budgetary terms) than replacing it.

The consulting reports by TransTech Management, Inc., cited in the References describe an alternative method to the previous forecasting approach that divides the estimated current replacement cost of the entire fleet by a target average replacement cycle (e.g., seven years) to estimate the average annual replacement budget needed for the fleet.

Under both of these approaches, estimates of future fleet replacement costs provide a benchmark against which past replacement spending levels can be compared. To the extent that a detailed year-by-year forecast of future costs has

been developed (as opposed to a simple estimate of average annual replacement cost), these consulting reports often reveal a large backlog of replacement spending needs. This is consistent with the findings of the survey of state DOTs conducted in this study.

Most of the consulting reports cited in the References present evaluations of different capital financing approaches, typically using the aforementioned replacement plans or forecasts as the foundation for making such comparisons. This is because fleet owners often believe one of the means for improving fleet replacement practices is to change the way they finance asset acquisition costs. Again, this perception accords with survey responses that indicated a preference for revolving funds over annual ad hoc appropriations for financing fleet replacement costs.

Most of the reports by MAXIMUS and Mercury Associates discuss the pros and cons of up to four different types of capital financing that are used by DOTs and other governmental entities: (1) the outright purchase of assets using funds secured through annual appropriations; (2) the purchase of assets using cash accumulated in revolving funds through the use of a cost charge-back system; (3) the purchase of assets using borrowed funds secured under an array of financing instruments including bonds, certificates of participation, master lease-purchase agreements, revolving lines of credit, and loans; and (4) the leasing of assets (see, e.g., Mercury Associates reports for the cities of Baltimore, Houston, Philadelphia, and Sacramento; and the states of California, Georgia, New Mexico, South Carolina, and Virginia.) The reports indicate that of these approaches the first is the most common and the last the least common, which agrees with the findings of the survey of DOTs performed in this study.

Some reports describe the attributes of different types of financing instruments used by public entities, including their legal aspects (see, e.g., TransTech Management, Inc., *Final Report: Administrative Analysis of the Ohio Fleet Management Program,* Ohio Department of Administrative Services, 2002). However, most devote little attention to the statutory feasibility of using one financing approach versus another and focus far more on the fiscal and economic impacts of the different methods (see, e.g., Mercury Associates, Inc., *Report on a Fleet Operations Review for the Florida Department of Transportation,* Florida Department of Transportation, 2007; and *Report on Fleet Management Operations,* South Carolina Budget and Control Board, 2005).

The basic logic of the latter approach is that one of the keys to persuading organizations to spend more money on replacing fleet assets is to show that doing so (1) is affordable for many (but not all) organizations if they are willing to change capital financing approaches; and (2) is beneficial from a long-term economic perspective. The message of these studies is that old fleets cost more than younger fleets, and that this can be demonstrated empirically using techniques such as equivalent annual cost analysis [see Fan et al. (*3,* p. 10) for an explanation of this analytical technique and its discussion in the engineering economy literature]. According to consultants, the biggest challenge associated with making a fleet younger, and thus more economical, is securing the funds needed to increase asset replacement spending levels.

Most of the reports by MAXIMUS and Mercury Associates make clear that the choice of the capital financing approach is central to the implementation of an effective fleet renewal strategy that will minimize total fleet costs. Using a multiyear replacement cost forecast as the foundation for comparing different financing approaches is frequently used to drive this point home.

These reports are consistent with the findings of the survey of DOT fleet managers that the outright purchase of assets with cash from annual appropriations is less desirable than other methods of financing asset acquisitions. The reports explain that this is because: (1) this approach has the biggest impact on an organization's budget in the near term, and (2) it frequently incentivizes organizations to repair and retain rather than replace obsolete assets. If an organization has a large replacement backlog, the funds required to eliminate it under a cash financing approach are substantial and difficult to obtain. Financing approaches that leverage cash—namely, debt financing and leasing—are usually shown in these reports to be much more viable methods for optimizing asset replacements in both fiscal and economic impact terms. Because such approaches permit the capital costs of fleet assets to be budgeted and paid for incrementally, they also result in far less fluctuating year-to-year replacement funding requirements.

Several of the MAXIMUS and Mercury Associates reports show that this is also true of sinking funds. The drawbacks of this type of financing are not related to its impact on long-term replacement funding requirements. Rather, they are the result of its limited ability to finance the modernization of a fleet (where a large replacement backlog exists), as well as the complexities of administering this type of financing program correctly (*6*).

Of the four broad types of capital financing discussed earlier, the consulting literature shows that leasing is the least common among government fleets, despite being widely used in the commercial sector in both the United States and Canada. Only one state, Michigan, uses true off-balance-sheet leasing on a large scale to finance the acquisition of fleet assets. In 2005, Michigan commissioned a review of its fleet management practices, which found that it has been well served by its use of leasing, which it has employed for more than 20 years (*7*). Among other things, the consulting study found that (1) the purchase prices the state was paying (through its leases) for vehicles were comparable to, and in some cases lower than, those being paid by other states that

purchase vehicles; (2) the state's Vehicle and Travel Services Section had been largely successful in "de-politicizing" fleet-related funding decisions in the sense that there was minimal intervention from the administration or legislature aimed at challenging the manner in which the fleet was managed; and (3) the state fleet was markedly younger than that of other states.

PRIMERS ON FLEET REPLACEMENT PRINCIPLES AND TECHNIQUES

Several years ago, TRB published a primer on several common capital financing methods used by state DOTs (*14*). The publication acknowledges the fiscal challenges faced in replacing fleet assets in a timely manner, but it does not attempt to link specific financing techniques to the effectiveness of replacement decision making.

