REPORT OF THE

JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION

ON

HIGHWAY CONSTRUCTION, MAINTENANCE

AND

TRANSIT NEEDS IN VIRGINIA

TO

THE GOVERNOR

AND

THE GENERAL ASSEMBLY OF VIRGINIA

SENATE DOCUMENT NO. 8

COMMONWEALTH OF VIRGINIA
RICHMOND
1982

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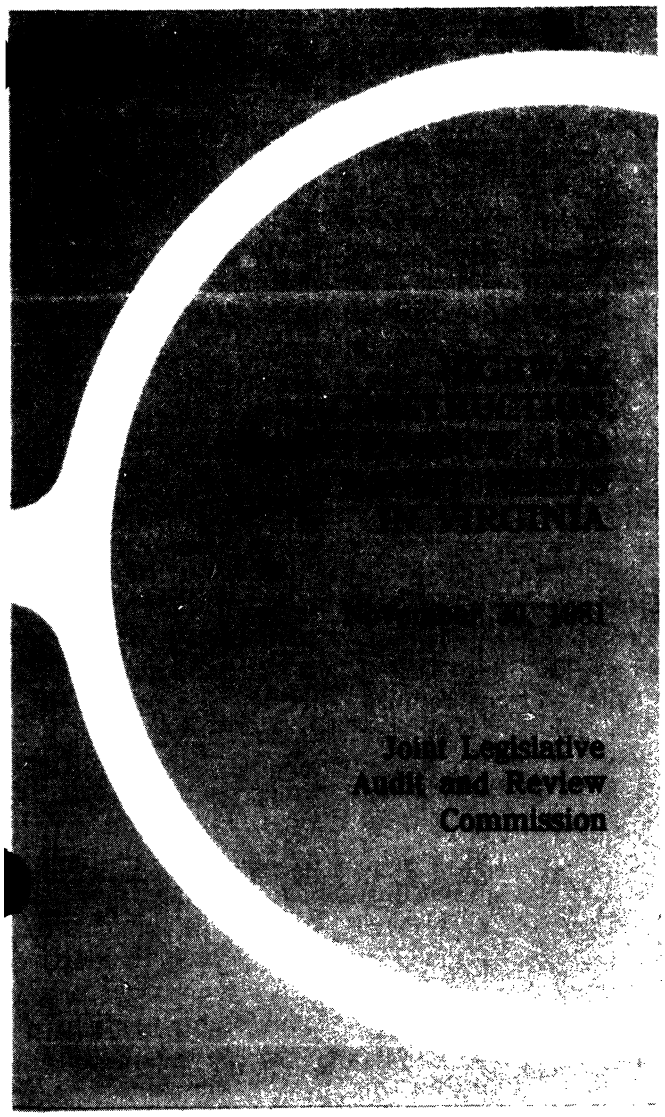
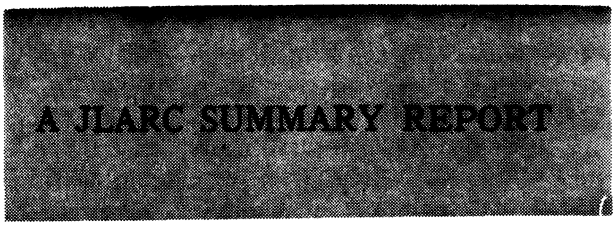


The demands for highway maintenance and construction spending, and for financial support for public transportation, will continue to increase over the next several biennia. Almost $3 billion in highway construction projects will compete for funding during the next six years, while maintenance costs are rising steadily and are expected to almost double by 1988. All of Virginia's public transit systems operate at a deficit, and federal budget cuts could result in the loss of more than $15 million in annual subsidies. To address these concerns, highway and transportation program management in the 1980s will require systematic evaluation of needs and careful selection of priorities.

Maintenance Needs (pp. 7 to 29)

The General Assembly has recognized that adequate maintenance is essential to preserving Virginia's highway system and ensuring the safety of the travelling public. In 1977, the Assembly directed that the Highway and Transportation Commission allocate "reasonable and necessary" funds for highway maintenance before allocating funds for other programs. The intent of this provision was to ensure that sufficient funds would be available to protect the Commonwealth's investment in its highway system and to provide acceptable levels of safety, comfort, and convenience.



Maintenance costs rose from $48 million in 1970 to $186 million in 1980. DHT projects that by 1985 maintenance costs will require all available funds from current revenue sources, effectively ending the construction program. This represents a substantial shift in the emphasis of the Commonwealth's highway program. New construction and system expansion were foremost in previous years; maintenance of existing roadways will be the dominant concern in the 1980s.

Some of the growth in maintenance costs is the result of growth in the highway system itself. Still, after adjusting for inflation and system expansion, expenditures show a real growth in maintenance spending of 20 percent over the last five biennia. All of this real growth has occurred in the area of maintenance replacement, which increased by 49 percent since 1976. Maintenance replacement includes larger-scale projects such as pavement overlays and major rehabilitation of bridges, drainage structures, and traffic control devices. In contrast, the construction program lost one-third of its purchasing power over the last decade.

This real increase in the maintenance program is now built into the base for future DHT budget requests. Therefore, establishing the need for future maintenance spending depends on the extent to which spending has

been consistent with the legislative mandate to budget for reasonable and necessary levels of maintenance. Several weaknesses in DHT maintenance budgeting practice indicate a need for more refined information, however.

Routine Maintenance. Routine maintenance budgets are developed through a Maintenance Management System (MMS) which uses standards to establish funding needs for the various activities. While the system appears fundamentally sound, the standards do not always reflect actual workloads nor do they necessarily guide field crews in carrying out routine maintenance.

For example, MMS budgets do not always reflect the actual work to be performed. A recent review of several workload indicators by the Virginia Highway and Transportation Research Council found that the workload estimates used in MMS varied from actual workloads by as much as 800 percent. While the research council did not attempt to project these findings to the entire system, an effort has been undertaken to measure more accurately workload for pavement surfaces, drainage structures, bridges, and other major components of the highway system.

Moreover, field staff often vary their workload from what was used to develop budgets based on standards. For example, 32 residencies spent $4.1 million, or 24 percent on the average, less on drainage than was budgeted by MMS. In contrast, 34 residencies spent approximately $5.5 million, or 27 percent on the average, over budgeted amounts for bituminous surface maintenance.

Although some variation necessitated by unanticipated events may be warranted, the degree of variation between maintenance expenditures and budgets raises questions about the actual value of the MMS as a means of assessing needs and budgeting for maintenance. DHT should carefully reevaluate its policy concerning residency compliance with budgets based on workload standards. Either closer adherence to the standards should be required or the value of maintaining and updating the standards should be reviewed.

Maintenance Replacement. Maintenance replacement activities are budgeted on the basis of previous years' activity coupled with a review of field office requests by district and central office staff. Budgeting for maintenance replacement follows a traditional incremental form based primarily on staff judgements and the availability of funds. While the pace of maintenance replacement spending has increased dramatically over the last several years, more systematic information on replacement needs should be made available. Adoption of a pavement management system and improvement of existing bridge rating procedures will help DHT to better relate the level of maintenance replacement spending to the legislative mandate for reasonable and necessary maintenance funding.

Maintenance Productivity. Efficient use of resources by DHT is also important in determining maintenance funding needs. Analysis of DHT expenditures and labor and equipment use shows that there is substantial variation in productivity between residencies, and that at least some of the variation can be attributed to the different practices used in performing maintenance. Statistical analysis of these differences indicate that DHT could achieve a savings of approximately eight percent in its ordinary maintenance program by improving productivity. This would amount to a biennial savings of $9.7 million. DHT should review its procedures for identifying and disseminating improved work practices to more quickly and effectively upgrade maintenance productivity.

Legislative Control. A review of DHT spending also found that the 1978-80 biennial maintenance budget was overspent by $59 million above legislative appropriations. Appropriations Act provisions clearly establish a spending limit for highway maintenance but this provision appears to have been disregarded. DHT contends that the overspending was for purposes more similar to construction than maintenance. However, similar activities have been coded as maintenance by DHT since at least FY 1971. A revision in control procedures within the Department of Accounts is necessary to ensure that future spending is consistent with the Appropriations Act.

Overall, the review found that the record is unclear on the degree to which past patterns of maintenance spending have been consistent with the legislative mandate to budget for reasonable and necessary levels of activity. What is known is that spending has increased in real terms and, in one case, beyond what was intended by the legislature. DHT progrm managers believe that the current spending level is required to avoid

premature deterioration of highway and bridge facilities as well as to promote the safety and comfort of highway users. However, better information and more systematic use of existing standards are necessary for DHT to be fully accountable for spending.

DHT should develop an annual maintenance program which assigns priorities for all maintenance activities. The program should identify alternative spending levels and the implications of funding each level. For example, protection of the existing highway network and provision of fundamental safety and comfort levels could be identified as a first priority. Additional maintenance activities which would provide higher levels of comfort, convenience, and aesthetics should be identified as a separate program level.

The Highway and Transportation Commission should review and approve the maintenance program and provide opportunity for review and consultation with appropriate legislative committees. A draft version of the program should be developed by January 1983 and a status report provided to the General Assembly. The approved program should then be available for incorporation into the development of the 1984-86 biennium budget.

Construction Needs (pp. 31 to 57)

Construction of new highways and major rehabilitation of existing roads has been the primary function of DHT in the past. In the last 15 years, $4.5 billion was spent for highway construction. Nevertheless, the most recent assessment prepared by DHT in 1980 showed additional construction needs totalling $6.7 billion, a figure acknowledged in the DHT report to be unfundable under any reasonable assumptions. Therefore, a means of establishing priorities among potential projects is essential if needs studies are to be of use to the General Assembly in establishing budgets and appropriate tax policies.

An analysis of projects contained in the 1980 needs report found that one reasonable approach to establishing priorities among projects reduced construction funding needs over the next three biennia to $2.35 billion. This amount would ensure receipt of the expected $1.5 billion in available federal aid, provide for continued funding of Virginia's interstate program, and address construction needs most directly related to current concerns for traffic volume, congestion, safety, and structural deterioration of existing roads. In urban areas where population growth and economic development are key factors, 82 projects now underway or awaiting funding would be moved to construction. In perspective, however, even this level of spending would amount only to 59 percent of the purchasing power of the 1978-80 construction program. This fact confirms that the combined effects of inflation, slow revenue growth, and increased maintenance spending will result in less construction in the future than was possible in the past.

Other options for construction funding are also possible and are detailed in this report. Subsequent to the draft of this analysis, DHT released a draft critical improvements program which provides yet another optional spending level for consideration by the General Assembly. In order for the legislature to conduct an orderly review of the implications of various construction spending proposals, DHT should prepare and submit as part of its budget requests to the General Assembly a four to six year construction program which is based on an analytic framework that clearly distinguishes when funds will be required for construction. The program should include provisions for annually updating and adjusting the program to report on progress in fulfilling program objectives and to accommodate General Assembly action or other changes in existing conditions.

In addition, the General Assembly may wish to amend statute to require that the Highway and Transportation Commission allocate sufficient funds to match available federal aid for highway construction. A review of current statute and legislative history suggest that this is consistent with the intent of the General Assembly. This action would prevent the lapsing of Virginia's apportionment of federal aid because of a lack of matching funds and would provide for a minimum construction budget of about $300 million annually. Implications of the current legislative priority on maintenance and the statutory allocation formula should also be considered.

Public Transportation Needs (pp. 59 to 74)

Public transportation in Virginia includes 15 public transit systems as well as a variety of ride-sharing programs sponsored by busi-

nesses and public agencies. The most critical issue today for public transportation in Virginia is meeting the cost of providing transit services. All transit systems operate at a loss which ranges from ten cents per passenger trip in one system to well over one dollar per trip in several others. During FY 1980, operating costs for the 15 systems exceeded $100 million, while revenues amounted to less than half that amount, resulting in a deficit of approximately $51 million.

Funds to meet transit operating deficits are provided largely by the localities and the federal government. However, current proposals before Congress and supported by the administration call for elimination of federal operating subsidies for local transit. Virginia could experience a loss of more than $15 million annually in federal aid. In response, transit systems would have to raise fares substantially as well as reduce existing service levels, or rely on local governments for additional financial support.

Current State policy prohibits the use of State funds for transit operating subsidies. In order to address the changing environment created by proposed shifts in federal policy, the General Assembly may wish to review legislative options through creation of a special joint subcommittee.

In order to assist the General Assembly in its review, the public transportation division of DHT must seek ways to better fulfill the role mandated in statute. The division is authorized to prepare needs assessments and funding proposals, as well as conduct investigations of transit system operating efficiency and economy. To date the division has not fulfilled this oversight role or provided the type and quantity of information necessary for full consideration of State policy in this area.

COMMONWEALTH of VIRGINIA

Joint Legislative Audit and Review Commission
Suite 1100, 910 Capitol Street
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November 30, 1981

The Honorable John N. Dalton, Governor
The Honorable Members of the General Assembly
State Capitol
Richmond, Virginia 23219

Ladies and Gentlemen:

We are pleased to enclose the report on highway and public transportation needs in Virginia. The report was prepared by the Joint Legislative Audit and Review Commission with the cooperation of a study committee designated by Senate Joint Resolution 50 of the 1980 Session.

Sincerely,

Theodore V. Morrison, Jr.
SJR 50 Committee Chairman

Richard M. Bagley
JLARC Chairman

TVM:RMB/jmi

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I. Introduction

This report on highway and public transportation needs in Virginia is one in a series prepared in response to Senate Joint Resolution 50 passed by the 1980 General Assembly. The report provides specific information on funding requirements for (1) construction of new highways, (2) maintenance of existing roads, and (3) public transportation.

Transportation is the third largest function of the State budget. Approximately $1.9 billion were appropriated for transportation programs in the 1980-82 biennium. Demands for additional construction, increased maintenance, and transit services now exceed available and projected revenues. As a result, careful review of proposed expenditures is needed to identify priorities for use of available funds. In order to conduct its review, the General Assembly requires comprehensive information on highway and transit needs, as well as specific options for alternate levels of program activity which assess the benefits gained or lost with each option.

This report demonstrates both how the maintenance and construction programs can be analyzed and how funding options can be developed. The report also reviews the financial condition of local transit systems and identifies the financial requirements for their continued operation at current levels of service.

Virginia's Highway System

The growing demand for State highway revenues results from the scope and size of the State highway system. DHT has the responsibility for constructing and maintaining most roads in the Commonwealth. Only cities, incorporated towns, and two counties (Arlington and Henrico) currently construct and maintain roads outside the State system. These localities receive financial assistance from the State highway trust fund.

Virginia has the third largest State highway system in the nation, with 60,881 miles of roads. The State highway system serves all levels of need for mobility and access, ranging from modern high-speed, controlled-access routes to two-lane country roads. Highways in Virginia are divided into four administrative systems: interstate, primary, secondary, and urban (Table 1).

Table 1

STATE HIGHWAY SYSTEM MILEAGE
(1980)

System	Centerlane	Lane
Interstate	969	4,200
Primary	7,895	20,159
Secondary	43,851	87,881
Urban	8,166	18,001
Total	60,881	130,241

Source: Department of Highways and Transportation.

Interstate System. The interstate highway system was created by the Federal-Aid Highway Act of 1956 and is authorized in §33.1-48 of the *Code of Virginia*. Specific interstate routes are designated by the Highway and Transportation Commission. Typically, these are four-lane divided highways on controlled access right-of-way. Virginia had completed 991 miles of interstate highways by January 1981, over 90 percent of its 1069 authorized interstate mileage.

Primary System. The primary system, authorized in §33.1-25 of the *Code of Virginia,* comprises roads in the State highway system not otherwise designated in statute. The commission has discretion to transfer roads into the primary system from the secondary system under §33.1-34. The primary system includes the arterial network which complements the interstate system and connects major cities and towns. Section 33.1-26 sets out criteria to be used in designating highways to be part of the arterial network.

Urban System. Primary highways which pass through cities and towns over 3,000 in population constitute urban highways. According to §33.1-41 of the *Code of Virginia,* these roads are designated by the State Highway and Transportation Commissioner, subject to the approval of the Highway and Transportation Commission.

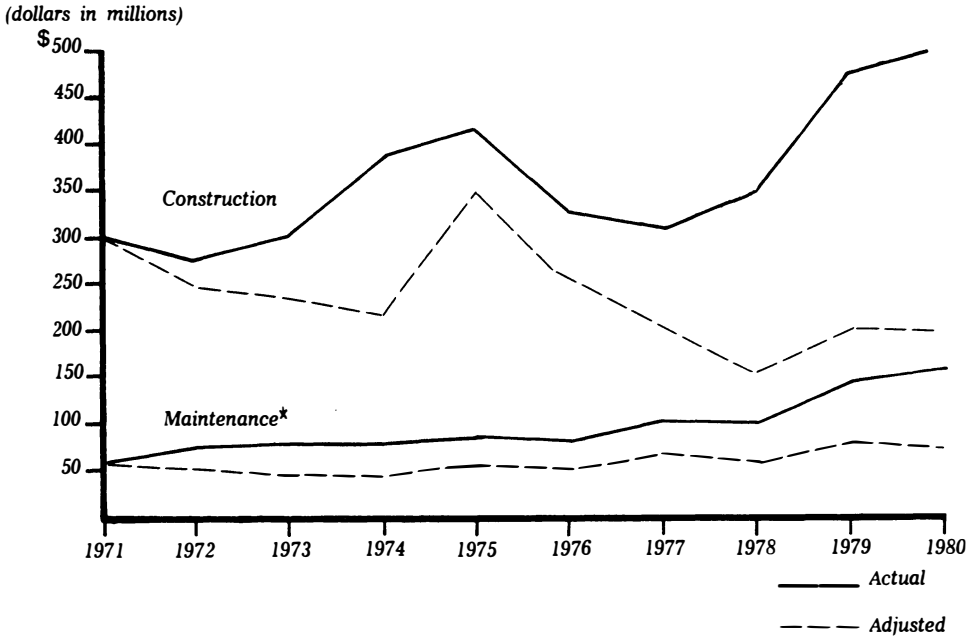
Secondary System. All public roads in the counties and all public roads and community roads leading to and from public schools, streets, bridges, and wharves in incorporated towns with 3,500 or fewer residents comprise the secondary system of highways. Certain other roads (for example, those connecting public schools to either primary or secondary highways) are also classified as part of the secondary system, as provided in §§33.1-67 and 33.1-68 of the *Code of Virginia*.

Maintenance and Construction Cost Trends

Expenditures for maintenance and construction increased during the 1970s. However, when the expenditures are adjusted for inflation, a different pattern is seen (Figure 1). Maintenance spending, measured in constant dollars, showed some real growth over the decade. But construction spending has been marked by a real loss in program scope when the effects of inflation are removed. Over the decade the construction program lost one-third of its purchasing power.