The publication includes some guidance that is at odds with the literature and survey findings of this study, such as the assertion that "Cash purchase is the lowest *cost* method for owning, operating, and disposing of a piece of equipment" (*14*, p. 4). There is much statistical analysis in consulting reports that indicates the assertion is not necessarily true (see, e.g., Mercury Associates, Inc., *Report on Fleet Renewal, Right Sizing, and Cost Reduction Opportunities*, City of Houston General Services Department, 2007). Although the cost of borrowing may make the acquisition costs of fleet assets higher under a financing approach that requires interest payments such as loans or leases, the more frequent replacement of assets using these approaches can yield operating cost savings and higher salvage values that more than offset interest payments. In addition, there is always an opportunity cost associated with using cash to finance the purchase of vehicles. That organizations do not pay themselves interest on cash does not change the fact that the DOT cash is no more "free" than cash borrowed from banks, bond holders, or leasing companies.

JOURNAL ARTICLES

Various articles dealing with the challenges of fleet replacement have been published in fleet industry periodicals, notably those of Bobit Business Media. The articles by Basich (*15,16*) cited in the References are typical of those from this publisher reporting the details of government jurisdictions changing replacement financing approaches. In some cases, the expected savings from downsizing the fleet or reducing fleet age and maintenance and repair costs as a result of making such changes are cited. That articles on business practices in these areas are published does not necessarily mean that they are reliable sources of information on the most effective practices.

Of particular interest is a relatively recent article on guaranteed buy-back programs (*17*). This article provides a fairly detailed discussion of how King County, Washington, uses such a program. The details are informative for someone not familiar with this type of asset acquisition process. However, some of the asserted benefits; for example, capital and cost savings, are not supported by any data in the article.

Although its primary readership is corporate fleet managers, Bobit's *Fleet Financials* (*18–24*) has many articles on the characteristics, pros, and cons of various types of fleet lease agreements, offering a good source of introductory information to state DOT fleet managers who are not familiar with these approaches.

CHAPTER FIVE

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

CONCLUSIONS

The objective of this study was to examine various fleet replacement financing and associated management approaches used by state departments of transportation (DOTs), and to summarize the relative advantages and disadvantages of each. There are advantages and disadvantages to each of the different methods being used by state DOTs. This section provides conclusions drawn from the literature review and survey, as well as a summary of research needs identified by this study.

- Recent fleet replacement spending levels generally result in long replacement cycles and old fleets.

For the period from 2009 through 2011, the average amounts spent each year on acquiring new fleet assets were roughly 3% to 6% of total fleet replacement cost. This implies asset replacement cycles in the range 16 to 30 years. Ninety percent of DOT fleets replace less than 10% of their assets each year, which implies replacement cycles of 10 years or longer. Sixty percent of DOT fleets have average replacement cycles of 20 years or longer. These findings suggest that DOT fleets might be managed in a more cost-effective manner, which would free up financial resources to be used for other purposes.

- DOT fleet managers believe that more should be spent on fleet replacement and that backlogged assets need replacing.

Both consulting reports identified in the literature and the DOT survey identified backlogs of replacement needs. More than 80% of the survey respondents believe that the replacement expenditures in 2011 for their fleets were too low and should be increased by an average of 40%. When asked about the current replacement backlogs in their fleets, 80% of the DOTs that responded estimated their average backlog at 20% of current fleet value. However, there was no statistical correlation among (1) the backlogs that survey respondents said need replacing, (2) recommendations survey respondents made for increases in spending, or (3) estimates respondents made of the average ages of their fleets.

- Fleet managers are satisfied with their methods for requesting fleet replacement funding.

At least six different methods are used by DOTs for requesting funds for fleet replacement. There is no consensus among fleet managers as to which methods are the most effective in securing funds. More than 80% of DOTs noted that they are either somewhat or entirely satisfied with the effectiveness of decision making regarding fleet replacement funding.

- Fleet managers are less satisfied with annual budgets for fleet replacement financing than with revolving funds.

About three-quarters of the DOTs use funds secured through annual budgeting processes to finance fleet asset acquisition costs, and 20% use revolving funds. Less than 20% of the DOTs using annual budgets are completely satisfied with them, compared with 50% using revolving funds that are completely satisfied. Only 7% of DOTs using annual budgets find them to be very effective in facilitating the timely replacement of assets compared with 86% of the DOTs using revolving funds that find them very effective. After taking account of the different percentages of DOTs using annual budgets and revolving funds, survey respondents made twice as many suggestions for improving annual budgeting processes as for improving revolving funds. More than one-third of the recommendations for improving the former focus on devoting more money to fleet replacement. More than half the DOTs using annual budgets for financing replacements would prefer a different method.

- Most fleet managers believe they are better served than other units of state government.

About one-quarter of the DOTs believe they are about as successful as other units of state government in securing funds for replacing fleet assets; however, nearly 60% believe they are more successful than other units.

- The use of decision support tools to justify replacement decisions is inconsistent.

At present, many DOTs do not analyze their asset replacement needs or substantiate their funding requests with eco-

nomic arguments. Although several different support methods are used for making fleet asset replacement decisions (see Table 10), no one or two methods emerge as front runners. As noted in the literature review and the survey, the level of complexity of decision support tools results in limited confidence in their use by DOT fleet managers on a day-to-day basis.

FURTHER RESEARCH

Several research needs were identified through course of this study. There is a lack of research regarding fleet management practices and a need for further documentation of methods being used by DOTs, more exploration about what is working well, and how performance measures are being used. Potential topics for future projects include:

- Research that identifies how states are managing fleet assets, including the type of data used in DOT fleet replacement decision-making processes and what systems are used to maintain fleet data.
- Research that explores effective fleet management practices used by DOTs and summarizes successful practices.
- Research that explores where performance metrics are being used for fleet management.
- Research that explores effective institutional arrangements in state DOTs that promote adequate funding and timely replacement of assets.

REFERENCES

REPORTS ON INDUSTRY PRACTICE

1. CTC & Associates, LLC, *Preliminary Investigation: National Survey of Equipment Management Practices,* Caltrans Division of Research and Innovation, Sacramento, 2012 [Online]. Available: http://www.dot.ca.gov/newtech/researchreports/preliminary_investigations/docs/equipment_management_national_practices_-_preliminary_investigation_2012-06-07.pdf.
2. Lauria, P.T., *Challenges and Opportunities: A Strategic Plan For Equipment Management Research, NCHRP Project 20-7/Task 309,* 2011 [Online]. Available: http://maintenance.transportation.org/Documents/NCHRP%2020-7,%20Task%20309,%20Final%20Final%20Report-October%202011.pdf.

STUDIES ON FLEET REPLACEMENT DECISION SUPPORT TOOLS

3. Fan, W., et al., *Equipment Replacement Optimization,* Research and Technology Implementation Office, Texas Department of Transportation, Austin, FHWA/TX-11/0-6412-1, 2011 [Online]. Available: http://www.utexas.edu/research/ctr/pdf_reports/0_6412_1.pdf 2011.
4. Gillespie, J.S. and A.S. Hyde, *The Replace/Repair Decision for Heavy Equipment*, Virginia Transportation Research Council, Charlottesville, 2004 [Online]. Available: http://www.virginiadot.org/VTRC/main/online_reports/pdf/05-r8.pdf.
5. Kim, D.S., et al., *Fleet Replacement Modeling: Final Report, SPR 670,* Oregon Department of Transportation and Federal Highway Administration, Salem, 2009 [Online]. Available: http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/2009/Fleet_Model.pdf?ga=t.
6. Mercury Associates, Inc., *Report on Fleet Management Best Practices Assessment,* City of Baltimore Department of General Services, 2011.
7. Mercury Associates, Inc., *Final Report on Evaluation of Selected Fleet Management Practices,* Michigan Department of Management & Budget, Lansing, 2005 [Online]. Available: http://www.wistrans.org/mrutc/files/02-01OptimalResourceAllocationTransitKhasnabis.pdf.
8. Khasnabis, S., J. Bartus, and J.D. Ellis, *Optimal Resource Allocation for the Purchase of New Buses and the Rebuilding of Existing Buses as a Part of a Transit Asset Management Strategy for State DOTs,* Midwest Regional University Transportation Center, and the Federal Highway Administration, Madison, Wis., 2003 [Online]. Available: http://www.wistrans.org/mrutc/files/02-01OptimalResourceAllocationTransitKhasnabis.pdf.
9. Kriett, P.O., W.N. Mbugua, D.S. Kim, and J.D. Porter, "Equipment Replacement at Departments of Transportation: Prioritization Measures, Software Tools, and Supplementary Data," *Transportation Research Record: Journal of the Transportation Research Board, No. 2150,* Transportation Research Board of the National Academies, Washington, D.C., 2010, pp. 10–15.
10. Weissmann, J. and A.J. Weissmann, "Computerized Equipment Replacement Methodology," *Transportation Research Record: Journal of the Transportation Research Board, No. 1824,* Transportation Research Board of the National Academies, Washington, D.C., 2003, pp. 77–83.

CONSULTING STUDIES OF INDIVIDUAL ORGANIZATIONS' FLEET REPLACEMENT PRACTICES

11. MAXIMUS, Inc. and David M. Griffith & Associates, Ltd. (acquired by MAXIMUS in 1997), Gaithersburg, Md.:
    - State of Alaska Department of Transportation and Public Facilities fleet management consulting study report, 2001.
    - State of New Jersey Department of the Treasury, fleet management consulting study report, 1996.
    - State of Utah Department of Administrative Services, fleet management consulting study report, 1996.
    - State of Utah Legislative Fiscal Analyst, fleet management consulting study report, 1998.
    - State of Wisconsin Department of Administration, fleet management consulting study report, 1999.
12. Mercury Associates, Inc., Gaithersburg, Md.:
    - State of Alabama Department of Corrections, fleet management consulting study report, 2012.
    - City of Baltimore Department of General Services, fleet management consulting study report, 2010.
    - State of California Department of General Services, fleet management consulting study report, 2006.
    - State of Florida Department of Transportation, *Report on a Fleet Operations Review for the Florida Department of Transportation,* fleet management consulting study report, Tallahassee, 2009.
    - State of Georgia Department of Administrative Services, fleet replacement consulting study report, 2006.
    - City of Houston, Texas, General Services Department, *Report on Fleet Renewal, Right Sizing, and Cost Reduction Opportunities,* fleet replacement and right-sizing consulting study report, 2007.
    - State of Iowa Department of Administrative Services, fleet leasing feasibility consulting study report, 2012.
    - State of Michigan Department of Management and Budget, fleet management consulting study report, 2005.
    - State of New Mexico Department of Transportation, fleet replacement consulting study presentation, 2007.
    - Province of Ontario Provincial Police, fleet vehicle replacement cycle consulting study report, 2005.