Figure 1

CONSTRUCTION AND MAINTENANCE EXPENDITURES
ACTUAL AND ADJUSTED FOR INFLATION (TO 1971)
1971-1980



*Excludes snow removal and ice control and winter and flood damage expenditures.

Source: Department of Highways and Transportation.

In 1977 the General Assembly directed the Highway and Transportation Commission to allocate all funds deemed reasonable and necessary for maintenance purposes before allocating expenditures for construction. The real increase in maintenance expenditures beginning in 1977 and continuing through 1980 reflects in part the priority given to the maintenance of existing highways. Meeting this priority and providing current levels of maintenance will require even greater spending throughout the 1980s.

In contrast to this likelihood, highway fund revenues are predicted by DHT to show little growth through the 1980s and will, in fact, experience a decline in purchasing power because of inflation. As a result, the department estimates that drastic reductions in construction will be necessary beginning in 1985 unless additional revenues are made available by the General Assembly.

Public Transit Financing

The financial picture for public transit systems in Virginia is also changing. All systems will continue to operate at a deficit, but the federal aid which has made up 30 percent of operating losses in the past is proposed for elimination. With the loss of federal aid, transit systems will be under considerable pressure to raise fares, reduce services, or obtain additional State and local aid.

Study Scope and Methods

The findings of the highway and transit needs study are based on the analysis of an extensive body of data pertaining to maintenance, construction, and public transit finance. DHT was the primary source for this information, which was supplemented by interviews with DHT field personnel, local and regional officials, and transit system operators. Specific data sources and analyses are presented in each chapter. The major analytical methods and sources are described below.

Maintenance. Analysis of the maintenance program was based on data from the Maintenance Management System, DHT estimates of future maintenance requirements, Maintenance Division budget and policy documents, and many interviews conducted at all levels of the maintenance organization. Expenditure data came from the 1978-80 biennium; future estimates covered fiscal years 1981 through 1988. Statistical regression analyses were applied to maintenance performance data to measure the productivity of field units.

Construction. Approximately 1,200 proposed construction projects on all four road systems were reviewed on the basis of five need indicators: (1) construction feasibility in the period between 1983 and 1988; (2) local endorsement; (3) traffic volume, congestion, and safety information; (4) structural condition; and (5) availability of federal aid. The projects were identified through use of DHT's 1980

Present Day Needs Study, random samples of projects in county six-year plans, the January 1981 status report on the Statewide Transportation Plan, and DHT bridge data. The analysis developed indicators for each project through use of DHT data and interview information to determine levels of need.

Public Transportation. The review of public transportation needs describes the current operational and financial status of transit systems in Virginia and the sources of funding for the systems. Interviews were conducted with DHT Public Transportation Division personnel, local transit operators, and federal officials. Cost and funding data used in the analysis were collected from these sources.

Report Organization

The remainder of this report presents the findings of JLARC's review of needs in three substantive areas as directed by SJR 50. Chapter II reviews the maintenance program and documents the need for improved budgeting and increased productivity. Chapter III analyzes construction needs and presents funding requirements for three potential construction programs. Finally, public transportation needs are examined in Chapter IV.

II. Maintenance Needs and Funding Requirements

The General Assembly has recognized that adequate maintenance is essential to preserving Virginia's highway system and ensuring the safety of the travelling public. In 1977, the Assembly directed that the Highway and Transportation Commission allocate all "reasonable and necessary" funds for highway maintenance before allocating funds for other programs. The intent of this provision was to ensure that sufficient funds would be available to protect the Commonwealth's investment in its highway system and to provide acceptable levels of safety, comfort, and convenience.

The cost of highway maintenance has risen steadily in recent years. Maintenance expenditures were $48 million in 1970; by 1980 they were $186 million. DHT estimates that maintenance will require all available funds by 1985, effectively ending the Commonwealth's construction program. This trend represents a substantial shift in the emphasis of the highway program. New construction and system expansion were foremost in the last two decades; maintenance of existing roadways will be the dominant concern in the 1980s.

A careful analysis of maintenance needs is required to determine reasonable and necessary levels of maintenance. The limited growth in highway revenues projected for the 1980s and continued inflation require that maintenance managers evaluate the need for maintenance services closely and seek more efficient ways to perform essential functions. DHT should set priorities for maintenance activities and inform the General Assembly what expenditure will provide a "reasonable and necessary" maintenance program. DHT can also become more productive in carrying out its maintenance mission. JLARC's review of maintenance operations suggests that $10 million or more can be saved each biennium through increased efficiency.

The Maintenance Program

The basic goals of the maintenance program are: (1) the preservation and restoration of existing facilities; and (2) the promotion of the safety of the travelling public. The maintenance budget also funds operation of special facilities (tunnels and weigh stations, for example) and provides for services, such as rest areas, which contribute to the comfort and convenience of highway users.

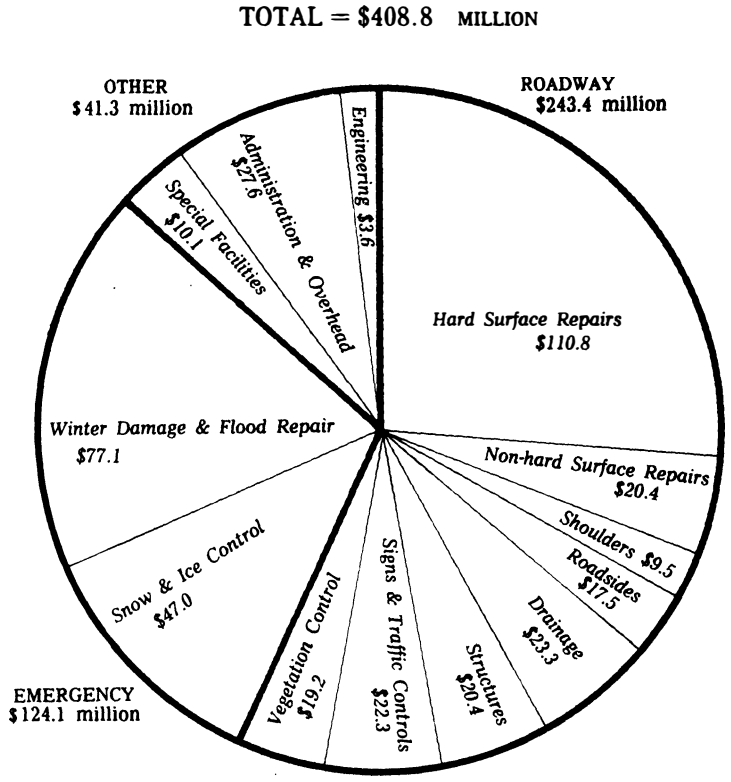
Maintenance work is classified into two broad categories: ordinary maintenance and maintenance replacement. These categories reflect the scope and frequency of work performed. Ordinary maintenance consists of routine activities intended to preserve roads in their current condition or to maintain essential operations. Examples of typical ordinary maintenance are filling potholes, removing brush, or cleaning ditches.

Maintenance replacement, on the other hand, is directed at restoring a deteriorated road to its original condition. This activity is primarily major rehabilitation work such as pavement resurfacing, replacing guardrails, signs, or drainage structures, and extensive bridge repair. Replacement work is generally more expensive and performed less frequently than ordinary maintenance.

During the 1978-80 biennium $205 million was spent for ordinary maintenance and $204 million for maintenance replacement. Despite the differences in scope and frequency, ordinary and replacement maintenance activities address similar purposes as shown by their combined expenditures (Figure 2). Almost 60 percent of the expenditures, $243 million, relate directly to maintenance of the roadway itself. This includes repair of road surfaces, shoulders, drainage systems, bridges, tunnels, and control of vegetation.

Figure 2

MAINTENANCE EXPENDITURES
1978-80 BIENNIUM



Source: DHT Maintenance Management System.

An additional 30 percent of maintenance expenditures, $124 million, was spent in the two emergency categories of snow and ice control and repair of winter and flood damages. The remaining expenditures covered the operation and maintenance of special facilities, such as weigh stations and ferries, as well as engineering, administration, and other miscellaneous purposes.

The maintenance program has grown substantially in the past ten years - reflecting partly the increasing size of the State highway system. Some 200 miles of interstate highway, two new tunnels, and 20 rest areas were added during the 1970s. When expenditures are examined on a lane mile basis and adjusted to account for inflation, however, it becomes apparent that the program has experienced real growth beyond the addition of facilities (Table 2).

Table 2

MAINTENANCE EXPENDITURES PER LANE-MILE
(indexed to 1971 costs)

Biennium	Total Expenditures	Ordinary Maintenance	Maintenance Replacement
1970-1972	$435	$264	$171
1972-1974	403	223	180
1974-1976	410	239	172
1976-1978	472	225	247
1978-1980	523	268	255
Percent Change	20%	2%	49%

Note: Excludes maintenance expenditures for categories which are not likely to be correlated with lane miles, such as weigh stations, drawbridges, and ferries. Also excludes repair of winter and flood damage, snow removal, general expenses, and supervisory costs.

Source: JLARC analysis of DHT data.

Even with the effects of inflation removed, combined maintenance expenditures per lane-mile increased 20 percent, from $435 to $523, over the last five biennia. Examining lane-mile expenditures for ordinary and replacement maintenance further illustrates the nature of the growth in the maintenance program. Lane-mile expenditures for ordinary maintenance varied over the decade but ended the period only slightly above the 1970-72 level. Thus, spending for ordinary maintenance kept pace with inflation but provided little real growth in the program.

In contrast, replacement maintenance accounts for virtually all of the real growth over the decade. Spending accelerated greatly in real terms in 1976-78 and kept to that high level in 1978-80. Overall, spending for maintenance replacement increased 49 percent in real terms over the decade.

Scope and Method of Maintenance Analysis

JLARC analysis of maintenance needs is based on a review of expenditures and activities during the 1978-80 biennium and DHT projections for fiscal years 1983 through 1988. The basic approach was to identify expenditure patterns and evaluate them against legislative intent and efficient use of resources. JLARC staff also interviewed DHT maintenance personnel at all organizational levels to determine how maintenance needs were identified and controlled.

DHT maintenance efficiency was evaluated by identifying differences in expenditures among residencies for accomplishing similar amounts of work in specific maintenance activities. The degree to which DHT employees, equipment, and materials are used efficiently influences significantly the need for maintenance funds.

NEEDS ASSESSMENT

The past spending for highway maintenance illustrated in Table 2 is built into the base of DHT budget requests. Therefore, establishing the need for future maintenance spending depends on identifying past spending patterns that are consistent with the legislative mandate to budget for reasonable and necessary levels of maintenance.

Two processes are used to assess maintenance needs and develop budget requests. The Maintenance Management System uses maintenance standards and past experience to budget for routine maintenance. Less routine, maintenance replacement needs are budgeted incrementally--previous years' funding levels are adjusted for inflation and any additional work that can be identified.

Routine Maintenance

The Maintenance Management System (MMS) is used to develop routine maintenance budgets for each county and road system. MMS is a performance budgeting and reporting system that prescribes the amount of work that should be accomplished each year, and allocates resources that standards and experience indicate are necessary. Approximately 86 percent of the routine maintenance budget is developed in this manner.

Maintenance Standards. The costs of the ordinary maintenance program are determined by the standards that constitute the foundation

of MMS. Each year's maintenance budget is developed on the basis of standards and the resources necessary to accomplish the work specified by the standards. On this basis, labor and expenditures are budgeted to permit accomplishment of the desired workload.

Maintenance standards were originally developed by a committee of maintenance engineers as part of the Virginia Maintenance Study conducted between 1963 and 1966 by Roy Jorgensen and Associates. On the basis of their judgements concerning investment protection, safety, and levels of service the public should receive for their comfort and convenience, committee members made qualitative statements about the conditions to be maintained and about how they should be achieved.

Performance standards were developed through a study of the actual work performed by 38 maintenance areas in nine residencies around the State and a review of three years' data. In addition, studies were performed to improve productivity in operations and to define activities and work unit measures. These efforts resulted in the establishment of standards for the following: (1) maintenance workloads for each activity; (2) the resources--labor, equipment, and materials--required for each activity; (3) the relationships between workloads and road types; and (4) the seasonal and geographical variations in workload and performance.

The Jorgenson study was comprehensive and the resulting MMS offered a sound approach to budgeting for routine maintenance. Subsequent changes in maintenance standards have reflected changes in workloads, conditions, costs, and policies. These adjustments have reduced the resource requirement per unit of output in most cases, suggesting either increased efficiency or a recognition that the original standards were higher than necessary. In general, however, the framework developed in the 1960s remains intact and serves as a base for budgeting.

These standards are used to develop maintenance budgets for most routine maintenance activities. Figure 3 illustrates the standards applied to one activity, machining (smoothing with a grader) non-hard surface roads. The number of machinings per mile of road, as well as the man-hours of effort required and the expected cost per mile, are specified for various regions of Virginia. Regional differences are based on variations in soil conditions, topography and material and labor costs.

Using the standards in Figure 3, for example, the Bedford residency would have an annual budget of $120 per mile of non-hard surface road, and it could expect to commit 9.6 man-hours per mile to satisfy the standard of eight machinings annually. Chesterfield County, on the other hand, would budget $335 and 25 man hours per mile to provide the desired 18 machinings annually.

Although the MMS provides a framework for budgeting routine maintenance, there are three problems with the current process. First,

Figure 3

EXAMPLE OF MAINTENANCE MANAGEMENT SYSTEM COMPONENTS

ACTIVITY: Machining Non-Hard Surface Roads on Secondary System

Inventory Unit

Miles of non-hard surface roads in county.

Quantity Standards

4 machinings/mile annually - Staunton, Salem, Bristol districts
8 machinings/mile annually - Culpeper and Lynchburg districts
18 machinings/mile annually - Richmond, Suffolk and Fredericksburg districts

Performance Standards

4.0 man hours/mile machined - West of Blue Ridge
2.4 man hours/mile machined - Counties bordering on eastern slope of Blue Ridge
1.4 man hours/mile machined - State

Unit Cost Allowance

$53.00/mile - Wise, Dickenson, Buchanan
49.50/mile - Staunton, Salem and Bristol districts
31.40/mile - Leesburg
30.00/mile - Amherst, Charlottesville, Culpeper, Warrenton, Bedford, Martinsville and Rocky Mount residencies
21.00/mile - Fairfax
20.00/mile - Manassas
18.60/mile - Lynchburg, Richmond, Suffolk and Fredericksburg districts and Louisa residency

Source: Department of Highways and Transportation.

some assumptions about workloads that are incorporated into MMS standards need to be reviewed and updated. Second, field staff commonly deviate from compliance with the budget targets. The third problem is that DHT does not establish priorities for routine maintenance.

Workload Assumptions. The assumptions about workload in different locations, originally developed in the 1960s, appear to need updating. Some have been adjusted by the Maintenance Division to meet changing circumstances. However, the Virginia Highway and Transportation Research Council (VHTRC) demonstrated in 1979 that in at least some cases, MMS workload assumptions did not reflect actual workloads.

VHTRC compared the actual workloads in three geographic areas with the workload standards assumed in MMS. In all three cases there were great differences between assumed and actual workloads for ditching activities (Table 3). For example, MMS workloads for machine ditching in Area A were 81 percent greater than actual workloads on hard surface roads and 76 percent greater for non-hard surface roads. Area A was budgeted for hand cleaning over 6,100 miles of ditches when in fact there were no ditches requiring hand cleaning. The hand ditching workload for Area C, however, was eight times greater than its workload assumption.

Table 3

ACTUAL WORKLOAD COMPARED WITH ALLOCATED WORKLOAD
FOR DITCHING ACTIVITIES IN THREE MAINTENANCE AREAS

	Area A		Area B		Area C	
Activity	Allocated	Actual	Allocated	Actual	Allocated	Actual
Machine Ditch-Miles						
Hard Surface Roads	100	55	186	175	225	225
Non-Hard Surface Roads	113	69	141	102	45	45
Hand Clean Ditch-Feet	6,156	0	24,458	16,880	40,509	335,150

Source: Virginia Highway and Transportation Research Council.

The VHRTC did not attempt to determine how common were such differences across the State. However, the substantial differences between MMS workload assumptions and actual workloads in Table 3 indicate that MMS standards are not always accurate predictors of work to be performed. As a result of the VHRTC findings, a statewide effort was undertaken by DHT to accurately measure workload for items such as drainage structures, signs, bridges, guard rails, lights, mowing areas, fences, sidewalks, and different types of pavement surfaces. This statewide inventory of maintainable items is almost complete and should enable the Maintenance Division to align budget allocations with actual workload more accurately.

Field Compliance. Once performance budgets are developed through MMS, decisions about the actual work to be performed are made by field managers. There was little consistency between budgeted amounts and actual spending during the 1978-80 biennium, however. A review of 1978-80 expenditures showed that field maintenance managers redirected maintenance emphasis among road systems. Most residencies overspent their secondary system budgets while underspending their interstate and primary system budget.

In addition, planned and actual expenditures for major routine maintenance activities also varied for the 1978-80 biennium (Table 4). Although most residencies performed routine work within their

total budgets, trade-offs between maintenance categories were made at the residency level to meet what were considered locally to be the most important needs. These trade-offs are reflected in the variation shown in Table 4.

Table 4

RESIDENCY BUDGET PERFORMANCE
IN SELECTED ORDINARY MAINTENANCE CATEGORIES
1978-80 Biennium

Maintenance Category	Residencies Under Budget			Residencies Over Budget		
	N	Median Amount	Median Percent	N	Median Amount	Median Percent
Bituminous	11	$100,025	20%	34	$140,640	27%
Concrete	21	7,275	86	7	3,181	54
Non-Hard Surface	16	21,954	10	27	55,193	27
Shoulder	30	73,039	26	15	37,858	26
Drainage	32	128,902	24	13	64,757	14
Roadside	38	32,859	32	7	47,403	14
Vegetation	32	61,268	17	13	45,744	11
Guard Rail	31	7,813	59	14	20,723	127
Structures	33	25,565	46	12	13,744	22
Signs & Traffic Signals	34	32,014	19	11	26,048	13

According to DHT such variation is acceptable because the budget targets are guidelines, and actual performance may be affected by unanticipated events. The broad tendency to underspend on drainage maintenance, for example, was generally acknowledged by field personnel to be caused by unanticipated increases in the cost of using heavy equipment as a result of high fuel costs. As a result, resident engineers reduced ditch cleaning activity and shifted funds into other areas such as bituminous surface repair where the high petroleum prices increased the cost of asphalt.

Although some variation in response to unanticipated events may be warranted, the degree of variation between maintenance expenditures and budgets raises questions about the actual value of the MMS as a means of assessing needs and budgeting for maintenance. The discrepancies between workload standards and actual workloads may also contribute to the variation between budgeted activities and actual performance.