- City of Philadelphia Managing Director's Office, fleet replacement consulting study presentation, 2010.
- City of Sacramento, California, Department of General Services, fleet management consulting study report, 2011.
- Salt Lake City Corporation, Utah, Public Services Department, fleet management consulting study report, 2010.
- City of San Antonio, Texas, Administrative Services Department, fleet replacement consulting study report, 2007.
- City and County of San Francisco General Services Agency, fleet management consulting study report, 2009.
- State of South Carolina Budget and Control Board, *Report on Fleet Management Operations*, fleet management consulting study report, Columbia, 2005.
- City of Tampa, Florida, Department of Public Works, fleet replacement consulting study report, 2009.
- Commonwealth of Virginia Department of Transportation, fleet replacement consulting study reports, 2005, 2008.
- Yukon Territory Department of Highways and Public Works, fleet management consulting study report, 2011.

13. TransTech Management, Inc., Greensboro, N.C.:
    - State of Ohio Department of Administrative Services, *Final Report: Administrative Analysis of the Ohio Fleet Management Program*, fleet management consulting report, Columbus, 2002.
    - State of Texas Department of Transportation, consulting study report: *Paving the Way: A Review of the Texas Department of Transportation*, 2001.

PRIMERS ON FLEET REPLACEMENT AND FINANCING

14. Swenson, A.T., et al., *Financial Aspects of Equipment Acquisition, Transportation Research Circular Number E-C047*, TRB Committee on Maintenance Equipment, Subcommittee on Equipment Acquisition, Transportation Research Board of the National Academies, Washington, D.C., 2002 [Online]. Available: http://onlinepubs.trb.org/onlinepubs/circulars/ec047.pdf.

JOURNAL ARTICLES

15. Basich, G., "Chattanooga Establishes Formal Fleet and Equipment Replacement Fund," *Government Fleet*, Apr. 12, 2012 [Online]. Available: http://www.government-fleet.com/Channel/Legislative/News/Story/2012/04/Chattanooga-Establishes-Formal-Fleet-and-Equipment-Replacement-Fund.aspx?prestitial=1.
16. Basich, G., "Rockford, Ill., Considering Fleet Leasing Plan," *Government Fleet*, Dec. 8, 2011 [Online]. Available: http://www.government-fleet.com/Channel/Leasing/News/Story/2011/12/Rockford-Ill-Considering-Fleet-Leasing-Plan.aspx.
17. Mitchell, M., "How King County Beat the High Cost of Off-Road Equipment," *Government Fleet*, Mar. 2008 [Online]. Available: http://www.government-fleet.com/channel/maintenance/article/story/2008/03/how-king-county-beat-the-high-cost-of-off-road-equipment/page/2.aspx?prestitial=1.
18. "Getting the Straight Scoop on Sourcing Strategies and Depreciation Management," July 2012.
19. "Strategies to Fund Fleets in Today's & Tomorrow's Economy," *Fleet Financials*, May 2012.
20. "Rollins Creates Open-End Leasing Savings," *Fleet Financials*, Jan. 2012, 6 pp.
21. Bosco, B., "Lease Accounting Changes & The Fleet Leasing Industry," *Fleet Financials*, Jan. 2012.
22. Zeiler, M., "10 Ways to Become a Depreciation Management Pro," *Fleet Financials*, July 2011.
23. Suizo, G.L. "Short-Term Leasing Leaves a Lasting Impression," *Fleet Financials*, July 2010, pp. 36–37.
24. Scanlon, G., "Why Leasing Makes Good Financial Sense for Fleet," *Fleet Financials*, Nov. 2009.

APPENDIX A

Fleet Manager Questionnaire

NCHRP Synthesis 20-05/Topic 43-14

Before you launch the questionnaire, please note the following:

It is important to answer all questions that appear on the screen. You will receive an error message if you leave any question blank. Throughout the survey, you will have the option of going to the "Next Page" or "Previous Page" to review or change your answers.

If you need to suspend answering the questions, you may do so at any time. Upon exiting the browser, all of your work will be saved automatically. Upon your next login, you will be sent to the last viewed page.

RESPONDENT INFORMATION (for the person completing this questionnaire):

1) **Please enter the name of the organizational unit (division, bureau, section, etc.) for which you work.**

_____

2) **Please enter the *title* of the person to whom you immediately report.**

_____

FLEET SIZE, COMPOSITION, AND CAPITAL COSTS

3) **Please indicate the number of active fleet assets currently in the DOT's fleet in each of the following categories:**

Licensed (on-road) Vehicles and Equipment _____

Construction/Agricultural (off-road) Equipment _____

Other Non-Licensed Equipment Assets/Attachments _____

4) **What is the estimated original acquisition cost of the assets identified in the previous question?**

Licensed (on-road) Vehicles and Equipment $_____ million

Construction/Agricultural (off-road) Equipment $_____ million

Other Non-Licensed Equipment Assets/Attachments $_____ million

5) **How much confidence do you have in the accuracy of these estimates?**

☐ A lot

☐ Some

☐ Not very much

6) **What is the estimated replacement cost (today) of these assets?**

Licensed (on-road) Vehicles and Equipment $_____ million

Construction/Agricultural (off-road) Equipment $_____ million

Other Non-Licensed Equipment Assets/Attachments $_____ million

7) **How much confidence do you have in your replacement estimates?**

☐ A lot

☐ Some

☐ Not very much

8) What is the estimated total purchase cost of DOT fleet assets acquired in *FY2011* in each of the following categories?

Licensed (on-road) Vehicles and Equipment $_____ million

Construction/Agricultural (off-road) Equipment $_____ million

Other Non-Licensed Equipment Assets/Attachments $_____ million

9) What is the estimated total purchase cost of DOT fleet assets acquired in *FY2010* in each of the following categories?

Licensed (on-road) Vehicles and Equipment $_____ million

Construction/Agricultural (off-road) Equipment $_____ million

Other Non-Licensed Equipment Assets/Attachments $_____ million

10) What is the estimated total purchase cost of DOT fleet assets acquired in *FY2009* in each of the following categories?

Licensed (on-road) Vehicles and Equipment $_____ million

Construction/Agricultural (off-road) Equipment $_____ million

Other Non-Licensed Equipment Assets/Attachments $_____ million

11) In general, how much would you say the DOT's fleet asset acquisition expenditures fluctuate up or down from year to year?

☐ A great deal (more than 50 percent)

☐ Somewhat (15 to 50 percent)

☐ Very little (less than 15 percent)

12) How much do you think the DOT should spend on fleet asset acquisition in average annual terms?

$_____ million

13) What is the current size of the backlog (if any) of fleet asset replacement spending needs in the DOT?

$_____ million (enter zero if none)

14) What is the current average age (in years) of the active assets in the DOT's fleet in each of the following categories?

Licensed (on-road) Vehicles and Equipment _____ years

Construction/Agricultural (off-road) Equipment _____ years

Other Non-Licensed Equipment Assets/Attachments _____ years

FLEET ASSET REPLACEMENT MANAGEMENT PRACTICES

Decision Support Tools

15) Which of the following tools (policies, guidelines, analytical methods, software, etc.) are used by the DOT in making decisions about the replacement of fleet assets? (Check all that apply.)

☐ Replacement cycle policies or guidelines for specific types of assets based on formal analysis of the life cycle costs of those assets in your department's fleet

☐ Replacement cycle policies or guidelines for specific types of assets based on subjective judgment, professional experience, past practice, industry rules of thumb, etc.

☐ Multi-year fleet replacement plans showing future replacement dates and costs by asset and for the fleet as a whole

☐ Replacement eligibility lists or reports identifying specific assets that meet or exceed pre-defined criteria (e.g., age, mileage, LTD maintenance and repair costs) for replacement

☐ A methodology for prioritizing specific assets for replacement in the next budget year when total fleet replacement spending requirements are expected to exceed available replacement funds

☐ A repair versus replace policy or decision making tool that is applied to specific assets requiring expensive repairs to remain operational

☐ Other method(s) or tool(s)

☐ None

16) Multi-year plan attributes.

What is the plan horizon or length? _____ years

If you like, please explain anything unique about this multi-year plan. _____

17) Please describe the other method(s) used by the DOT to assist it in making fleet replacement decisions.

_____

_____

18) Which is the *most important* of the tools you checked in answering the previous question in making fleet replacement decisions?

☐ Replacement cycle policies or guidelines for specific types of assets based on formal analysis of the life cycle costs of those assets in your department's fleet

☐ Replacement cycle policies or guidelines for specific types of assets based on subjective judgment, professional experience, past practice, industry rules of thumb, etc.

☐ Multi-year fleet replacement plans showing future replacement dates and costs by asset and for the fleet as a whole

☐ Replacement eligibility lists or reports identifying specific assets that meet or exceed pre-defined criteria (e.g., age, mileage, LTD maintenance and repair costs) for replacement

☐ A methodology for prioritizing specific assets for replacement in the next budget year when total fleet replacement spending requirements are expected to exceed available replacement funds

☐ A repair versus replace policy or decision making tool that is applied to specific assets requiring expensive repairs to remain operational

☐ The other method(s) or tool(s) described above

19) Which is the *second most important* of the tools you checked in answering the previous question in making fleet replacement decisions?

☐ Replacement cycle policies or guidelines for specific types of assets based on formal analysis of the life cycle costs of those assets in your department's fleet

☐ Replacement cycle policies or guidelines for specific types of assets based on subjective judgment, professional experience, past practice, industry rules of thumb, etc.

☐ Multi-year fleet replacement plans showing future replacement dates and costs by asset and for the fleet as a whole

☐ Replacement eligibility lists or reports identifying specific assets that meet or exceed pre-defined criteria (e.g., age, mileage, LTD maintenance and repair costs) for replacement

☐ A methodology for prioritizing specific assets for replacement in the next budget year when total fleet replacement spending requirements are expected to exceed available replacement funds

☐ A repair versus replace policy or decision making tool that is applied to specific assets requiring expensive repairs to remain operational

☐ The other method(s) or tool(s) described above

20) How often is the *most important method* as indicated by your previous answer used for making fleet replacement decisions?

☐ All the time

☐ Most of the time

☐ Occasionally

☐ Seldom

21) What impact do the decision support tools that you use have on the DOT's ability to secure the approvals and funds needed to replace fleet assets in a timely manner?

☐ They are essential; without them our fleet definitely would be older

☐ They help us somewhat, but provide only moderate confidence that we will secure the approvals and funds we request

☐ They have little impact on our ability to secure requested approvals and funds

22) What is the single most important reason that the decision support tools identified do not have a more positive impact on replacing the DOT's fleet assets?

☐ We do not have the proper tools and/or information required to produce convincing reports to decision makers on replacement needs

☐ Replacement decision making (which specific fleet assets to replace) is decentralized (e.g., at the division or district level, outside the department, etc.) and ultimately beyond the control of this office

☐ We are not given the opportunity to present the results of our analyses to the right decision makers

☐ Top decision makers in the DOT do not consider the use of analytical tools like those I checked in answering Question 21 to be very important for making fleet replacement funding decisions

☐ The timely replacement of fleet assets is not a high priority in the department

☐ The timely replacement of fleet assets is not considered to be a high priority by our governor, state budget office, and/or legislature

☐ Other

23) Please explain why you selected "Other."

_____

_____

_____

Studies

24) Has the DOT commissioned or been the subject of any formal studies of its fleet replacement practices in the last 10 years?

☐ Yes

☐ No

☐ Don't know

25) Indicate who has performed formal studies of its fleet replacement practices in the last 10 years? (Check all that apply.)