The inventory of maintainable items is a good first step toward developing more accurate workload standards. As the inventory is incorporated into MMS workload standards, DHT should carefully reevaluate its policy with regard to residency compliance with budgets

based on workload standards. Either closer adherence to the standards should be required or the value of maintaining and updating the standards should be reviewed.

Lack of Priorities. The third problem with the current process for assessing routine maintenance needs is the lack of a mechanism for setting priorities based on the best information available to DHT. In the past, the need for careful review of spending on routine maintenance was lessened by the relatively small size of the budget and the availability of adequate revenues to meet both construction and maintenance demands. Now, however, maintenance needs must be carefully scrutinized to ensure that all expenditures are necessary.

DHT is presently considering a number of reductions in maintenance activities as a means of limiting costs. In effect, such reductions would mean that the priority for some activities would be lowered or eliminated altogether. For example, one proposal under consideration would change snow removal standards to save an estimated $2 million annually. The department has already eliminated holiday service patrols and cut back on dead animal and litter patrols.

Most priority setting, however, is done at the individual residency level. A consultant employed by DHT in 1980 concluded that management decisions regarding cutbacks and service reductions are made at the individual field office level rather than as part of a deliberate and consistent adjustment to maintenance operations. JLARC staff field work confirmed that the same lack of statewide priorities for routine maintenance continues to be the case. As a result, the ability of the commission and department managers to develop and implement spending priorities through adjustments of MMS standards is weakened.

Maintenance Replacement

All highway facilities eventually deteriorate and need major repair. This category of work is maintenance replacement. The most common type of maintenance replacement is road resurfacing, with a cost of approximately $35.8 million in the 1978-80 biennium. Other examples of replacement maintenance include major rehabilitation of bridges and the replacement of guardrails, drainage structures, and signs. Because needs lie at the base of the maintenance replacement budget, the department must use appropriate mechanisms for assessing needs -- such as a pavement management system and an inventory of bridge condition.

Development of Maintenance Replacement Budgets. Budget requests for maintenance replacement are based primarily on past experience with increases to provide for inflation and to meet some critical needs specifically identified by department engineers. Once the legislature appropriates maintenance funds, the department conducts a field review to establish priorities for maintenance replacement. Unlike

ordinary maintenance, where budgets are developed using standards and assumed levels of need based on experience, maintenance replacement needs are identified and addressed to the extent that funding is available each year.

The replacement needs assessment process for secondary roads differs from the process for interstate and primary roads. On the secondary system, funds are allocated to residencies based on county mileages and anticipated differences in costs. The resident engineer reviews replacement needs, often in consultation with county boards of supervisors, and funds the projects considered to be most important within budget limits. Thus, resident engineers exercise a high degree of discretion on which secondary system replacement projects to undertake within a county.

On the interstate and primary systems much more centralized control is exercised in selecting projects. Budgets for these two systems account for almost 40 percent of replacement maintenance expenditures. Residency staff request funding for projects, and these requests are reviewed and amended by district staff and forwarded to the central office. A field review of individual requests is conducted and priorities are negotiated among residencies, districts, and the central office.

A review of the differences between residency and district requests and final allocations for primary resurfacing revealed wide differences in opinion about needs and funding requirements. Residencies typically request far more maintenance replacement than can be funded. Examination of residency requests in three districts showed that districts reduce initial residency requests by between 60 and 90 percent. More significantly, the graphs in Figure 4 show that there is some inconsistency between district and central office judgements. Although most graphs show the expected pattern of district requests being reduced by a relatively constant percentage, Fredericksburg and Staunton show several years when field office requests were actually less than the amount eventually allocated.

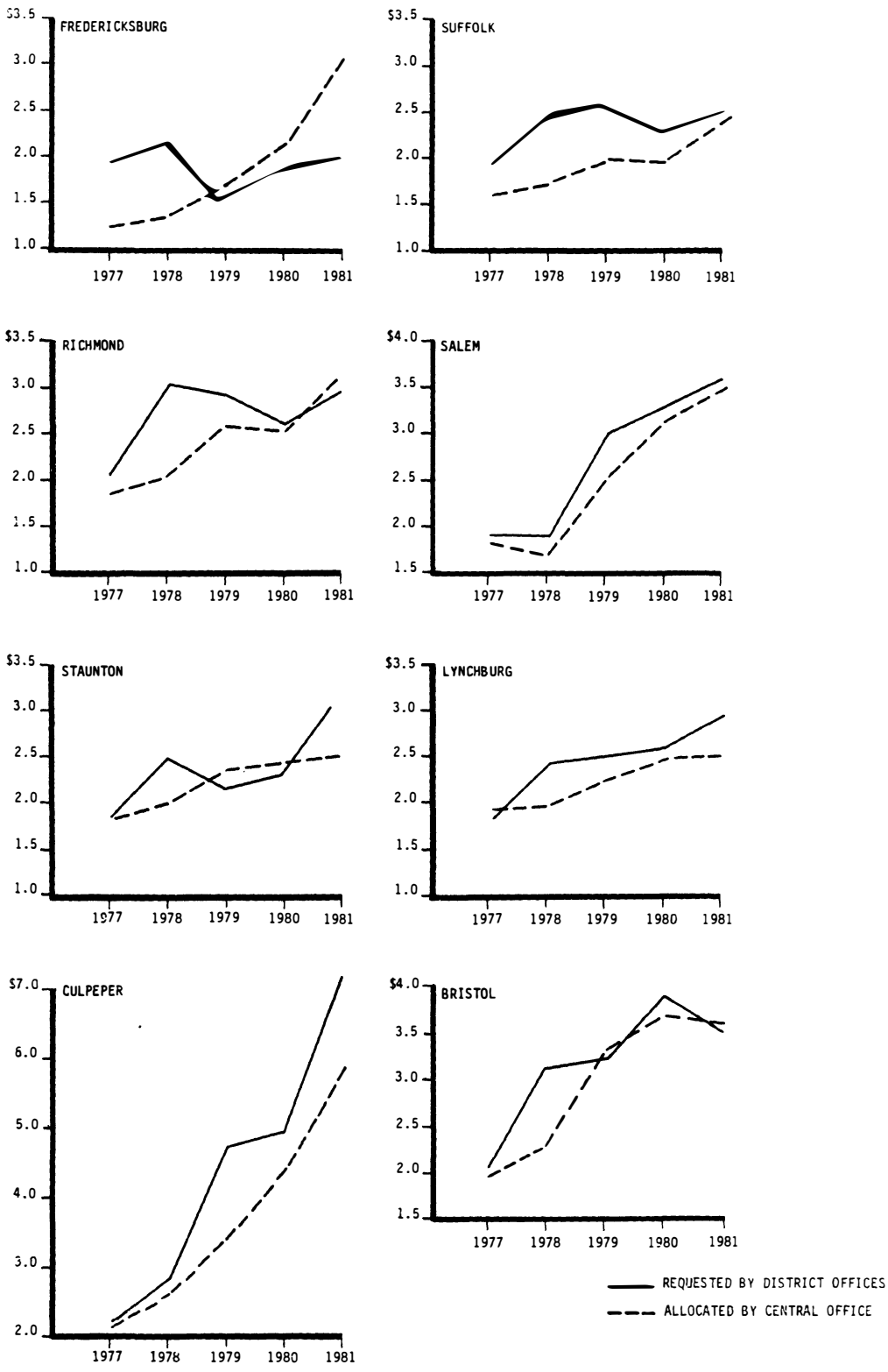
The variability in estimating needs for maintenance replacement is also illustrated by differences between intended and actual resurfacing schedules. DHT staff stated that primary roads should be resurfaced every eight to 12 years. A review of maintenance records shows that primary roads have been resurfaced on an average cycle of 15 years. The discrepancy would suggest that road surface quality should be deteriorating. However, the 1980 consultant study found Virginia's roads to be in good condition and DHT maintenance staff believe that the only loss in service level has been in the difficult-to-define category of ride quality. Nevertheless, appropriately spaced resurfacing is necessary to ensure the continued serviceability of the highway network.

Pavement Management System. DHT staff acknowledge a need for a more systematic means of determining what level of maintenance

Figure 4

PRIMARY SYSTEM RESURFACING
FY 1977-FY 1981

(Dollars in Millions)



replacement is required. A pavement management system (PMS) incorporating state-of-the-art assessment methods would improve DHT's ability to evaluate current roadway conditions, distribute funds, and predict more accurately the resources needed to maintain pavements.

A PMS collects and analyzes data from a systematic sample of highways on the pavement condition including surface distress such as cracking and rutting, ride quality, structural integrity, and skid resistance. This information is used to index pavement condition and monitor changes. Policy can then be established regarding the level of pavement deterioration which will trigger replacement spending. As a result, budgets could be developed and funds distributed to geographic areas and among road systems on the basis of a more systematic evaluation of pavement conditions.

The Maintenance Division has initiated the development of a PMS for Virginia's highways. According to the maintenance engineer, pavement condition data on the interstate system will be available by the end of 1981. Given an adequate priority, data on a representative sample of the primary, urban, and secondary systems could be developed in 1982. DHT should place a high priority on developing a pavement management system for Virginia. The preliminary information should be incorporated in a status report to the 1983 General Assembly, and complete assessment of highway condition should be completed by the beginning of the 1984-86 biennial budget cycle.

Bridge Maintenance Information. A second area of maintenance replacement needs assessment and budgeting which underutilizes existing information is bridge maintenance. DHT spent $11 million in 1978-80 for maintenance replacement work on bridges. Bridge maintenance funds are budgeted and allocated to residencies on the basis of a field review which incorporates professional judgement, field requests, and complaints.

The DHT Bridge Division maintains a comprehensive inventory of bridges on all systems. The inventory provides information on bridge condition based on periodic field inspections made by district bridge engineers. Reports made by the inspectors are used to rate the condition of each bridge. Ratings range from 100 (excellent condition) to zero (very poor condition). In addition, inspectors' reports often contain recommendations for specific maintenance needs on the bridges.

Despite the potential usefulness of the bridge condition inventory, the reports are not reviewed by the central office maintenance staff in developing maintenance replacement budgets. According to the maintenance engineer, districts are supposed to use bridge ratings and inspection reports to set priorities for bridge maintenance work. There is, however, no systematic use of the data statewide.

The bridge inventory can serve as an important source of information for assessing replacement maintenance needs and developing budgets. The data maintained on the inventory can be used to generate

reports on bridge conditions and problems. In order to be fully useful for this purpose, however, greater uniformity in bridge inspections is needed, particularly among districts. Some district bridge inspectors tend to rate bridges very low while bridges in similar condition in other districts are rated higher.

> *Two bridges in different districts have a sufficiency rating of 4.6, an indication of very poor condition. However, review of actual inspection reports reveals that one bridge is in generally good condition and not in need of immediate replacement or major maintenance work while the second shows evidence of significant deterioration and should be replaced.*

Bridge Division personnel indicated that inconsistent ratings and reports are a problem which limits the usefulness of the bridge inventory. Greater emphasis on consistent reporting to ensure statewide comparability of data would significantly enhance the usefulness of the bridge inventory in assessing maintenance need.

Legislative Control of Maintenance Expenditures

A major purpose of the maintenance needs assessment process is to inform the General Assembly of the funding required to provide a necessary and reasonable level of maintenance. As noted above, however, weaknesses in DHT's maintenance needs assessments limit the ability of the legislature to evaluate funding requests for maintenance. The lack of priorities for maintenance activities is a particular hindrance to legislative review. Presentation of budget requests as a single sum with no further detail on activities to be funded or an indication of the priorities for the activities does not permit the General Assembly to make its own determination of needed maintenance funding.

Regardless of these difficulties, the maintenance appropriations made by the General Assembly represent the basic legislative control over the program. DHT is provided with some flexibility to increase its appropriations through specific provisions, but these provisions also specify a limit to such increases.

Although the General Assembly has sought to limit DHT expenditures through appropriations restrictions, the department has overspent appropriations for highway system maintenance beyond levels authorized in the 1978-80 Appropriations Act. In the 1976-78 and 1978-80 biennia total appropriations were exceeded by 39 percent and 35 percent respectively (Table 5). The overspending was authorized in 1976-78 but was not authorized for 1978-80.

The overspending for the 1976-78 biennium was authorized under the general provisions of Section 185 which allowed the Governor

Table 5

MAINTENANCE APPROPRIATIONS AND EXPENDITURES
(dollars in millions)

	1976-78 Biennium			1978-80 Biennium		
	FY 1977	FY 1978	Total	FY 1979	FY 1980	Total
Interstate						
Appropriation	$ 16.0	$ 17.1	$ 33.1	$ 21.5	$ 22.8	$ 44.3
Expenditure	18.6	20.9	39.5	25.0	24.5	49.5
Overexpenditure	$ 2.6	$ 3.8	$ 6.4	$ 3.5	$ 1.7	$ 5.2
Primary						
Appropriation	$ 35.3	$ 37.8	$ 73.1	$ 50.5	$ 51.8	$102.3
Expenditure	46.7	66.0	112.7	68.6	59.4	128.0
Overexpenditure	$ 11.4	$ 28.2	$ 39.6	$ 18.1	$ 7.6	$ 25.7
Secondary						
Appropriation	$ 68.1*	$ 65.2*	$133.3	$ 84.4	$ 76.0	$160.4
Expenditure	69.8	109.9	179.7	134.6	102.5	237.1
Overexpenditure	$ 1.7	$ 44.7	$ 46.4	$ 50.2	$ 26.5	$ 76.7
All Systems						
Appropriation	$119.4	$120.1	$239.5	$156.4	$150.6	$307.0
Expenditure	135.1	196.8	331.9	228.2	186.4	414.6
Overexpenditure	$ 15.7	$ 76.7	$ 92.4	$ 71.8	$ 35.8	$107.6
Percent Over-expenditure	13%	64%	39%	46%	24%	35%

*Prior to the 1978-80 biennium, secondary system maintenance and construction expenditures were made under one item. The appropriation amount is the amount allocated by the highway commission.

Source: Appropriations Act for 1976-78 and 1978-80 as amended, and financial supplements to DHT annual reports, 1977-80.

subsequently to appropriate non-general funds when, in his judgement, later developments were believed to make such expenditure necessary. However, item 622.1 of the 1978-80 Appropriations Act specifically limited authorized overspending for highway construction and mainte-

nance to no more than ten percent of the appropriated amount plus additional amounts necessary to provide a cost of living increase and compensation supplements to DHT employees and to utilize contributions from local governments. The same provision is included in the current Appropriations Act.

The ten percent figure would have authorized an additional $31 million in spending over the biennium, while the other provisions would have added an estimated $17 million, for a total of approximately $48 million. In fact, overspending exceeded $107 million. The $59 million difference between adjusted appropriations and actual spending was without legislative basis and contrary to the directions of the General Assembly.

The record is unclear on the degree to which past patterns of maintenance spending have been consistent with the legislative mandate to budget for reasonable and necessary levels of activity. What is known is that spending has increased in real terms and, in one case, beyond what was intended by the legislature. DHT program managers believe that the current spending level is required to avoid premature deterioration of highway and bridge facilities as well as to promote the safety and comfort of highway users. However, better information and more systematic use of existing standards are necessary for DHT to be fully accountable for spending.

DHT should develop an annual maintenance program which assigns priorities for all maintenance activities. The program should identify alternative spending levels and note the implications of funding each level. For example, protection of the existing highway network and provision of fundamental safety and comfort levels could be identified as a first priority. Additional maintenance activities which would provide higher levels of comfort, convenience and aesthetics should be identified as a separate program level.

The Highway and Transportation Commission should review and approve the maintenance program and provide opportunity for review and consultation with appropriate legislative committees. A draft version of the program should be developed by January 1983 and a status report provided to the General Assembly. The approved program should then be available for incorporation into the development of the 1984-86 biennium budget.

MAINTENANCE PRODUCTIVITY

Most routine maintenance of Virginia's highways is the responsibility of DHT field crews assigned to the 45 residencies and 241 area headquarters. The productivity of these crews in performing maintenance affects the cost of the maintenance program. To assess maintenance productivity JLARC compared the performance of residency crews. Data for the analysis were drawn from Maintenance Division reports on work accomplishments and expenditure.

There is substantial variation between residencies in the cost of performing routine maintenance work. Although many factors contribute to the varying costs of maintenance, some of the variation can be attributed to different management practices and technologies used by residencies in the maintenance program. An aggressive methods improvement program is needed to systematically identify, evaluate, and transfer innovations which improve residency productivity.

Productivity Review

The relative productivity of residencies in performing specific maintenance operations was examined by comparing residency costs for accomplishing a given amount of work. Regression analysis was used to measure the relationship between the amount of work accomplished by each residency and the cost of performing that particular maintenance function. Residency productivity was analyzed for 30 maintenance activities for which unit cost data were available. Of these, 19 major activities were selected for review because they were performed by most residencies across the State.

The analysis showed that in general there is a strong relationship between the resources--maintenance funds, man-hours, and equipment hours--devoted to a specific maintenance activity and the amount of work accomplished. These relationships are illustrated in Figure 5 for one activity--sealing and patching bituminous pavement. The graphs plot each residency in terms of work accomplished as measured by the tons of asphalt applied and the use of resources. In each case the relationship was tested statistically and found to show a strong correlation between accomplishments and the three factors of expenditures, labor, and equipment.

Using this information, it is possible to plot a line across each graph which represents the statewide average or norm for accomplishment at different levels of expenditure, labor, and equipment use. Residencies which fall above the line are relatively more productive than the statewide average. For example, residencies above the line plotted for tons of material in Figure 5 spend relatively less per ton of asphalt applied than the statewide norm. The same relationship applies to the other graphs.

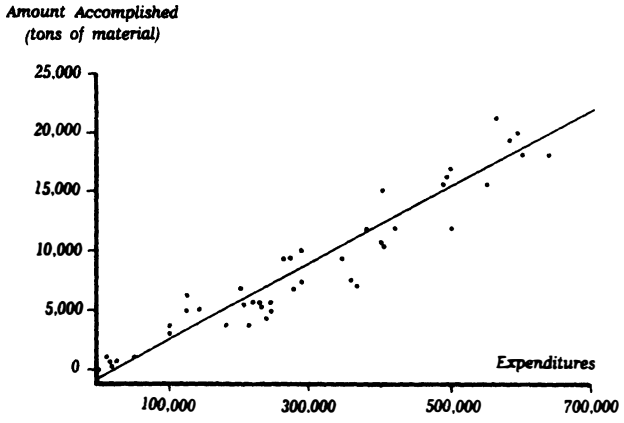
A look at the locations of high and low productivity residencies showed them to be located in all regions of the State, both urban and rural. Thus, it is reasonable to conclude that the productivity variations are not caused solely by regional differences in terrain or costs, but that they result at least in part from the management of the field crews who perform the maintenance.