☐ A state (executive or legislative branch) auditor

☐ A departmental auditor/inspector general

☐ An outside academic institution or research organization

☐ An outside consulting firm

☐ Someone else

26) Please describe who "someone else" refers to.

_____

_____

27) If you answered yes to any part of the previous question, are copies of any of these reports available to the public?

☐ Yes

☐ No

☐ Don't know

28) Please describe the reports that are available.

_____

_____

_____

29) How would you describe the *positive* impact of the formal studies that have been conducted on the timeliness with which the DOT replaces its fleet assets?

☐ High

☐ Moderate

☐ Low

Decision Making Responsibility and Authority

30) In what organization of state government would you say most of the final decision making occurs each year regarding the amount of funding devoted to the replacement of DOT fleet assets?

☐ A central fleet management organization within the DOT

☐ A fleet management organization in a state agency other than DOT

☐ Individual DOT districts or divisions

☐ Another organizational unit within the DOT or a commission governing the DOT

☐ Another executive branch agency (e.g., the budget office, the governor's office)

☐ The legislature

31) If you selected "another organizational unit within the DOT or a commission governing the DOT," please describe.

_____

_____

_____

32) How would you rate the overall effectiveness of fleet replacement decision making as it relates to the DOT's fleet?

☐ Entirely satisfactory

☐ Somewhat satisfactory

☐ Not satisfactory

33) How do you think the effectiveness of the DOT's fleet replacement practices compares with that of other major fleet-using departments in your state?

☐ Better

☐ About the same

☐ Worse

☐ Don't know

34) If you like, explain the reason for your selection to the previous question.

_____

_____

FINANCING THE FLEET'S CAPITAL OR ACQUISITION COSTS

35) What is the *primary* method used to finance the capital costs of acquiring the assets in the DOT fleet?

☐ Outright purchase using money appropriated for this purpose through the annual (or other) budget process

☐ Outright purchase using money accumulated in a fund or account specifically created for this purpose, such as a fleet revolving fund

☐ Outright purchase using borrowed funds

☐ Leasing

☐ Other

36) Please explain why you selected "Other" as the primary financing method for fleet acquisition.

37) Who *manages* the primary method used to finance the capital costs of the DOT's fleet assets?

☐ A central fleet management organization within the DOT

☐ A fleet management organization in a state agency other than the DOT

☐ Individual DOT districts or divisions

☐ Another organizational unit within the DOT or a commission governing the DOT

☐ Other

38) Please describe the other organizational unit or commission who manages the primary financing method.

39) Please describe the "Other" entity that manages the primary financing method.

40) In whose budget do *most* funds spent on DOT fleet asset acquisition appear? (Check the *primary* budgeting method used.)

☐ The budget of the central DOT fleet management organization only

☐ The budgets of individual fleet user organizations within the DOT only

☐ The budgets of both a central DOT fleet organization and individual fleet user organizations (usually applies to state DOTs using their own fleet internal service fund)

☐ The budgets of both another fleet management organization and individual fleet user organizations (usually applies to state DOTs who obtain assets from a fleet internal service fund in another state agency)

☐ The budget of another organizational unit within the DOT only

☐ The budget of another state agency only

41) Describe the other organizational unit within the DOT where most budgeted asset acquisition funds appear.

42) Describe the other state agency where most budgeted asset acquisition funds appear.

43) Are the funds budgeted for fleet asset acquisition accounted for using line items or accounting codes just for this purpose or line items that include amounts for other spending purposes?

☐ Amounts for fleet asset acquisition have their own distinct accounting code(s) in the budget

☐ Amounts for fleet asset acquisition are combined in the budget with amounts for other fleet-related costs such as fuel, maintenance, and repair

☐ Amounts for fleet asset acquisition are combined in the budget with amounts for both fleet and non-fleet-related costs such as the acquisition or improvement of other types of capital assets

☐ Other

44) Please explain why you selected "Other."

45) How well do you and/or other employees who report directly to you understand the mechanics or inner workings of the primary method used to finance the capital costs of the assets in the DOT fleet?

☐ Completely

☐ Reasonably well

☐ Not well

46) How well would you say that fleet *user* organizations within the DOT understand the mechanics or inner workings of the primary method used to finance the capital costs of the fleet assets they use?

☐ Completely

☐ Reasonably well

☐ Not well

47) How effective do you believe the primary method used to finance the capital costs of fleet assets is in promoting the timely replacement of these assets?

☐ Very effective

☐ Somewhat effective

☐ Ineffective

☐ Don't know/not sure

48) If you think the primary method is ineffective in promoting timely replacement, please explain.

_____

_____

_____

49) How effective do you believe the primary method used to finance the capital costs of fleet assets is in promoting understanding of asset costs (e.g., trade-offs between capital and operating costs), and opportunities to optimize these costs (e.g., by reducing fixed fleet costs through proactive fleet utilization management and rightsizing)?

☐ Very effective

☐ Somewhat effective

☐ Ineffective

☐ Don't know/not sure

50) If you think the primary method is *ineffective* in promoting an understanding of asset costs, please explain.

_____

_____

_____

51) Is there a second method used to finance the capital costs of acquiring a significant portion (i.e., 20 to 50 percent) of the assets in your fleet?

☐ No

☐ Outright purchase using money appropriated for this purpose through the annual (or other) budget process

☐ Outright purchase using money accumulated in a fund or account specifically created for this purpose, such as a fleet revolving fund

☐ Outright purchase using borrowed funds (i.e., debt financing)

☐ Leasing

☐ Other

52) Please explain why you selected "Other."

_____

_____

_____

53) Approximately what percentage of the assets in the DOT's fleet is financed using the secondary method identified?

_____%

54) If the costs of acquiring the assets in your department's fleet are financed using a replacement reserve or revolving fund, how are the monies in this fund obtained?

☐ Through lump-sum appropriations or transfers of monies to the fund

☐ Through revenues from the payment of charge-back (or "lease" or "rental") rates specifically identified as being for asset capital cost recovery only

☐ Through revenues from the payment of charge-back rates intended to recover both asset capital and operating (maintenance, fuel, etc.) costs

☐ Other

55) Please explain why you selected "Other."

_____

_____

_____

56) Are monies in the revolving fund kept in separate accounts for (1) asset replacement costs and (2) asset operating costs?

☐ Yes

☐ No, monies for these two purposes are pooled

☐ Don't know

57) Are the charge-back rates used to replenish the revolving fund sufficient to cover its costs?

☐ Yes

☐ No

☐ Don't know

58) Do you know the year that the charge-back rates were last updated?

☐ Yes

☐ No

59) In what year were the charge-back rates last updated?

_____

60) Is there a documented methodology for calculating the charge-back rates used to replenish monies in the revolving fund?

☐ Yes

☐ No

☐ Don't know

61) Do you understand the methodology(ies) used to calculate the charge-back rates?

☐ Yes, completely

☐ Yes, for the most part

☐ No

62) Do you believe the methods used to calculate the charge-back rates to be sound?

☐ Yes, completely

☐ Yes, for the most part

☐ No

63) Please explain why you do not believe that the methods used to calculate the charge-back rates are sound.

_____

_____

64) Do you know the approximate unrestricted fund balance in the revolving fund at the end of Fiscal Year 2011?

☐ Yes

☐ No

65) What was the approximate unrestricted fund balance in the revolving fund at the end of Fiscal Year 2011?

$_____million

66) How often have monies in the revolving fund been removed to be used for purposes different than the fund's purposes?

☐ Frequently, every 1 or 2 years

☐ Occasionally, every 3 to 5 years

☐ Seldom, once every 6 or more years

☐ Never, as far as I know

67) If the capital costs of acquiring the assets in the DOT's fleet are financed primarily using borrowed funds, what is the primary method of borrowing or debt financing used?

☐ Loans or lines of credit from banks or other commercial finance institutions

☐ Bonds or certificates of participation

☐ Other

68) Please explain why you selected "Other."

_____

_____

_____

69) How often have statutory limits (caps) on the amount of debt that can be incurred restricted the DOT's ability to replace fleet assets in a timely manner?

☐ Frequently, once every 1 or 2 years

☐ Occasionally, once every 3 to 5 years

☐ Seldom, once every 6 or more years

☐ Never

70) Is there bureaucratic, political, or other opposition to using debt (borrowed funds) to finance the acquisition of fleet assets for the DOT?

☐ Yes, the opposition is quite strong

☐ Yes, but the opposition is weak to moderate

☐ No, there is no significant opposition to debt financing

71) Has opposition to using debt financing (borrowed funds) restricted the ability of the DOT to replace fleet assets in a timely manner?

☐ Not applicable, there is no opposition to use debt financing

☐ Yes, opposition to debt financing has frequently prevented DOT from acquiring all of its needed assets in a timely manner

☐ Yes, opposition to debt financing has occasionally prevented DOT from acquiring all of its needed assets in a timely manner

72) If the capital costs of acquiring the assets in the DOT's fleet are financed using borrowed funds, are the costs of servicing the debt (i.e., principal and interest payments) passed on to fleet users via a cost charge-back system?

☐ Yes

☐ No

☐ Don't know/not sure

73) If debt service costs associated with acquiring fleet assets are passed on to the fleet users, are these costs charged separately or are they recovered using charge-back rates that combine fleet asset capital and operating costs?

☐ Fleet users are charged separately for fleet asset capital (i.e., debt service) costs and asset operating costs

☐ Fleet users pay charge-back rates that combine fleet asset capital and operating costs

74) If the capital costs of acquiring the assets in the DOT's fleet are financed primarily using leases, what types of leases are used?

☐ Open-end operating leases

☐ Closed-end operating leases (including guaranteed buy-back programs)

☐ Finance (e.g., fair market value or $1 buy-out) leases

☐ Other

75) Please explain why you selected "Other."

_____

_____

_____

76) How often have statutory limits on the use of leases restricted your department's ability to replace fleet assets in a timely manner?

☐ Frequently, once every 1 or 2 years

☐ Occasionally, once every 3 to 5 years

☐ Seldom, once every 6 or more years

☐ Never

77) Is there bureaucratic, political, or other opposition to using leases to finance the acquisition of fleet assets for your department?

☐ Yes, the opposition is quite strong

☐ Yes, but the opposition is weak to moderate

☐ No, there is no opposition to using leases

78) Has opposition to using leases restricted the ability of your department to replace fleet assets in a timely manner?

☐ Not applicable, there is no opposition to using leases

☐ Yes, opposition to using leases has frequently prevented DOT from acquiring all of its needed assets in a timely manner

☐ Yes, opposition to using leases has occasionally prevented DOT from acquiring all of its needed assets in a timely manner

79) If the capital costs of acquiring the assets in the DOT's fleet are financed using leases, are the lease payments passed on to fleet users via a cost charge-back system?

☐ Yes

☐ No

☐ Don't know/not sure

80) If fleet leasing costs are passed on to fleet users, are these costs charged separately or are they recovered using charge-back rates that combine fleet asset capital and operating costs?