Similar analyses were applied to the other major routine maintenance activities. Overall it appears that if low productivity residencies were brought up to the statewide norm, routine maintenance

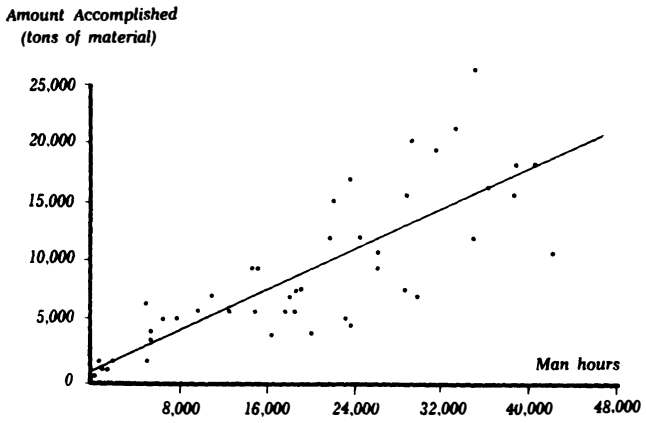
Figure 5

ANALYSIS OF MAINTENANCE PRODUCTIVITY OPERATION: SPOT SEAL AND SKIN PATCH

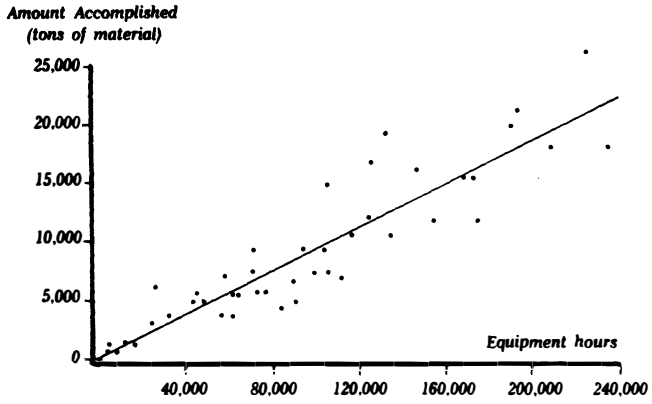
COST RELATIONSHIP

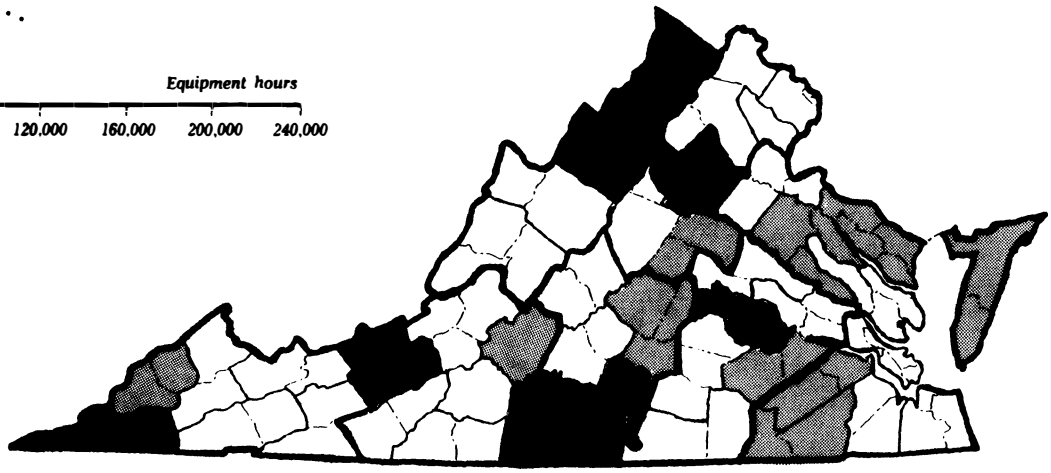


LABOR RELATIONSHIP



EQUIPMENT RELATIONSHIP





The Location of High and Low Productivity Residencies

High productivity

Low productivity

costs could be reduced by as much as eight percent. This may be a conservative estimate because it assumes that the Statewide norm is the "best" level of productivity possible. Therefore, reducing ordinary maintenance costs by eight percent, or approximately $5 million annually, would appear to be realistic and achievable goal for DHT.

Methods Improvement Program

An important way to promote increased maintenance productivity is through a statewide methods improvement program. A series of interviews conducted during the study revealed that residencies are experimenting with various methods in performing maintenance tasks. A strong program to identify and, where appropriate and feasible, transfer successful innovations would allow residencies to benefit from others' experience and thereby reduce maintenance costs. Increased maintenance productivity and reduced cost might also result from more methodical planning and scheduling of maintenance activity and from contracting some maintenance work.

Technology Transfer. DHT needs to strengthen its methods improvement program by increased attention to two areas. First, the Maintenance Division has not gathered specific information about the various approaches used by residencies and ways these approaches might be used by other residencies. The division does not systematically identify and evaluate methods used by residencies to determine if they do in fact reduce costs and can be transferred to other residencies. At present, as the following cases indicate, technology transfer is largely informal.

> *Ditching is a very expensive operation which is essential to roadway preservation. The cost of cleaning ditches can be reduced in many cases through the use of rotary ditchers. A rotary ditcher eliminates the need for hauling material removed from ditches in dump trucks. Instead, material is thrown back onto banks, or into woods and fields. Because the material is thrown, this piece of equipment cannot be used in densely populated areas or in places where the soil is too rocky.*
>
> *Two residencies have used a rotary ditcher. One residency is using the ditcher on about 60 percent of its ditches, while the second residency uses it on 25 percent of its ditches. Where the equipment has been used, costs have been reduced by two-thirds--from a range of $300 to $350 per mile using the traditional method, to $70 to $100 with rotary ditchers.*

Although the rotary ditcher was first introduced in 1979, the Maintenance Division has not evaluated its performance and compared it with methods used in other residencies.

A third residency recently requested a rotary ditcher after seeing one in use. The resident engineer said that this was done without urging or information from the district or central offices.

In short, productivity can be improved by transferring more efficient maintenance methods wherever possible. The division should strengthen its methods improvement program by systematically identifying and evaluating the potential efficiency and transferability of the various methods used by residencies.

The second weakness in the methods improvement program is that changes which can improve maintenance productivity are not uniformly implemented. For example, even when one resident engineer determined that a change was worthwhile, not all area headquarters in that residency adopted the new method.

Four of seven maintenance areas in one residency altered tar kettles by removing hand held hoses and installing nozzles to spray tar during sealing and patching operations--a change that cost under $100. Both the resident engineer and the maintenance supervisor believed the innovation increased productivity by reducing time spent spraying tar. They also said the altered kettles did a better job. Three areas, however, did not make this inexpensive adjustment even though residency management thought it worthwhile.

As the first line managers, resident engineers need to be involved in an aggressive approach to productivity improvement. Not all improvements are feasible in each residency, but where changes are found to be of value, the central office should be sure innovations are known in the field and each responsible field engineer at the residency and district level should ensure that they are carried out.

Planning and Scheduling. Management efforts to ensure that maintenance crews are fully utilized and to avoid significant down time also contribute to productivity. Interviews with Maintenance Division personnel and resident engineers indicate that much improvement is needed in the ability of area superintendents to plan and schedule activities for their crews.

Superintendents must be able to plan for full utilization of crews and to anticipate contingencies that may require plans for alternate work to be available. For example, equipment and personnel must

be scheduled to carry out specific operations on a given day. If the needed equipment breaks down or weather is unfavorable, the plan must be sufficiently flexible to productively use the labor elsewhere. According to Maintenance Division personnel, some area superintendents do not accept the need to plan activities in advance. These superintendents rely on their own experience to determine, sometimes on a daily basis, the activities of their field crews. Some other superintendents who do prepare work plans do so only as a "paper exercise" and do not use the plans.

The DHT program proposal for 1982-84 includes as one of its goals improving planning and scheduling at area headquarters. The goal continues previous efforts which have met with limited success. The Maintenance Division should emphasize planning as a means of improving field productivity and should work with resident engineers to increase the awareness of superintendents about the importance of planning in maintaining high productivity.

Contract Maintenance. Contracting some routine maintenance activities now performed by DHT crews also offers the potential for cost savings. Use of private contractors for routine maintenance would reduce the personnel needed to staff departmental field crews. For some activities, contractors may perform work at a lower unit cost than can DHT.

Few states have had much experience in using contractors for routine maintenance. The Florida Department of Transportation has conducted a small demonstration project on contract maintenance for the past two years. Approximately $740,000 of work has been contracted out in one area, less than one percent of the state's total maintenance budget. The contract maintenance activities included patching small potholes, ditch cleaning, brush control, bridge operation and tending rest areas.

The Florida department estimates that approximately $200,000 or 20 percent, was saved in the performance of these activities. However, data for the various activities were not collected in a consistent manner, and there is some uncertainty about actual benefits. Moreover, it is not clear how extensive savings will be or what additional costs may be incurred if contract maintenance is implemented statewide.

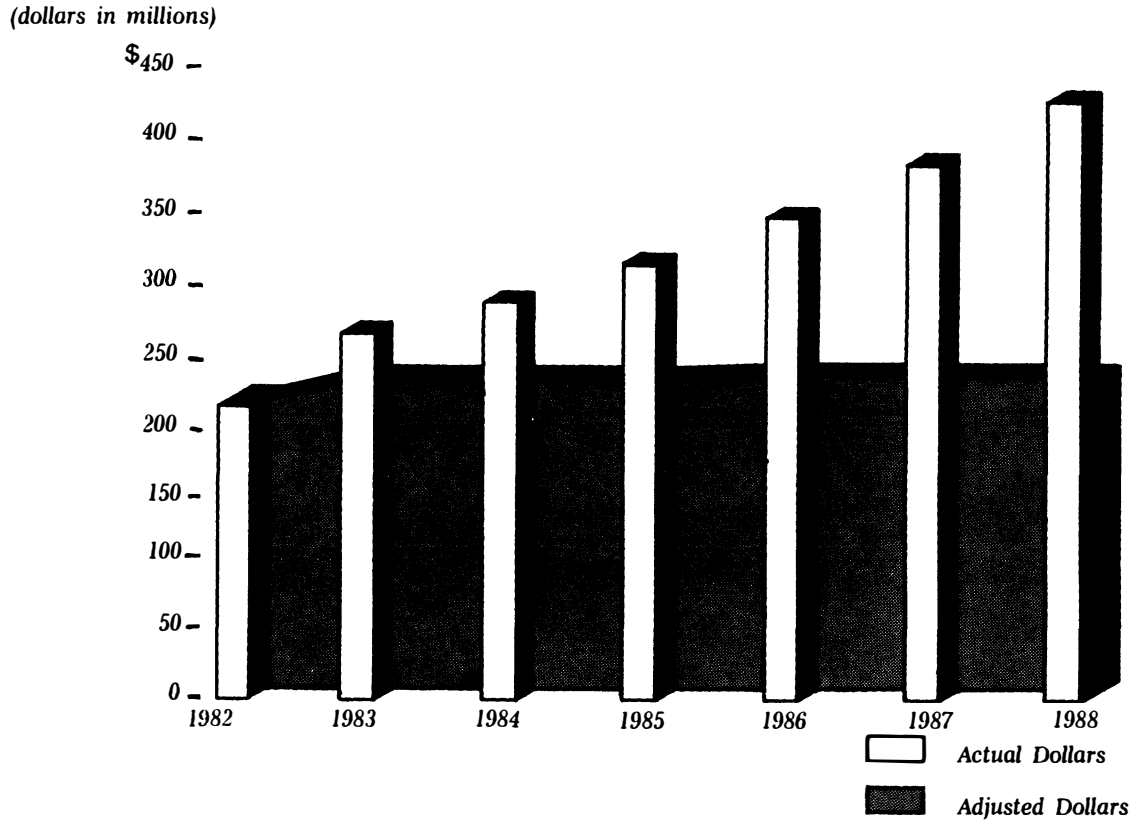
Florida's experience suggests that contract maintenance may result in lower costs for some routine maintenance activities although the evidence is far from conclusive. Nevertheless, the potential savings through contract maintenance should be explored by DHT as one means of reducing costs.

MAINTENANCE FUNDING REQUIREMENTS AND RECOMMENDATIONS

DHT proposes spending $261 million in FY 1983 and $287 million in FY 1984 for highway maintenance. For the entire six-year planning period incorporated in the program budget, DHT proposes increasing maintenance spending by 97 percent over the FY 1982 budget. When adjusted for inflation, however, the maintenance budget projection represents essentially a steady level of maintenance activity (Figure 6). The budget projections include an additional $14.2 million per year after FY 1982 for increased pavement repair work and bridge replacement and to address some of what DHT considers backlogged sidewalk repair work. A small increase is projected for FY 1986 for additional facilities on the interstate system. Otherwise, the projected budget provides for the existing level of service at an assumed 9.8 percent average inflation rate.

Figure 6

PROJECTED MAINTENANCE BUDGETS
FY 1982 - FY 1988
ACTUAL AND ADJUSTED



The basis for the proposed spending level should be carefully reviewed by the General Assembly following completion of a formal maintenance program as described earlier. Appropriations for the maintenance program made by the 1982 General Assembly should be conditioned on the provision that DHT develop a budgeting process based on optional levels of maintenance. Maintenance options should be presented to the 1983 General Assembly for consideration. Presentation of maintenance options should be the basis for all future maintenance budget requests.

Recommendation (1). DHT staff should develop an annual maintenance program to provide the necessary level of accountability for spending. The program should identify (1) a minimum funding level necessary for maintenance which constitutes a program to protect the highway investment and provide for reasonable levels of safety and comfort to the travelling public, and (2) other spending levels above the minimum program which are recommended as desirable to provide for higher levels of comfort, convenience and other maintenance enhancements. The intent of this recommendation is to ensure that DHT provides the General Assembly with at least two alternative levels for funding highway maintenance and the implications of each spending level.

The Highway and Transportation Commission should review and approve the maintenance program and provide opportunity for review and consultation with appropriate legislative committees. A draft version of the program should be developed by January 1983 and a status report provided to the General Assembly. The approved program should then be available for incorporation into the budget development cycle for the 1984-86 biennium.

The 1982-84 Appropriations Act should mandate that a complete assessment of highway condition be completed and a suitable maintenance program developed by the start of the 1984-86 biennial budget preparation cycle.

Recommendation (2). Workload standards used to develop routine maintenance budgets should be reviewed to ensure that they accurately reflect potential workload. The inventory of maintainable items now being developed can provide the basis for the review. Either closer adherence to the standards by field managers should be required or the value of maintaining and updating the standards should be reconsidered.

Recommendation (3). DHT should place a high priority on full implementation of a pavement management system for Virginia. Using appropriate sampling procedures, the system should be able to provide analytically based data on pavement conditon on all of the highway systems. The preliminary information should be incorporated in the maintenance program described earlier for a 1983 status report to the General Assembly.

Recommendation (4). Greater emphasis should be placed on the bridge condition rating system by the Bridge Division. The Bridge Division should take the lead in developing a training program for bridge engineers to ensure that ratings are consistent. Data from the rating system should be used systematically by maintenance staff to set statewide priorities for bridge maintenance.

Recommendation (5). The management services division should take the lead in developing a methods improvement program for DHT aimed at reducing costs and improving efficiency. The management services division, in conjunction with the maintenance engineer, should undertake a comprehensive review of the various methods used by residencies to perform maintenance activities and the conditions under which methods can be transferred to improve productivity. When productivity improvements are feasible and appropriate, maintenance managers should ensure that they are fully implemented.

III. Highway Construction Needs and Funding Requirements

The Commonwealth has undertaken a program of major improvements to its highway system over the past 15 years. More than $4.5 billion was spent by the Department of Highways and Transportation (DHT) to construct and upgrade highways between 1967 and 1980. Construction accounted for over 70 percent of DHT expenditures during most of those years.

Faced with projections of declining construction revenues, the 1980 General Assembly requested JLARC to prepare an assessment of highway construction needs and associated funding requirements. DHT had prepared recent studies of Virginia's present day needs in 1978 and 1980. However, these studies showed only that the identified needs could not be funded under any reasonable assumptions of inflation, increased maintenance requirements, or projections of population and economic growth patterns.

In order for a needs assessment to be fully usable, identified construction needs must be linked to the Commonwealth's budget process. In the 1980 study, DHT projected present day construction needs to be $6.7 billion. However, approximately $3.8 billion of this need represents construction projects which cannot realistically be put under construction before the end of the current six-year budget planning period.

The remaining $2.9 billion in projects probably still exceeds a realistic level of available funding. Thus, a means of classifying and describing the types of construction needs which can be addressed must be developed to provide the General Assembly with a framework for establishing construction priorities and reviewing proposed budgets. Such an approach to needs assessment and funding can be used by the General Assembly for examining proposed construction needs in relation to expected revenues and for determining what needs can be addressed by additional revenues.

Prior Needs Assessments

DHT has prepared a number of construction needs studies since World War II. A 20-year plan for construction was completed in 1945 and updated in 1951 and 1962. The next DHT needs study was conducted in 1971 during preparation of the 1972-1982 ten-year plan. The plan called for a $1.3 billion expenditure to finance "vast programs of improvements in all highway systems." This plan was considered realistic and fundable by DHT when presented to the 1972 General Assembly.

In 1974 DHT reported to the General Assembly that the ten-year plan could not be completed by 1982 because of inflation. DHT recommended extending the plan to 1985 and either reducing the number

of projects or increasing revenue. No specific proposals for either option were advanced by the department.

The most recent needs studies were completed by DHT in 1978 and 1980 in conjunction with the Joint Subcommittee Studying the Planning, Allocation and Use of Highway Funds. Both the 1978 and 1980 studies were intended to include all "present day needs" and their most current estimated cost. The 1978 study set present day needs at $4.1 billion. The 1980 study gave an estimate of $6.7 billion.

The 1978 study projected that full funding of identified needs could not be accomplished before 1997 under a conservative assumption of a 7.5 percent inflation rate. The 1980 study simply concluded that present day needs could not be funded under any reasonable assumptions of inflation. The joint subcommittee introduced its report to the 1980 General Assembly by noting that it had been unable to obtain a clear understanding either of just what Virginia's needs were, or of what amount of revenues were required to meet those needs.

In addition to construction needs studies prepared by DHT, local planning agencies and the Secretary of Transportation are also involved in assessing construction need. DHT planners worked with local and regional officials to prepare thoroughfare plans for 66 urbanized areas in Virginia. Thoroughfare plans are intended to identify needed highway improvements and establish priorities for construction. These plans generally use a 20-year timeframe and are updated periodically. Thoroughfare plans are often prepared without consideration of revenue projections and, therefore, are inclusive in their identification of need.

In 1981 the Secretary of Transportation released a status report on the statewide transportation plan now being prepared to fulfill a statutory mandate first issued by the 1974 General Assembly. The status report consisted of an inventory of deficiencies in rural highways and incorporated recommendations for highway construction from urban thoroughfare plans. Beyond the inclusion of thoroughfare plan recommendations, however, the status report makes no recommendations for highway and bridge improvements, it does not identify specific project needs, and it provides no cost estimates.

In summary, the General Assembly has had the benefit of a series of construction needs assessments. But recent needs assessments have not addressed the problem of classifying needs and setting priorities among projects in response to limited revenues. Legislative review of proposed construction budgets is hindered by a lack of information about priorities among projects.

Scope and Method of the JLARC Review

The JLARC review of construction needs examined Virginia's plan for completing the interstate system as well as over 1,200 pro-

posed construction projects on the primary, urban, and secondary systems. Data were drawn from 140 hours of interviews with DHT engineering, planning, and programming staff, and examination of construction project files, county six-year plans, and the 1981 status report of the Secretary of Transportation.

The first step in the analysis was establishing a study time frame. The 1978 and 1980 DHT needs assessments were limited in their usefulness because they were open-ended. Although each study listed its contents as present day needs, construction was projected into the late 1990s. No distinction was made among projects which could be constructed in the near future and those which were only conceptual in nature. For example,

> *A proposed project in Alexandria called for upgrading a portion of existing Route 1 to a six-lane limited access facility. The project was intended to improve traffic flow at the intersection of Route 1 and the proposed extension of I-595. The I-595 extension is itself only a concept. Moreover, the city does not now desire more than four lanes in this corridor. Therefore, it does not appear that Route 1 will be under construction in the immediate future.*

The immediacy of construction need is clearly an important element of legislative review. Virginia's budget includes information and projections for a six-year period consisting of the upcoming biennium and four subsequent fiscal years. The General Assembly's budgetary review in the 1982 session will focus on fiscal years 1983 through July 1988. Using this time period, the construction needs assessment in this study is consistent with the existing budget framework and provides a reasonable period of time for estimating future inflation and economic and population changes.

Need and funding requirements for the interstate system were analyzed separately from the primary, urban, and secondary systems. Interstate funding requirements present a special case for analysis because current statutory language requires the Highway and Transportation Commission to budget sufficient funds to match interstate aid. Moreover, interstate construction is almost totally dependent on the availability of federal aid.

Analysis and classification of primary, urban, and secondary construction needs and associated funding requirements followed a three-step process. First, a baseline of project data was developed. Second, projects were screened to determine whether they could be brought to construction before the end of FY 1988. Finally, projects which could feasibly be under construction during FY 1983-1988 were classified for relative need using several specific criteria including

structural and functional deficiencies, local, State, and federal endorsements, safety and congestion, and special bridge needs.

Baseline Data. Baseline data are the list of potential construction needs on the primary, urban, and secondary systems which were subject to analysis. The projects included in the 1980 DHT study represent the most comprehensive listing of proposed primary and urban system projects available. Additional primary and urban projects identified since the 1980 DHT study were also included.

Baseline data for the JLARC review of secondary system projects were drawn from the county six-year plans authorized in Section 33.1-70.01 of the *Code of Virginia*. These plans represent the six-year needs identified by local boards of supervisors in conjunction with resident engineers. Samples of projects drawn from the current plans were used to profile and classify the types of construction needs considered most urgent by local officials.

Finally, data on the replacement and rehabilitation needs for existing bridges were drawn from the computerized deficiency listing maintained by the department. This listing is based on the results of on-site inspections and includes all bridges considered in need of rehabilitation or replacement due to structural deficiencies or functional limitations.

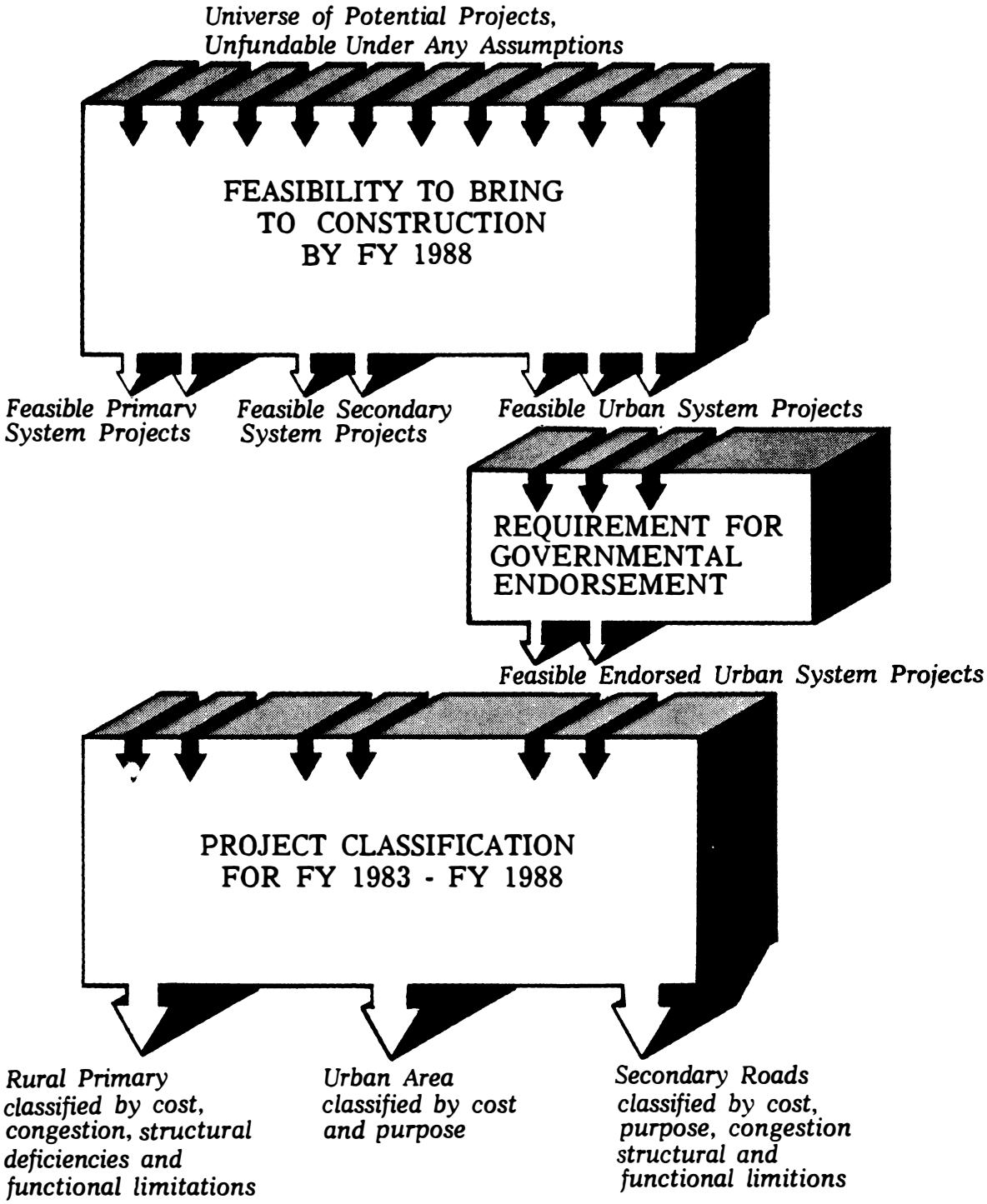
Project Feasibility. The primary, urban, and secondary projects included in the data base were then examined to determine which could realistically be brought to construction before the end of fiscal year 1988. The relationship between the feasibility review and subsequent levels of review as it applies to the primary, urban, and secondary projects is shown graphically in Figure 7. JLARC staff conducted an extensive series of interviews with DHT engineering, planning, and programming personnel to identify projects that were not likely to be ready for construction prior to 1988. Feasibility criteria used included the degree to which planning work had been initiated, project designs and required environmental studies were underway, and right of way was acquired.

According to the recently completed report of the R. J. Hansen consulting firm, DHT is experiencing a steadily increasing period of time between the initiation of construction project planning and actual construction. The consultant estimated that the lead time for a typical project exceeded eight years in 1980. In other words, most projects, especially those on the urban and primary systems, which are at the initial planning stage in 1982 would not be ready for construction until about 1990 if they followed the general pattern. These projects, regardless of any relative measure of need, do not represent construction needs for the three biennia to be considered by the 1982 General Assembly.

A special type of feasibility consideration can be applied to urban system projects. State law (Section 33.1-44) requires that local governments share in the cost of all construction projects carried out

Figure 7

PRIMARY, URBAN AND SECONDARY SYSTEM-CONSTRUCTION NEEDS ASSESSMENT



in cities and towns over 3,500 in population. DHT policy requires that each proposed construction project be formally endorsed by the city or town governing body. In the absence of such a request, DHT policy is to delay an urban system project. Therefore, the lack of endorsement limits the likelihood that a proposed urban project will reach the construction stage.

Secondary road improvement plans developed by each county board of supervisors and resident engineers provide a similar feasibility screen for secondary system projects. Projects included in county six-year plans receive local endorsement.

Project Classification. Screening all projects for construction feasibility and local government endorsement produces a residual set of projects. Providing that funds are available, these projects are likely to reach the construction phase by the end of FY 1988. Additional analysis of the residual projects illustrates the nature of highway construction need in Virginia. The analysis groups projects into categories of need which can be used to set construction priorities.

For analytic purposes, the administrative designations of primary, urban, and secondary highways were modified slightly to reflect the different demands of rural versus urban area travel and the special nature of bridge replacement and rehabilitation needs. Four categories were developed: (1) rural primary highways, (2) urban area highways, (3) secondary roads, and (4) bridges on all systems.

The remainder of this chapter presents an analysis of the construction needs for each of these four categories and the interstate system. Interstate system needs are based on estimates of available federal aid rather than individual projects. Construction needs for the four categories noted above are analyzed by classifying projects into three levels of need. The final section of the chapter presents funding options for construction ranging from a minimum budget based only on federal aid to construction of all feasible projects by the end of FY 1988.

INTERSTATE SYSTEM FUNDING REQUIREMENTS

The interstate system is a network of limited access highways linking metropolitan areas and economic centers of regional and national importance. The interstate system is limited by law to 42,500 miles nationwide, of which 1,069 miles are authorized in Virginia. As of January 1981, 991 miles were open to traffic.

The General Assembly has consistently endorsed by resolution and statute completion of Virginia's interstate routes as a priority. Up to 90 percent of the cost for constructing approved projects is paid for by federal aid. Analysis of interstate construction needs must

therefore be based on federal approval of projects and the availability of federal aid.

Federal Approval

DHT currently estimates that $2.26 billion is needed to complete the interstate system in Virginia (Table 6). However, $403 million in projects have not been approved by the federal government. These projects, if they were to be built, would require 100 percent state and local funding. Federally approved construction projects total approximately $1.9 billion.

Proposals to revise federal highway aid now being considered by Congress will redefine what is considered essential to the completion of the interstate system. As a result, it is likely that some projects previously approved for federal construction aid may be deleted from the list of federally approved construction needs. Others may be added. However, the magnitude of costs shown in Table 6 confirms that there is no shortage of federally approved interstate projects to be funded.

Federal Aid Availability

In light of the high cost of many interstate improvements, the determining factor for State budget decision-making is the availability of federal aid. Federal construction assistance is available for approved projects at a ratio of 90 percent federal funds to a 10 percent State match. In addition, federal aid is available for restoration, resurfacing, and rehabilitation of interstate highways.

Construction Aid. Under Title 23 *United State Code* Virginia receives a percentage of the total federal construction authorization equal to the ratio of (1) the estimated cost to complete interstate systems in Virginia, to (2) the estimated cost to complete the entire system. The estimated cost to complete the system is recalculated every two years and serves as the basis for apportioning federal funds for the subsequent two-year period. The most recent estimate of the cost to complete the system in Virginia was prepared by DHT in September 1980.

The apportionment factor for federal FY 1983 and 1984 (October 1982 through September 1984) is 3.527 percent. In other words, Virginia can expect to receive an allocation of slightly more than three and one-half percent of the total interstate construction funds authorized by Congress for those two fiscal years. The factor used for Virginia for federal FY 1981 and 1982 was an almost identical 3.55 percent. Although the percentages for individual states will vary over time, an estimate of 3.5 percent appears reasonable for the period under review in this study.

Table 6

INTERSTATE CONSTRUCTION PROJECTS AND COST ESTIMATES
(January 1980)

Proposed Project	Estimated Cost (millions)	
Projects Approved for Federal Aid		
I-664 (Hampton, Newport News and Bridge-tunnel crossing James River)	$539.0	
I-264 (Elizabeth River Tunnel and connector in Norfolk)	258.2	
I-95 (relocation between Petersburg and Richmond)	219.7	
I-95 (addition of two lanes between Ashland and Triangle)	158.8	
I-85 (extension to Prince George County line)	48.7	
Other projects	121.0	
Improvements in approximately 300 locations	512.1	
Subtotal		$1.857 Billion
Projects Not Currently Approved for Federal Aid		
I-95 (extension of reversable lanes in Fairfax, Prince William counties)	$ 59.5	
I-64 (addition of two lanes in Hampton, Newport News)	44.7	
I-64 (addition of two reversable lanes in Norfolk)	53.1	
I-295 spur (four lanes on new location)	34.9	
I-95 (addition of two lanes near Woodrow Wilson bridge)	34.1	
Various interchange modifications	94.9	
Other projects	81.7	
Subtotal		$403,043,000
Total, all projects		$2.260 Billion

Source: Department of Highways and Transportation.

Congress has not completed final action on the federal budget; therefore, estimates of available aid are tentative. For interstate construction, however, both the administration proposal and the Senate version project steady funding at or near the level of actual expenditures for 1981. The Reagan budget calls for authorizations of $3.625 billion, the Senate version $3.4 to $3.5 billion for the period

September 1982 to September 1986. Virginia could expect to receive approximately $122 to $129 million in construction funds annually depending on which budget was adopted.

Virginia can probably expect a total of $756 million in federal interstate construction aid over the next three biennia. State funds required to match this federal aid would be approximately $85 million. If the Commonwealth is able to utilize all available federal aid for interstate construction for FY 1983-1988, $833 million in interstate projects can be developed and constructed.

3-R/4-R Aid. In addition to interstate construction aid, the federal government also provides funds for resurfacing, restoring, and rehabilitating interstate highways (3-R program). The 3-R funding process is identical to that for interstate construction in that each state is entitled to a fixed proportion of the total appropriations made by Congress. To qualify for this aid, states are required to fund 25 percent of project costs while the federal government provides the remaining 75 percent.

Thus, estimates of State funds needed to match available 3-R aid will depend on the outcome of the federal budget process. Legislation now before both houses of Congress will substantially change the program in three ways.

- The types of projects eligible for aid will be expanded to include interstate reconstruction as well as resurfacing, restoration, and rehabilitation (4-R).

- The federal-state matching ratios will be changed to 90 percent - 10 percent.

- The formula for calculating state 4-R entitlements will be based on total interstate lane miles and total interstate vehicle miles travelled. The current formula includes only lane-miles five or more years old.

Since these provisions are subject to change, estimates of 4-R funding for Virginia are tentative.

Proposed funding for the 4-R program for federal fiscal years 1983-1988 would average about $1.9 billion per year. Virginia's apportionment based on the current formula would range from approximately $33 million in 1983 to $61 million in 1988. If the current proposal in Congress is enacted, therefore, Virginia could expect approximately $320 million in federal 4-R funds between fiscal years 1983 and 1988. This level of aid would require $36 million in State matching funds.

In summary, current statutory language requires the Highway and Transportation Commission to budget sufficient State funds to match federal apportionments to Virginia for interstate construction. It is reasonable to apply the same basic standard to 4-R funds. Therefore, the interstate funding for FY 1983-1988 requires a State match of

approximately $121 million which would provide a total budget of $1.197 billion in State and federal funds (Table 7).

Table 7

ESTIMATED FEDERAL INTERSTATE AID
AND REQUIRED STATE MATCH
FY 1983-1988
(millions)

	Federal	State	Total
Construction	$ 756	$ 85	$ 841
4-R Program	320	36	356
Total	$1,076	$121	$1,197

Priorities for interstate construction projects are established by the Highway and Transportation Commission in consultation with federal authorities. However, the basic decision on project priorities rests with the State. The General Assembly may, of course, influence the priorities set by the Highway and Transportation Commission through resolution or other appropriate means.

PRIMARY, URBAN, AND SECONDARY SYSTEM NEEDS

Analysis of construction needs for the primary, urban, and secondary systems was based on two criteria: project feasibility and classification of need. Project feasibility measures the likelihood that a project can be put under construction by the end of FY 1988. Classification of need measures the immediacy of the funding requirement.

Project Feasibility

With the FY 1983-1988 budget review period as a basis, proposed construction projects were reviewed to determine whether they are likely to require funding during the period. For this step in the analysis, secondary projects were reviewed separately from the list of individual urban and primary projects included in the 1980 needs study.

Secondary Project Feasibility. Secondary construction projects are generally much smaller and less complex than those proposed for the urban and primary systems. The typical secondary project costs about $550,000 compared to between $4 and $5 million for the typical urban or primary project. The size and scope of urban and primary projects also increase greatly the possibility for delay. It is assumed, therefore, that all proposed construction spending on the county six-year plans could reasonably be advanced to construction by the end of FY 1988, providing that funds are available.

Urban and Primary Project Feasibility. An examination of primary and urban construction projects listed by DHT in the 1980 study revealed an estimated $1.9 billion in projected spending which, in the judgement of department staff, involves projects unlikely to reach the construction phase until after the end of FY 1988. These projects, regardless of their long-term merit, do not represent construction needs for the current budget review period.

Projects can be delayed for a variety of reasons. In many cases projects listed as present needs by DHT are, in fact, still only concepts for which little or no preliminary planning and survey work has been completed. Delays in more fully developed projects may also develop through environmental impact studies, litigation, acquisition, local citizen opposition, or withdrawal of local government support. Seventy-one urban system projects included in the 1980 DHT listing have not been formally endorsed by city and town councils as required by DHT policy. In these cases it is unlikely that the project will advance to the construction phase.

In most of the cases reviewed a number of factors have combined to delay project development. The following examples illustrate projects included in the 1980 DHT needs study which are not likely to be ready for construction until after the end of FY 1988.

> *Route 174 in Henry County was shown in the 1980 study as needing an improvement costing $7 million. This construction would make Route 174 a four-lane divided highway between Routes 220 and 108. No plans have yet been developed for this project, nor is any development work proposed in the current DHT program.*
>
> * * *
>
> *An urban construction project on Route 154 in Covington was included in the 1980 needs study. The project was estimated to cost $3.7 million and would expand Craig Avenue to a four-lane divided highway. The project had not been requested by the city and Urban Division personnel indicated that the city had never expressed an interest in the project. In the absence of a local request, no project development has been done for this project.*
>
> * * *
>
> *Four-laning a 14-mile segment of Route 33 in Greene County was shown as a need to complete a portion of the plan of the arterial network. Much of the plan has been completed but the remaining development was stopped when costs began to escalate. No further development or right-of-way acquisition is proposed by DHT in the current four-year plan.*

* * *

Improvements to the Carrington Street and Nine Mile Road Corridor were requested by the Richmond City Council in 1978. However, opposition to the proposed project surfaced in the affected neighborhood which desired a pattern of development that would preclude the roadway improvements. The project was indefinitely deferred by the city in 1980 and the city is now considering removing the proposed project from its master plan.

* * *

The 1980 needs study showed a need for $84 million to extend Chippenham Parkway (Route 150) across the James River and link up with Laburnum Avenue. This project is under study at present but is still largely conceptual. No specific proposals have yet been developed and any construction is well into the future.

The net effect of applying the construction feasibility consideration to the urban and primary projects listed in the 1980 DHT study was to reduce the estimate of funding required for construction on the two systems by $1.9 billion, or 55 percent of the 1980 total estimate. The remaining primary and urban projects and associated costs for construction could probably be advanced to the construction stage by the end of FY 1988 if funds are available.

In total, about $1.55 billion in primary, urban, and secondary projects could be candidates for funding between FY 1983 and 1988. Constructing all of these projects would require an annual construction budget, exclusive of interstate, of approximately $304 million in 1980 dollars for each year the six-year period. Preliminary projections for the 1982-84 biennium call for construction spending, exclusive of interstate, of about $152 million annually. These projections, accompanied by continuing inflation of construction costs, suggest that full funding of all feasible projects is not likely.

Classification of Need

Once projects have been identified which can feasibly enter construction by 1988, priorities need to be established among projects. Criteria for classifying feasibile projects measure the immediacy of funding requirements. Rural primary and secondary construction proposals address three needs: current structural deficiency, current congestion, or an existing functional limitation such as narrow lanes or poor alignment. Urban area projects, on the other hand, all address problems of current congestion or the demands of a growing population. Urban area projects were found to be subject to particular delays, and their status relative to immediate construction was used as a classifi-

cation. Bridges, finally, were classified on the basis of the immediacy of their need for replacement or rehabilitation.

Rural Primary Projects. This category consists of primary system projects, including the arterial network, which lie outside urban planning areas. Most primary highway mileage is rural and serves to connect major population and economic regions of the State. As such, these roads provide for longer distance through trips. Alternative routes between major termini are generally limited. Therefore, the traffic volume and relative congestion on a given route is a good indication of travel demand in the corridor.

A second characteristic of the rural primary system is the fact that much of the mileage consists of older sections of highway designed and constructed to meet lower standards than those currently in use. As a result, a portion of the rural primary system is structurally deficient and in need of reconstruction.

A total of 55 construction projects on rural primary routes are feasible between FY 1983 and 1988. For the most part, these projects do not develop new corridors or relocate major sections of highway. Rather, their primary purpose is to address existing structural deficiencies or increase the travel capacity of existing roads.

Table 8 classifies the 55 rural primary projects by their primary purpose. Twenty-three of the 55 projects are intended primarily to address structural deficiencies requiring construction or reconstruction as a result of damage or deterioration in the existing pavement or base. Examples of structural deficiencies include chipping of the pavement surface, severe cracking, shoulder separation from the pavement, or undercutting of the pavement caused by poor drainage and subsequent erosion.

Table 8

CLASSIFICATION OF RURAL PRIMARY PROJECTS
(FEASIBLE FOR CONSTRUCTION FY 1983-1988)

Principal Purpose	Number of Projects	Estimated Cost (millions)
Correct Structural and Functional Deficiency	23	$ 99
Relieve existing congestion	21	100
Correct Functional Deficiencies	11	31
Total	55	$230

Structural deficiencies in these 23 projects are accompanied by, and are often the result of, some kind of functional problem. Functional deficiencies refer generally to narrow lane width or poor alignment or grade for the roadway relative to traffic volume. Functional deficiencies can sometimes lead to structural failure. For example, if a lane is too narrow, the outside tire of a tandem wheeled truck will extend onto the shoulder. The weight of the truck will damage the shoulder, leaving the pavement edge exposed. The result can be pavement deterioration and erosion of the roadway base.

The second classification in Table 8 includes projects which are structurally sound but currently carry more traffic than their design capacity. Capacity is measured by a ratio of actual traffic to the number of vehicles which could use the facility at a desired speed without impeding one another or creating undue safety hazards. Capacity can be limited by a combination of excess traffic and physical features of the roadway which impede safe travel such as narrow lanes, sharp curves, or steep grades.

The third classification in Table 8 includes 11 projects considered by DHT to have poor alignment or grade or narrow pavement relative to traffic volume. However, the roadway is structurally sound and not considered to be currently congested.

Urban Area Projects. Urban area projects include both the urban administrative system and primary and arterial routes within urban transportation planning areas. The two administrative systems are combined for analysis because they share many planning considerations: the effects of complex land use patterns, zoning, high population density, and heavy travel volumes.

An additional consideration for treating urban system and urban area primary roads as a single category is the interrelationship of the transportation needs on the two systems, as shown in the following example.

> *Construction needs in much of suburban Chesterfield County are directly related to the travel demands generated by commuting between the county and Richmond City. In 1980 DHT listed $228 million in construction needs in Chesterfield County involving existing commuter routes, including Routes 147, 150, 10, 60, 360, and 76, and two new circumferentials. Most of this proposed construction, although involving routes on the State primary system, is conditioned by travel patterns on urban routes which link northern Chesterfield County to the metropolitan area.*

Virtually all proposed construction in urban areas is intended primarily to expand the capacity of existing roadways or relieve congestion by developing new corridors as by-passes or expressways.

These projects are designed to improve traffic flow by adding turn lanes or traffic signal systems, by realigning or widening lanes, or by adding new lanes to existing roadways. In several cases the proposed projects will reconstruct narrow bridges or underpasses or create a grade separation at a railroad crossing. Also projected are completion of sections of major relocations in Fredericksburg, Lynchburg, and Danville and completion of ongoing work on primary by-passes around Warrenton, St. Paul, Courtland, Emporia, and Saluda.

The principal distinction between urban area projects considered feasible for construction by FY 1988 is the immediacy of the funding requirement. Table 9 shows that 40 projects on urban area primary routes and 42 projects on the urban system are either underway or currently ready for construction. The second level of immediacy shown in Table 9 includes projects currently in the latter stages of planning and design and for which necessary right-of-way acquisition is scheduled. These projects will probably enter the construction phase by the middle of the decade if funds are available.

Table 9

CLASSIFICATION OF URBAN PRIMARY AND URBAN SYSTEM PROJECTS
Feasible for Construction
FY 1983-1988
(cost in millions)

Immediacy of Funding Requirement	Urban Primary		Urban		Total	
	Number	Cost	Number	Cost	Number	Cost
Continuation of project now underway/Project ready for construction	40	$146	42	$143	82	$289
Planning, design, right-of-way acquisition advanced, construction by mid-decade	15	$ 95	25	$118	40	$213
Project in preliminary stages	26	$176	19	$146	45	$315
Total	81	$417	86	$407	167	$817

The final category in the table includes 26 projects on urban primary routes and 19 urban system projects which, although DHT believes they could be brought to completion by FY 1988, are only at preliminary design and engineering stages. In several cases the status of the project remains uncertain, as illustrated in the following example.

At the present time, the extension of I-664 in Hampton and Newport News and a bridge-tunnel crossing of the James River are included on Virginia's approved interstate system. However, the interstate designation ends at the south shore line of the James because the FHWA has allocated all of the 42,500 miles of interstate routes allowed in statute. Under present conditions Virginia will be required to provide a primary extension built to interstate standards to link the bridge-tunnel with Route 17 near Belleville at an estimated cost of $32.3 million. However, if another state relinquishes some portion of its allocated mileage and an interstate designation is given to the extension, the project will be eligible for 90 percent federal funding.

Secondary System Projects. Secondary system projects present a particular classification problem because only one-fourth of the secondary system serves the same general purpose as roads on the primary and urban systems--the movement of relatively large numbers of vehicles along transportation corridors of county, city, regional, or statewide significance. These secondary routes can be classified similarly to rural primary highways.

The remaining three-quarters of the secondary system is classified as local roads under the current Federal Highway Administration definitions (Table 10). Local roads serve primarily to provide access to individual residences. As such, they carry a much lower traffic volume than collectors and arterials which have countywide significance.

Table 10
CLASSIFICATION OF SECONDARY ROADS

Classification	Centerline Mileage	Percent
Arterial/Collector - Roads with higher volume traffic and countywide significance	10,809	25%
Local Roads - Roads with only local significance for residential and commercial access.	32,820	75%
Total	43,629	100%

Arterial and collector roads account for 10,809 miles of the State's secondary highway system, 490 miles of which are proposed for improvements in current county six-year plans. Construction needs on these roads can be classified in the same manner as rural primary routes (Table 11). The distribution of mileage and the calculation of projected costs in Table 11 are based on data from a sample of 74 projects drawn from all current plans.

Table 11

SECONDARY SYSTEM PROJECTS
(Feasible for Construction)
FY 1983-1988

Principal Purpose	Estimated Mileage	Cost (millions)
Correct structural and functional deficiencies	269	$ 74
Relieve existing congestion	123	$ 34
Correct functional deficiencies	98	$ 27
Total	490	$135

The largest classification in Table 11 includes road segments with structural deficiencies in the pavement or base, including severe cracks, surface distortions, or shoulder deterioration. Structural deficiencies are particularly prevalent on secondary roads which very often evolved from dirt roads and were never designed with an adequate base. Problems occur especially when new industries bring increased truck traffic --traffic that can damage inadequate pavement and shoulders. Reconstruction and construction improvements are necessary to preserve road condition and avoid higher maintenance costs than might otherwise be needed.

The second level of classification includes approximately 123 miles of roadway which are considered congested on the basis of traffic flow and design standards. Approximately one-half of the mileage involves pavement lane width of less than eight feet, a width considered inadequate for the safe passing of two trucks.

The final classification includes approximately 20 percent of the mileage which has some form of functional limitation in grade or alignment but which does not currently cause congested conditions or structural damage.

Local roads have the lowest travel volume in the State highway system. Their primary purpose is to provide access to individual residences, businesses and farms. Classifying local road need is difficult because of their limited geographic significance. The Secretary of Transportation excludes local roads entirely from consideration in the statewide transportation plan because of their lack of statewide transportation significance.

Setting priorities for local road construction is best done at the county level. Estimates of overall funding requirements can be done on any reasonable assumptions about funding equity. One option would be to apply the same criteria as those shown in Table 11 for establishing priorities among higher-volume arterial and collector routes.

Incidental construction involves a variety of small construction activities. Incidental construction funds are not budgeted by project but are used to fund work during the year as identified by the resident engineer. As was the case with local road construction funds, setting priorities for incidental construction funding can be based on a range of equitability assumptions. Applying the breakdown shown in Table 11 is one reasonable option.

If the classifications in Table 11 were applied to the total amount allocated to local road and incidental construction in the current six-year plans, 55 percent or $139 million would be assigned to the relatively high priority level, $63 million or 25 percent to a second level, and $50 million or 20 percent to the third funding requirement level.

Bridge Projects. DHT lists 687 bridges on the primary, urban, and higher volume secondary roads which are considered in need of replacement or major rehabilitation. These bridges, identified by an on-site inspection by DHT staff or city engineers, involve either structural defects in the bridge deck, superstructure or substructure, or functional limitations such as narrow lanes, low clearances, or poor alignment of approach roadways.

Data for classification of bridge needs were drawn from the DHT bridge inventory and interviews with bridge engineers. All primary and urban bridges on the deficiency list were reviewed. A sample of 47 bridges was drawn from the list of deficient bridges on the higher volume secondary roads.

Table 12 shows a classification framework for bridges considered by DHT to be structurally deficient and in need of replacement. Seventy-one bridges are judged to fall within this category; these represent the highest priority for bridge replacement.

The second classification level shows 58 bridges which are posted for use below the legal weight limit. All but 6 of the posted bridges are on higher-volume secondary roads. Posted bridges will serve for the 1983-1988 period but will limit the use of the road segment by heavier vehicles. A third classification includes 210 bridges that are considered deficient but which will serve beyond FY 1988.

In addition to the bridge replacement needs shown in Table 12, there are 191 bridges in need of rehabilitation beyond what would be classified as maintenance expenditures. The projected cost for the rehabilitation program is $30 million over the six-year period.

Table 12

CLASSIFICATION OF BRIDGE REPLACEMENT
Feasible for Construction
FY 1983-1988
(costs in millions)

	Urban Primary		Secondary		Total	
	No.	Cost	No.	Cost	No.	Cost
Structurally deficient, in need of replacement	42	$134	29	$ 15	71	$149
Structurally deficient and posted	6	$ 3	52	$ 27	58	$ 30
Structurally or functionally deficient, will last 10 years.	176	$ 88	34	$ 18	210	$106
Total	224	$225	115	$ 60	339	$285

CONSTRUCTION FUNDING OPTIONS

The review of proposed construction funding needs for FY 1983-1988 confirms that it will be necessary to evaluate needs carefully in the light of limited revenues. The estimated cost of all projects on the interstate, urban, primary, and secondary systems is $2.9 billion in 1980 dollars; these would require an average annual construction budget of $502 million without consideration for inflation.

In fact, DHT projects significant reductions in the availability of construction funds for the 1982-84 biennium and subsequent fiscal years. Preliminary departmental projections call for spending a total of $712 million for construction in FY 1983 and 1984. Even this projected budget falls well short of the annual expenditures necessary to fund a $2.9 billion program over six years. And beyond the next biennium DHT projects a sharply decreased construction program caused by an inability to match federal aid.

Inflation will also have a major impact on construction costs. In the last two years inflation was 6.8 and 7.6 percent respectively. At a seven percent inflation rate, the $501 million spent for construction in FY 1980 would purchase only $431 million in FY 1982; by FY 1988, the purchasing power would be $280 million.

Levels of Need: 1983-1988

The project classification presented in this chapter provides a method for setting priorities among construction projects which can be put underway by the end of FY 1988. Each category of projects on the primary, urban, and secondary systems was classified into three levels of need. These project-based levels are in addition to an assumption that Virginia will make full use of interstate apportionments during the 1983-88 time period. These levels illustrate options for choosing priorities for construction funding.

Level I includes the highest priority projects for each category. In addition to an assumed $1.076 billion in federal interstate aid and $121 million in required State matching funds, Level I includes the following:

		1980 Cost Estimate
1.	Rural primary: structurally deficient	$ 99 million
2.	Urban primary: underway or ready for construction	146 million
3.	Urban system: underway or ready for construction	143 million
4.	Secondary arterial/collector: structurally deficient	74 million
5.	Secondary local road and incidental construction: 55 percent of current plan	139 million
6.	Bridges: most seriously deficient	149 million
	Subtotal	$750 million
	Add Interstate Construction	$1.197 billion
	TOTAL	$1.947 billion

Level II includes all Level I projects and the interstate construction assumption plus the second priority for each category.

		1980 Cost Estimate
1.	All Level I projects	$ 750 million
2.	Rural primary: congested	100 million
3.	Urban primary: ready for construction by mid-1980s	95 million
4.	Urban system: ready for construction by mid-1980s	118 million
5.	Secondary arterial/collector: congested	34 million
6.	Secondary local roads and incidental construction: additional 25 percent of current plan	63 million
7.	Posted bridges	30 million
	Subtotal	$1.190 billion
	Add Interstate Construction	$1.197 billion
	TOTAL	$2.387 billion

Level III includes interstate construction plus all primary, secondary, and urban projects feasible for construction by the end of FY 1988.

		1980 Cost Estimate
1.	Rural primary	$ 230 million
2.	Urban primary	417 million
3.	Urban system	407 million
4.	Secondary arterial/collector	135 million
5.	Secondary local roads and incidental construction	252 million
6.	Bridges	285 million
	Subtotal	$1.726 billion
	Add Interstate Construction	$1.197 billion
	TOTAL	$2.923 billion

The cost estimates for the primary, urban, and secondary system projects in each level are presented in 1980 dollars. Therefore, the costs must be adjusted to account for inflation. Table 13 shows the costs for each level for FY 1983 through 1988 adjusted for eight percent inflation. For practical purposes the estimates of interstate apportionments and required State matching funds have not been adjusted for inflation because of the high cost of such a policy. For example, if Virginia wanted to compensate for inflation beyond what is projected in federal apportionments, it would require an additional $205 million in State funds over six years and increase the State's effective matching ratio from 10 to 30 percent of interstate construction costs.

Table 13

FUNDING LEVELS BY FISCAL YEAR ADJUSTED FOR INFLATION
FY 1983-1988
(dollars in millions)

Fiscal Year	Level I	Level II	Level III
1980 Base Estimate	$ 750	$1,190	$1,726
1983	$ 157	$ 249	$ 363
1984	170	269	392
1985	184	291	423
1986	199	341	457
1987	214	339	494
1988	232	366	533
Subtotal	$1,156	$1,828	$2,662
Interstate	1,197	1,197	1,197
Total	$2,353	$3,025	$3,859
Source of Funding			
Federal Aid	$1,533	$1,533	$1,533
State Match	251	251	251
Supplemental State Funds Required	569	1,241	2,075
Total	$2,353	$3,025	$3,859

When adjusted for inflation, the cost of constructing Level I primary, urban, and secondary projects increases from $750 million in 1980 dollars to $1.156 billion in adjusted dollars. Using available interstate apportionments during the period increases the total program to $2.353 billion. Levels II and III show correspondingly higher funding requirements.

A combination of federal and State funds will be needed to fund the various program levels. A total of $1.533 billion in federal aid is expected to be available during FY 1983 through 1988; this amount of federal aid will require $251 million in State matching funds. As indicated by Table 13, however, this amount falls $569 million short of meeting Level I needs. These additional funds must be provided entirely by the Commonwealth. Federal aid plus State matching funds will be $1.241 billion less than needed to finance Level II and $2.075 billion less than needed for Level III.

1982-84 Biennial Funding Options

This section translates the high-priority spending option (Level I) described previously into funding requirements for the biennium. Two other alternatives for funding are also described: (1) a "minimum" budget which provides sufficient revenue to match expected federal aid apportionments consistent with statutory allocation requirements, and (2) a budget somewhat above that for the high-priority projects which also satisfies the statutory allocation formula.

Minimum Aid Budget. The minimum construction budget option provides sufficient State funds to match all expected federal aid allocations to the State primary, secondary, and urban systems as required by law (Section 33.1-23.1). The law provides for: (1) 3.75 percent of available construction funds (exclusive of federal interstate and Appalachian development aid) to be allocated for paving non-hard surface roads, and (2) distribution of 50 percent of the remaining funds to the primary system and 25 percent each to the secondary and urban systems. Although federal aid for interstate construction and Appalachian development are excluded from the allocation requirements, State matching funds for these programs are subject to the requirements. Interstate matching funds are part of the 50 percent primary system allocation. Appalachian matching funds are drawn from the individual system for which aid is used.

Ensuring that matching funds are available to meet the requirements of federal aid programs conflicts somewhat with Virginia statutory allocation requirements. For example, the unpaved road allocation must be made from State funds since virtually all unpaved roads are excluded from the federal aid system. Similarly, much of the State urban system (81 percent) and secondary system (73 percent) mileage is not part of the federal aid system. Therefore, supplemental State funds beyond the minimum amounts needed to match federal aid will be needed to secure all aid and to comply with State law. Table 14 shows the minimum amount of State funding required to meet these twin goals in FY 1983 and 1984.

Approximately $49 million in State funds will be required in FY 1983--$43 million to match federal aid plus a supplement of $6 million to ensure that sufficient funds are available for the urban and secondary systems and for unpaved roads. In FY 1984 the total requirement for State funds will be $65 million. State matching funds will be

Table 14

ESTIMATED FUNDS REQUIRED TO MATCH FEDERAL AID
AND COMPLY WITH STATUTORY ALLOCATION REQUIREMENTS
(1982-84, dollars in millions)

Fiscal Year 1983	Federal Aid	State Match	Supplemental State Funds	Total
Interstate	$159	$18	$ 0	$177
Primary	32	11	0	43
Urban & Secondary	45	13	2	60
Appalachian Development Program	5	1	0	6
Unpaved Roads	0	0	4	4
Totals	$241	$43	$6	$290
Fiscal Year 1984				
Interstate	$177	$20	$ 0	$197
Primary	34	11	0	45
Urban & Secondary	36	9	19	64
Appalachian Development Program	5	1	0	6
Unpaved Roads	0	0	5	5
Totals	$252	$41	$24	$317

about $41 million, but the needed supplement will increase to $24 million with the expected termination of federal aid for the urban and secondary systems.

The figures shown in Table 14 are based on an assumption designed to minimize the amount of supplemental State funding. All available funding for bridge replacement and rehabilitation has been used on the urban and secondary systems in both years. This allows for the lowest possible supplementation of State funds to bring the primary, urban, and secondary systems allocation into compliance with statute. It does not indicate that there are no bridge replacement needs on the primary system.

Level I Priority Budget. The second option for construction funding provides funds for Level I, the highest-priority projects identified in the construction analysis. This program would use all interstate federal aid and provide funds to meet the highest-priority projects on the primary, urban, and secondary systems. The total cost for this program over a six-year period with consideration for inflation is $2.353 billion (Table 13); the cost during the 1982-84 biennium will total $701 million (Table 15).

Table 15

ESTIMATED FUNDING FOR HIGH-PRIORITY CONSTRUCTION NEEDS
(1982-84, dollars in millions)

	1982-84 Biennium		
	FY 1983	FY 1984	Total
Interstate	$177	$197	$374
Primary, Urban & Secondary	157	170	327
Total	$334	$367	$701
Source of Funding			
Federal Aid	$241	$252	$493
State Match	43	42	85
Supplemental State Funds	50	73	123
Total	$334	$367	$701

Supplemental Level I Budget. A third option for construction funding is to supplement the Level I budget to bring it into compliance with the statutory allocation formula. The allocation of funds under the Level I option, based on a project analysis, would provide 44 percent of the budget to primary construction, 29 percent to the secondary system, and 27 percent to urban projects (Table 16).

Table 16

ESTIMATED FUNDING FOR HIGH-PRIORITY
CONSTRUCTION NEEDS SUPPLEMENTED TO
COMPLY WITH STATUTE
(1982-84, dollars in millions)

	FY 1983	FY 1984	Total
Interstate	$177	$197	$374
Level I primary, urban, secondary	157	170	327
Additional Supplement	28	30	58
Total	$362	$397	$759
Source of Funding			
Federal Aid	$241	$252	$493
State Match	43	42	85
Supplemental State Funds	78	103	182
Total	$362	$397	$759

Statute requires that 50 percent of all construction funds not specifically excluded from the formula be allocated to the primary system and 25 percent each to the urban and secondary systems. Therefore, an additional supplementation of State funds would be needed to budget for a Level I program without deleting projects identified in the analysis as a high priority. Table 16 shows that for 1982-84, $58 million in additional State funds would be needed to fully fund Level I within the statutory allocation formula. Most of this amount would be allocated to the primary system.

CONCLUSIONS AND RECOMMENDATIONS

The analysis of construction need suggests that a biennial spending program of $701 million for 1982-84 would meet the highest priority construction needs on all systems within the constraints of federal aid availability. A budget of $759 million for the two-year period would be necessary to fund high-priority construction needs within the statutory allocation formula. The additional funds would be available to meet some second priority needs within statutory constraints.

An optional budget of $607 million would capture Virginia's federal aid apportionments for FY 1983 and 1984 but would fall short of meeting a number of high priority needs, particularly on the urban and secondary systems. Ensuring that available federal aid funds are matched appears to be the intent of the legislature, but this priority is not stated explicitly in existing law.

Recommendation (6). The General Assembly may wish to amend statute to require that the Highway and Transportation Commission allocate sufficient funds to match available federal aid. This action would have the effect of providing for a minimum construction program that would to be given priority above maintenance spending.

Funding a highway construction program is a legislative prerogative through the appropriations process. In order to effectively oversee this responsibility, the General Assembly needs a clearly presented framework for evaluating construction needs, establishing priorities, and monitoring the construction program. In the past, DHT-supplied needs assessments have been open-ended and unrealistic. As a result, the highway planning process of the department has little value to the General Assembly without a means for translating open-ended needs assessments into alternative programs for funding consideration.

Recommendation (7). DHT should improve its construction needs assessment process by taking the following actions:

a. All future needs assessments done by the department should reflect the immediacy of the funding requirement in terms of when each project can realistically advance

to construction. Projects which are not anticipated to require construction funds within the six-year planning cycle used for the Commonwealth's budget should be clearly identified and distinguished from projects which can be moved to the construction phase within six years.

b. An analytic framework should be developed for establishing priorities among highway construction needs and presenting several levels of spending as alternatives in the biennial budget. The analytic framework should include but not be limited to the following factors: (1) federal aid availability; (2) traffic volume and congestion; (3) safety; (4) structural deterioration and functional limitations of the existing facility; and (5) local government endorsement.

c. DHT should expedite the completion of a highway improvement program which identifies high-priority spending objectives for construction during the subsequent four- to six-year period. The program should be completed and made available to the General Assembly for review in the 1982 session. The program should provide for an annual updating and adjusting to report on progress in fulfilling program objectives and to accommodate General Assembly action or other changes in existing conditions.

d. The Highway and Transportation Commission should formally review and approve the highway improvement program and annual updates as well as keep apprised of progress made by the department in meeting program objectives.

IV. Public Transportation Needs and Funding Requirements

Virginia has 15 public transit systems which provide one-half of the State population with bus, rail, and other transportation services in 32 cities and counties. Almost 114 million passenger trips were made on public transit during 1980. Six of the transit systems serve major metropolitan areas in Northern Virginia, Tidewater, Peninsula, Richmond, Roanoke, and Lynchburg. Together these six systems carried approximately 97 percent of all transit passengers. The remaining nine transit systems serve smaller cities and some rural areas.

The overriding issue for most public transportation systems in Virginia today is meeting the cost of providing transit services. During FY 1980 operating costs for the 15 systems exceeded $100 million. Fares and other revenues amounted to less than half that amount, leaving an operating deficit of approximately $51 million. Funds to cover this deficit were provided by the federal and local governments. However, federal budget policy now appears to favor eliminating federal aid for transit operations.

Transit systems are even more dependent on governmental support for capital investment in buses, railcars, and related facilities. Virtually all bus purchases are funded through government grants. In the case of the enormously expensive metrorail system, local governments in Northern Virginia are using a combination of local gasoline sales tax revenues and bonds to fund ongoing construction.

Transit operators are attempting to address their fiscal problems in a number of ways. Greater emphasis will be placed on ensuring that bus routes are cost effective and on recovering a greater portion of costs from fares. Localities with transit systems are also looking to the State for additional financial assistance or for the authority to levy local taxes to support operations. The changing policy environment resulting from recent federal action will require the division of public transportation and the Highway and Transportation Commission to play a more active role in overseeing transit operations in Virginia.

As transportation systems attempt to become more cost effective in a period of reduced revenues, ride-sharing as an alternative or supplement to systems has also developed into a phenomenon of some significance to transportation planning and funding.

PUBLIC TRANSPORTATION SYSTEMS

Public transportation is largely a local responsibility in Virignia; local governments and regional authorities own and operate the 15 public transit systems. Two State agencies, however, do have a role in promoting and funding public transportation.

Public Transportation Agencies and Programs

Both the Department of Highways and Transportation Public Transportation Division and the Transportation Section of the Office of Emergency and Energy Services (OEES) have responsibility for certain aspects of the State involvement in public transportation.

Public Transportation Division. The Public Transportation Division has five principal statutory responsibilities: (1) determining present and future needs for public transportation and the economic feasibility of providing facilities and services, (2) formulating and implementing plans and programs for the improvement of facilities and services, (3) investigating matters affecting the efficient and economic operation of public transportation activities, (4) providing data on public transporation in the Commonwealth, and (5) administering grants. The statute clearly gives the division broad authority for transit oversight. The division has also been designated by the Governor as the lead agency for ride-sharing in the Commonwealth.

Grant administration is the most visible of the division's activities. In all, nine programs are administered through this agency. Transit systems as well as innovative programs such as ride-sharing are funded through the State Experimental Mass Transportation and Ride-Sharing Program. These State programs and seven federal Urban Mass Transit Administration (UMTA) grant programs provided approximately $44 million to the 15 transit systems in Virginia during FY 1980.

The division has not been as effective in fulfilling its oversight role, however. A needs estimate was developed in preparing the 1982-84 budget, and the division has provided technical assistance to some systems. Still, the division has not conducted any investigations of transit system efficiency and economy or fully assessed the economic feasibility of providing various services. For example, one continuing question underlying State policy development is the degree to which operating costs can be recovered through fare increases without triggering a major dropoff in ridership. The public transportation division is ideally placed to address this important concern.

Although the division is responsible for providing data on public transportation, the information is not provided in a clear, timely, and comparable format for use in policy development and budget review. More than three months of staff time was required to prepare comparable operating data on all transit systems for this report, and the division summary of 1980 operating statistics for transit in Virginia was not issued until 16 months after the end of the fiscal year.

Statute gives the public transportation division a strong mandate to provide evaluative information and program oversight of transit operations in Virginia. This oversight is essential to provide accountability for State funds appropriated for transit assistance.

The division should increase its oversight activity by (1) standardizing reporting formats, (2) expanding its evaluative role as provided for in law, (3) continuing the preparation of needs assessments and improvement programs, and (4) preparing a comprehensive and timely report on public transportation needs and programs. This report should be prepared at least biennially and provided to the appropriate committees of the General Assembly.

Office of the Emergency and Energy Services. The Transportation Section of the Energy Division of OEES administered federal Department of Energy grants for ride-sharing until early 1981. Ride-sharing programs funded through OEES were part of the State's energy conservation program. During FY 1980 these grants provided approximately $80,000. By direction of the Governor, however, responsibility for administering energy grants for ride-sharing was transferred to the DHT Public Transportation Division. OEES continues to apply for Energy Department grants as part of its conservation program, but once these grant funds are received, they are distributed by the Public Transportation Division.

Transit Services

Public transit systems in Virginia provided 114 million passenger trips while operating approximately 39 million miles during FY 1980. The levels of service provided by the different systems varied substantially (Table 17). The most extensive services were provided by the six large systems located in the State's major urban areas. These systems accounted for approximately 97 percent of transit ridership and miles operated in that year.

For descriptive purposes, the transit systems shown in Table 17 are divided into three groups based on their size and scope of operations. The nine small systems typically operate 12 hours daily, range in size from five to 93 route miles, and serve relatively limited geographic areas. Five large systems provide extensive services over wide areas. The final category is the Washington Metropolitan Area Transit Authority (WMATA) whose Metrobus and Metrorail services in Northern Virginia make it the largest in the State. Because of its size and unique combination of bus and rapid rail transit, WMATA cannot be readily compared to other systems.

The trend in transit operations in recent years has been toward increasing ridership and maintaining a relatively stable level of mileage covered. Bus ridership increased 23 percent between 1977 (the 25-year low point) and 1980. With the exception of the addition of rapid rail service in Northern Virginia, the number of miles operated by transit systems has not increased appreciably since 1977. This trend indicates that more people are using existing transit services rather than transit systems expanding their services to draw more riders.

Table 17

PUBLIC TRANSIT OPERATIONS
FY 1980

	System	Jurisdiction	Land Area Served Square Miles	Population Served	Total Miles of Transit Routes	Daily Hours of Services	Passenger Trips	Revenue Miles
SMALL SYSTEMS	James City County Transit	James City Co. Williamsburg	148	22,513	21	12	70,800	187,000
	Jefferson Area United Transportation, Inc. (JAUNT)	Albemarle Nelson Fluvanna Greene Louisa Charlottesville	2,179	140,234	93	12	93,900	333,500
	Harrisonburg City Bus Service	Harrisonburg	6	19,300	5	11	38,600	77,800
	Bristol City Bus Service	Bristol, Va. Bristol, Tenn.	13	45,858	53	12	159,100	152,000
	Winchester City Transit	Winchester	9	23,100	52	12	141,500	140,000
	Staunton Transit Service	Staunton	10	25,000	43	10	149,700	120,400
	Charlottesville Transit Service	Charlottesville	10	42,000	75	14	640,556	308,900
	Danville Bus Service	Danville	16	46,346	75	12	445,600	156,900
	Petersburg Area Transit Service	Petersburg Colonial Heights	23	60,000	72	12	1,029,700	342,400
LARGE SYSTEMS.	Greater Lynchburg Transit Co.	Lynchburg	50	68,000	115	19	1.9 million	1.1 million
	Greater Roanoke Transit Co.	Roanoke Vinton	43	99,000	194	16	2.6 million	1.3 million
	Greater Richmond Transit Co.	Richmond	145	220,000	359	21	24.1 million	5.0 million
	Peninsula Transportation Dist. Comm.	Hampton Newport News	122	271,000	261	22	4.8 million	2.4 million
	Tidewater Transportation Dist. Comm.	Chesapeake Norfolk Va. Beach Suffolk Portsmouth	670	760,000	450	23	14.5 million	6.6 million
METRO	Washington Metropolitan Area Transit Authority (Virginia portion only)	Alexandria Falls Church Fairfax City Arlington Fairfax County	453	828,900	Bus: 486 Rail: 10	24 14	33.9 million 28.5 million	16.8 million 4.4 million

TRANSIT FINANCE

The major problem facing both large and small transit systems is securing the funds needed to maintain operations. Before 1972 most transit systems were privately operated. But declining profits led the private systems to cease operations, and local governments took over the systems as a means of ensuring continued service. However, the same problems which caused private companies to discontinue operations--increasing labor, fuel, and capital costs and resistance to higher fares--have also created financial difficulties for publicly owned systems. There are two major components of transit finance: operational finance and capital acquisition.

Operational Finance

Operational finance encompasses costs incurred in the daily operation of a transit system. Labor, fuel, and maintenance are three major operational costs.

Expenses and Revenues. Each of the 15 transit systems in Virginia operated at a loss during FY 1980 (Table 18). Examination of previous years' reports confirms that the systems failed to meet expenses from their revenue in those years as well. WMATA alone accounted for 60 percent of the total $50.8 million transit deficit, while the other large systems incurred approximately 37 percent. The total deficit for the nine small systems was approximately $1.2 million.

Table 18 also shows two indicators of transit system financial status: (1) the extent to which revenues meet expenses and (2) the operating loss per passenger trip. No system recovered all operating costs from its revenues during FY 1980, although some did better than others. For example, among the larger systems only Richmond (63 percent) and the Metrorail portion of WMATA (61 percent) recovered over one half of costs through fares and other revenues. Among the smaller systems Petersburg (75 percent) and Danville (68 percent) were the only other systems to rival Richmond and Metrorail in cost recovery.

In terms of individual passenger trips, Petersburg came closest to cost recovery with a loss of 10 cents per trip. Richmond lost 18 cents per trip, while the average was 45 cents, and four of the smaller systems lost over $1.00 for each passenger carried.

Table 18 clearly shows the gap between farebox receipts, which account for over 90 percent of transit revenues, and the cost of providing services. Transit operators acknowledge that it is highly unlikely that fare receipts will ever totally meet operating costs. There are two reasons for this. First, transit is considered by localities to be a public good whose benefits (such as reduced highway congestion and access to business and work places) extend beyond the

Table 18

FINANCIAL STATUS OF PUBLIC TRANSIT SYSTEMS
(amounts in thousands)

System	Operating Expenses	Total Revenue	Operating Deficit	Revenue As A Percent of Operating Cost	Deficit Per Passenger Trip
James City	$ 119	$ 35	$ 84	29%	$1.19
JAUNT	236	122	144	52	1.53
Harrisonburg	125	70	54	56	1.40
Bristol	216	119	97	55	.61
Winchester	164	41	123	25	.87
Staunton	246	97	149	39	1.00
Charlottesville	537	163	373	30	.58
Danville	456	310	147	68	.33
Petersburg	428	322	105	75	.10
Small System Sub Total	$ 2,527	$ 1,279	$ 1,248	51%	$ .52
Lynchburg	1,495	584	911	39	.48
Roanoke	1,962	677	1,285	35	.49
Richmond	11,635	7,374	4,261	63	.18
Peninsula	3,801	1,507	2,294	40	.48
Tidewater	15,991	6,054	9,937	38	.69
Large System Sub Total	$34,884	$16,196	$18,688	46%	$ .37
WMATA:					
Bus	43,300	20,079	23,220	46%	.68
Rail	19,530	11,889	7,643	61	.27
Sub Total	$62,830	$31,967	$30,863	51%	$ .49
Total All Systems (in millions)	$100.2	$49.2	$50.8	49%	$ .45

Source: Department of Highways and Transportation.

riders who are its direct beneficiaries. Second, public transit often serves those who lack independent means of transportation. Included in this group are the elderly and the poor for whom higher fares are considered to be an economic hardship.

Despite these concerns, transit system operators interviewed by JLARC indicate that they are committed to increasing the proportion

of costs recovered from farebox receipts as well as streamlining operations. Systematic review of operations can help identify ways to reduce costs as illustrated in the following example.

> *The Tidewater Regional Transit System (TRT) systematically reviews its transit services. Routes are evaluated quarterly to determine cost effectiveness and those routes whose deficit per passenger rank in the lowest 20 percent are restructured or eliminated. In the last quarter of 1980, TRT eliminated one route, reduced two routes, and consolidated two others.*
>
> *For areas where TRT does not find bus routes to be cost effective, the system has purchased passenger vans which are leased to commuters at a rate which covers all costs (purchase, maintenance, insurance). TRT also provides matching services for persons wishing to initiate a van pool.*

Base fares for Virginia transit systems have increased between 20 and 60 percent in recent years. As a result, revenues were 48 percent greater in 1980 than in 1977 (Table 19). Still, the additional revenue produced by the increased fares has been offset by operation costs which grew 58 percent between 1977 and 1980. Even with the fare increases, the proportion of operating costs covered by system revenues declined from 52 percent in 1977 to 49 percent in 1980.

Table 19

TRANSIT SYSTEM FINANCIAL TRENDS
FY 1977-80
(amounts in millions)

Fiscal Year	Operating Costs	Total Revenue	Deficit	Revenue As A Percent Operating Costs
1977	$ 63.9	$33.5	$30.4	52%
1978	69.7	34.5	35.2	49
1979	79.3	38.5	40.8	48
1980	101.2	49.4	51.8	49
Cumulative Change	58%	48%	70%	

Source: Department of Highways and Transportation.

Table 18 further shows that most systems face practical limitations in the ability of farebox receipts to recover costs. While it could be argued that 10-cent and 18-cent increases in Petersburg and

Richmond could move those systems toward a breakeven point, systems with 40, 50, or 60 cent per-trip losses are unlikely to be able to raise fares by this amount without unacceptable declines in ridership. Therefore, the proposed reduction in federal operating subsidies raise critical questions for local governments.

Operating Subsidies. Virginia's transit systems receive subsidies from federal, State, and local governments (Table 20). Approx-

Table 20

SUBSIDIES FOR TRANSIT SYSTEM
OPERATION AND ADMINISTRATION
FY 1980
(amounts in thousands)

System	Total Subsidies	Source		
		Federal	State	Local
James City County	$ 84	$ 55	$ --	$ 29
JAUNT	205	135	1	69
Harrisonburg	54	37	3	14
Bristol	97	--	15	82
Winchester	123	80	15	28
Staunton	149	78	15	56
Charlottesville	373	274	25	74
Danville	147	--	25	122
Petersburg	105	55	25	25
Small System Sub Total	$ 1,337	$ 714	$124	$ 499
Lynchburg	911	386	25	500
Roanoke	1,286	675	25	586
Richmond	4,261	2,250	100	1,911
Peninsula	2,295	1,293	75	927
Tidewater	9,937	3,984	100	5,853
Large System Sub Total	$18,690	$8,588	$325	$ 9,777
WMATA				
Bus	24,543	6,122	125	17,296
Rail	7,643	0	0	7,643
Sub Total	$31,186	$6,122	$125	$24,939
Total All Systems (in millions)	$51.2	$15.4	$0.6	$35.2

Source: Department of Highways and Transportation.

imately $51.2 million was provided for operating and administrative expenses during FY 1980. This amount includes funds from federal programs, aid for transit administration, and subsidies from the respective local governments.

Localities subsidized most of the total operating deficit, providing $35 million in FY 1980. The federal government was the other major source of operating subsidies; over $15 million in transit operating and administrative aid was provided by the federal government in FY 1980. The State presently provides no operating aid to transit systems and a small amount of aid for system administration. State administration aid totalled $574,000 in FY 1980 and has been increased to $2 million for FY 1981 and 1982.

Local governments have often expressed concern about the growing local subsidy requirements for public transit. Local governments rely primarily on property taxes from which all city or county services must be funded. Local officials claim that public transit is taking an increasingly larger share of these limited funds. If federal aid is withdrawn localities would be called upon either to assume the full $15 million subsidy previously provided from federal funds, or to reduce or eliminate services. In any case, local government in Virginia can expect increased financial pressure as a result of current federal proposals. Furthermore, inflation will continue to increase the burden on local government (Table 21).

Table 21

PROJECTED TRANSIT OPERATING DEFICITS
FY 1983-88
(amounts in millions)

	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88
Small Systems	$ 2.6	$ 2.9	$ 3.2	$ 3.6	$ 4.1	$ 4.6
Large Systems	25.1	28.1	31.4	35.1	39.4	44.2
WMATA	57.1	66.6	79.6	90.0	100.8	112.5
Total	$84.8	$97.6	$114.2	$128.7	$144.3	$161.3

Source: Department of Highways and Transportation and Northern Virginia Transportation Commission.

Capital Acquisition

In addition to operating expenses, transit systems must also purchase new vehicles and other capital equipment. As the preceding section demonstrates, however, transit systems in Virginia cannot even meet their operating expenses. The necessary funds for capital purchases, then, are provided by the federal and State governments with local governments providing matching funds.

Most of the assistance for capital acquisition is for the purchase of new transit vehicles. In addition, the Commonwealth has provided $17 million to the WMATA system during the 1980-82 biennium for construction of Metrorail in Northern Virginia. Federal and State aid are also provided for acquisition of other capital such as ancillary equipment and transit facilities.

Vehicle Acquisition. Virginia's 15 transit systems operated more than 1300 buses during FY 1980. Ninety-two percent of the buses belonged to the six largest systems and almost half were operated by WMATA. Of the nearly $20 million in total assistance for bus acquisition provided during FY 1980, 62 percent was from the federal government, 33 percent from the Commonwealth, and five percent from localities (Table 22). Seventy-five percent of the funding was provided to the six largest systems.

Table 22

SOURCE OF FUNDING FOR TRANSIT BUS ACQUISITION
FY 1980
(amounts in thousands)

System	Total Assistance	Source		
		Federal	State	Local
James City County	$ 69	$ --	$ 66	$ 3
JAUNT	70	56	13	1
Harrisonburg	260	208	49	3
Bristol	--	--	--	--
Winchester	1,065	721	318	26
Staunton	119	--	113	6
Charlottesville	985	777	197	11
Danville	333	--	316	17
Petersburg	857	576	259	22
Small System Sub Total	$3,758	$2,338	$1,331	$ 89
Lynchburg	--	--	--	--
Roanoke	1,505	1,019	449	37
Richmond	3,325	2,243	1,000	82
Peninsula	866	485	356	25
Tidewater	2,439	1,283	1,082	74
Large System Sub Total	$8,135	$5,030	$2,887	$218
WMATA	8,427	5,355	2,426	646
Total All Systems (In Millions)	$20.3	$12.7	$6.6	$1.0

Source: Department of Highways and Transportation.

Vehicle replacement is usually staged over a period of years, particularly for sytems with large numbers of buses. Thus, it is likely that capital acquisition costs will vary between FY 1983 and 1988. The public transportation division estimates that 825 buses will reach or exceed their expected useful life of 12 years before the end of FY 1988 (Table 23). Assuming that replacement buses cost $150,000 each in 1980, with the effect of inflation on heavy vehicle prices, approximately $141.3 million will be required over the 1983-1988 period to fund the purchase of new buses. In addition, DHT estimates that Northern Virginia's share of railcar replacement will require approximately $2.3 million during the period.

Table 23

ESTIMATED TRANSIT VEHICLE REPLACEMENT SCHEDULE
FY 1983-88

Fiscal Year	Buses Number	Buses Cost (millions)	Rail Cars Cost (millions)
1983	134	$ 20.1	$0.3
1984	117	19.5	0.4
1985	87	15.4	0.4
1986	241	45.6	0.4
1987	102	20.6	0.4
1988	144	20.1	0.4
Total	825	$141.3	$2.3

Source: Department of Highways and Transportation.

Other Capital. Transit systems also make capital expenditures for such ancillary equipment as vans, fare boxes, spare parts for buses, service vehicles, radio equipment, shop equipment, bus stop signs and shelters, computer equipment and software, and numerous other items required to support a transit program. Over the last four years 64 cents was spent on ancillary equipment for each federal grant dollar spent on buses. The public transportation division expects this need to remain unchanged through FY 1988. Based on the estimated costs of bus replacement shown in Table 22, ancillary capital funding will require $90.4 million during FY 1983-1988.

Another major capital investment in the public transportation industry is in transit maintenance and operations facilities, administrative buildings, and park-and-ride lots. These items are typically funded under the same program as bus purchases. DHT estimates that approximately $30 million will be needed to fund the facility construction shown in current transit development plans between FY 1983 and 1986. No estimates are available for FY 1987 and 1988.

In summary, approximately one-quarter billion dollars will be necessary to replace aging buses and acquire ancillary equipment and facilities over the next six years, exclusive of metrorail construction. According to the public transportation engineer, federal aid for capital acquisition is expected to be sufficient to meet these needs providing sufficient State and local matching funds are available. Based on current estimates, about $8.2 million annually will be needed for the State share of capital acquisition projects involving federal funds. (The State provides 19 percent of project costs involving federal, State and local funds.) In addition, the State provided just under $1 million annually in the 1980-82 biennium to offset 95 percent of acquisition costs for projects which do not involve federal funds. Local funding requirements for capital acquisition are expected to be only $500,000 annually.

Metrorail Construction. The Washington Metrorail system is unique among Virginia public transit systems. Metrorail is operated by WMATA and is the only rapid rail system serving Virginia. The original cost of the 101 rail-mile system which will serve the District of Columbia and its Maryland suburbs as well as five cities and counties in Northern Virginia was estimated to be $2.5 billion in 1969. The most recent estimate puts the cost at $8.2 billion.

Funding for Metrorail construction has come from a number of sources. Initially, funding was provided through the issuance of bonds by WMATA. The bonds totaled $997 million plus $77 million interest which were to be redeemed by the participating localities. In Virginia, the five localities which constitute the Northern Virginia Transportation Commission (NVTC)--the cities of Alexandria, Falls Church and Fairfax and the counties of Arlington and Fairfax--have had primary responsibility for Metrorail funding.

The five Virginia localities paid approximately $145 million for Metrorail construction through FY 1980 while the Commonwealth provided $75 million during the period. State aid included $28 million for parking facility construction between FY 1973 and 1980. An additional $7 million in State funding will be provided for parking facilities during FY 1981 and 1982 as well as a $10 million appropriation in the 1980-82 budget. Both of these State funding sources are due to expire at the end of FY 1982.

The costs of constructing the Metrorail system have added to the financial burdens of the participating Northern Virginia localities. A 1979 study prepared for the Secretary of Transportation showed that these localities had a higher overall local tax burden than the rest of the Commonwealth and that the burden was growing more rapidly than in the remainder of the State. The study also concluded that Metrorail funding requirements (both construction and operations) were likely to consume a progressively higher share of local general funds and that the burden would fall increasingly on the single family homeowner.

In 1980 the U.S. Congress enacted the Stark-Harris Bill which commits the federal government to provide $1.7 billion which is expected to fully fund 80 percent of the remaining construction of the 101-mile system and to retire two-thirds of the rail system's outstanding debt of almost $1 billion. The participating localities are to fund the remaining 20 percent of construction and one-third of debt service.

Stark-Harris required each jurisdiction to enact a "stable and reliable" source of funding for all WMATA operations. In Virginia, this requirement was fulfilled by the General Assembly's passing the regional gasoline sales tax in Northern Virginia which became effective in FY 1981. The sales tax was two percent in FY 1981 and produced approximately $8.8 million in revenue, of which $3.1 was applied to debt service and the remainder was used to fund the NVTC share of the WMATA deficit. Collections for FY 1982 are projected to be $10.4 million.

The present Metrorail funding schedule runs through FY 1985 during which period construction will be initiated on most of the remaining system mileage in Virginia. Table 24 shows the estimated costs for construction and debt service for which Northern Virginia localities are responsible during that period.

Table 24

METRO RAIL FUNDING REQUIREMENTS
FY 1982-1985
(millions)

Fiscal Year	Construction	Debt Service	Total
1983	$ 25.8	$ 7.2	$ 33.0
1984	33.4	7.4	40.8
1985	36.1	7.4	43.5
Total	$ 95.3	$22.0	$117.3

Source: Northern Virginia Transportation Commission.

RIDE-SHARING

Ridesharing is an alternate form of public transportation now being promoted throughout Virginia by both government and private organizations. The most common form of ride-sharing, carpooling, has long been used by individuals to reduce the cost of daily commuting trips. In recent years, however, ride-sharing has become a quasi-public approach to public transportation which is seen by some local governments as a means of lessening roadway congestion. In addition several public transit systems have developed ride-sharing programs to

supplement their bus routes, particularly in low-density residential areas.

Ride-sharing Programs

Although the direct benefits of ride-sharing accrue mainly to the individuals involved, public goals of reducing traffic congestion, saving energy, and reducing the demand for transit services in marginal areas are also served. For these reasons, public agencies have become involved in ride-sharing programs. Public involvement usually takes one of two approaches: some programs only assist individuals in locating persons with whom to share rides, while others also purchase vehicles and lease them to individuals for the purpose of initiating a vanpool. These publicly sponsored activities are identical to ride-sharing programs sponsored by private employers and organizations.

Ride-sharing Issues

There are two primary issues in promotion of ride-sharing as an alternate form of public transportation. The first issue, legal and regulatory barriers, appears to have been largely resolved with the passage of House Bill 1031 by the 1981 General Assembly. The ride-sharing bill excluded carpools and vanpools from the legal requirements imposed on commercial operators. Discussions with public transportation division and energy office officials indicate that no major legal or regulatory barriers are likely to hinder future ride-sharing efforts.

The second issue is funding. The Commonwealth presently has no funding specifically targeted for ride-sharing. The financial support provided to date has come through the State's experimental demonstration grants program and federal energy grants. The experimental grant program provides funds only for the first year, after which the sponsoring locality must fund the program.

The DHT program proposal for FY 1983 and 1984 includes specific funding for ride-sharing. The proposed aid would be $200,000 in the first year and $150,000 in the second. This aid would finance up to 75 percent of program costs. The experimental grant program will be funded at $770,000 for the biennium and will continue to be available to fund the first year of a ride-sharing program.

Under federal law additional funding for ride-sharing programs can be obtained through the use of federal primary, secondary, and urban construction funds. However, there is some question as to whether such transfers can be made under Virginia law. Sections 33.1-46.1 of the *Code of Virginia* authorize use of construction funds for the acquisition or construction of highway-related mass transit facilities, a capital activity.

DHT defines ride-sharing programs as public transportation operation and interprets the Appropriations Act prohibition against operating subsidies to preclude use of any federal construction funds for ride-sharing. The 1980-82 Appropriations Act states

> *Funds allocated pursuant to Financial Assistance for Mass Transit may be paid to any local governing body or transportation district commission in aid of the administration of transportation services and capital costs of public mass transportation, except as otherwise stated herein, but in no case of operating subsidies, except as provided in Paragraph D.*

Paragraph D refers to the experimental grant program which is used to fund ride-sharing as well as other programs for a period limited to one year.

No court case or opinions of the Attorney General have addressed this issue. Allowing localities to use federal construction funds for ride-sharing would expand available funding for ride-sharing beyond the amounts specifically identified in the Appropriations Act. DHT should consider requesting an opinion from the Attorney General to clarify the status of ride-sharing for funding under Section 33.1-46.1.

FUNDING POLICY OPTIONS FOR PUBLIC TRANSIT

The General Assembly's policy with regard to public transportation is clearly spelled out in the language of the Appropriations Act which prohibits the use of State funds for operating subsidies except for small limited-duration experimental grants. In contrast, the State has provided substantial funding for capital acquisition. Local governments and transit systems must fund only one percent of federal-participation capital grants, and five percent of non-federal grants. Local funding requirements for capital acquisition, aside from metrorail construction, is expected to be only $500,000 annually over the next several biennia.

Metrorail construction represents a special situation for Northern Virginia localities. Although the State will have provided $92 million in metrorail construction assistance through the end of FY 1982, local governments in the metro service area have been required to raise even larger amounts through bonding and the local sales tax on motor fuel. Of particular concern to officials of the Northern Virginia Transportation Commission (NVTC) is the proposed cut in metrorail assistance for 1982-84. DHT has requested approximately $8 million less for NVTC in the upcoming biennium. This reduction is principally the result of the expiration of a 10-year letter of agreement between DHT and NVTC to provide $3.5 million annually for construction of parking facilities for metro.

The proposed elimination of federal support for operating subsidies raises a new and immediate concern for Virginia. Elimination of federal support will require localities to assume up to $15 million annually in subsidy beyond the $35 million presently provided by local governments to offset operating losses.

The combined impact of proposed substantial reductions in metrorail funding assistance coupled with the possible loss of federal operating subsidies has created a new policy environment for public transportation. In order to address the changing environment the General Assembly may wish to make a formal review of State policy.

Recommendation (8). The General Asembly may wish to create a special joint committee to review State policies regarding public transportation. The committee should be directed to review the financial needs of public transit, ride-sharing programs, and other mass transportation activities in light of changing federal aid policies. Among the alternatives that should be considered are (1) provision of direct State support for operating expenses of public transportation, (2) authorizing local governments to impose special taxes, or (3) other alternatives which would provide a stable and reliable source of funding for public transportation. The committee should identify policy options and make recommendations to the 1983 General Assembly.

The public transportation division should take the lead role in providing the General Assembly with information, analysis, and options for consideration in policy development as provided for in law.

Recommendation (9). The public transportation engineer should take the lead in developing uniform financial and operating report formats which provide comparable information on all transit systems. As a part of a technical assistance program to local transit systems, the public transportation engineer should aggressively pursue identifying ways of reducing operating costs and evaluating transit services.

Finally, the public transportation engineer should prepare a biennial report on public transportation in Virginia which includes the results of efficiency reviews carried out under statute as well as a detailed assessment of public transportation needs of the Commonwealth. This report should have wide distribution and be provided to the appropriate committees of the General Assembly.

Recommendation (10). The Department of Highways and Transportation should request an opinion from the Attorney General to clarify the eligibility of ride-sharing for funding under the Highway Aid to Mass Transit provisions of the *Code of Virginia* (Section 33.1-46.1).

TECHNICAL APPENDIX

The analytic methods used to prepare the Highway and Public Transportation Needs report are described in each chapter. This appendix provides additional technical information on the analysis of maintenance productivity.

Maintenance Productivity Review

The productivity analysis reported in Chapter II reviews the relative efficiency