☐ Fleet users are charged separately for fleet asset capital (i.e., leasing) costs and asset operating costs

☐ Fleet users pay charge-back rates that combine fleet asset capital and operating costs

81) How satisfied are you with the ability of the primary capital financing method currently used for the DOT fleet to ensure the timely replacement of the assets in the fleet?

☐ Completely satisfied, I wouldn't change a thing

☐ Fairly satisfied but there are some improvements I would like to see made

☐ Dissatisfied, the method is not very effective

82) Describe the improvements you would like to see made.

83) Explain why you are not satisfied with the current method.

84) If you could choose any method for financing the capital costs of the assets in the DOT's fleet *other than* the primary method used today, which method would you choose?

- ☐ I would not want to change the primary method we currently use
- ☐ Outright purchase using funds earmarked for this purpose through the annual (or biennial) appropriations process
- ☐ Outright purchase using funds from an account or fund established specifically for this purpose
- ☐ Outright purchase using borrowed funds
- ☐ Leasing
- ☐ Other

85) Please explain why you selected "Other."

86) Please explain why you feel that the alternative financing method you identified in your response to the previous question would be better than the method currently used.

87) In addition to the fleet asset financing methods already discussed, does your department use any other acquisition strategies to improve the condition of its fleet such as short-term rental of seasonal equipment (e.g., mowers in the summer, loaders in the winter)?

- ☐ No
- ☐ Yes

88) If you are inclined, please describe the short-term asset acquisition strategies that your department uses and explain their purpose.

89) Does your department buy used in lieu of new fleet assets in order to stretch limited fleet asset acquisition budget dollars?

- ☐ Rarely or never
- ☐ Occasionally
- ☐ Frequently

90) Describe the types of assets you acquire and their purpose.

91) Does your department employ manufacturers' guaranteed buy-back programs in order to save money and/or improve the predictability of asset acquisition costs?

☐ No

☐ Yes

92) Please describe the types of assets acquired through the guaranteed buy-back programs and the benefits of acquiring them in this manner.

_____

_____

_____

93) Is there any other information about your department's fleet asset replacement management and/or financing practices not covered by the previous questions that would be helpful for other state DOT fleet managers to know about?

_____

_____

_____

Press the "Submit" button to submit your questionnaire.

THANK YOU AGAIN FOR YOUR ASSISTANCE!

APPENDIX B

Survey Respondent Information

State	Number On-Road Assets	Number Off-Road Assets	Number Other Assets	Total Number Assets	Cost On-Road $ Million	Cost Off-Road $ Million	Cost Other $ Million	Total Cost $ Million
AK	5,618	1,286	500	7,404	217.0	195.0	30.0	442.0
AL	2,764	628	0	3,392	1.4	5.6	0.0	7.0
AR	3,015	2,645	3,525	9,185	93.0	77.0	6.0	176.0
AZ	2,508	464	1,696	4,668	138.0	28.0	24.5	190.5
CA	12,168	710	29	12,907	647.6	96.0	6.0	749.6
CT	4,800	1,200	1,200	7,200	100.0	50.0	50.0	200.0
DE	1,084	404	4,143	5,631	61.0	19.0	27.0	107.0
FL	4,090	1,352	58	5,500	121.0	17.0	9.0	147.0
GA	4,055	4,830	0	8,885	N/A	N/A	0.0	N/A
HI	691	281	148	1,120	32.2	1.1	3.9	37.2
ID	1,630	350	1,999	3,979	90.0	28.7	30.6	149.3
IL	4,551	1,740	10,916	17,207	179.0	65.0	63.0	307.0
IN	3,500	750	3,650	7,900	180.0	25.0	35.0	240.0
IO	2,500	250	250	3,000	150.0	25.0	25.0	200.0
KY	1,874	1,570	6,745	10,189	104.0	82.0	27.0	213.0
MD	2,280	420	600	3,300	114.0	22.8	3.0	139.8
ME	1,500	300	3,000	4,800	N/A	N/A	0.0	N/A
MI	1,675	722	1,446	3,843	72.1	14.7	14.1	100.9
MN	4,100	750	7,200	12,050	206.0	45.0	50.0	301.0
MS	2,543	493	21,766	24,802	84.0	37.0	89.0	210.0
MT	1,950	746	2,072	4,768	100.0	45.0	23.0	168.0
NC	9,100	15,100	0	24,200	254.0	381.0	0.0	635.0
NE	2,647	609	5,649	8,905	95.0	33.0	48.0	176.0
NH	775	142	225	1,142	43.0	8.0	2.0	53.0
NJ	15,000	5,000	2,000	22,000	200.0	150.0	3.0	353.0
NY	5,070	1,588	5,776	12,434	327.0	83.0	51.0	461.0
NM	2,100	4,333	0	6,433	30.0	215.0	0.0	245.0
OH	4,948	1,646	10,167	16,761	193.1	73.5	83.7	350.3
OR	2,235	1,246	2,397	5,878	135.0	105.0	40.0	280.0
PA	5,013	800	16,400	22,213	330.0	280.0	160.0	770.0
SC	3,800	2,762	5,685	12,247	87.5	90.0	22.4	199.9
SD	1,132	1,311	2,276	4,719	N/A	N/A	N/A	N/A
TN	3,500	2,000	500	6,000	250.0	50.0	10.0	310.0
TX	10,796	5,018	7,000	22,814	386.0	297.0	48.0	731.0
UT	1,544	239	2,146	3,929	73.0	18.0	26.0	117.0
VA	6,349	2,128	24,024	32,501	264.1	141.0	115.2	520.3
VT	477	120	40	637	40.0	10.0	0.5	50.5
WY	2,500	1,000	250	3,750	55.0	45.0	3.0	103.0

N/A = not available.

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation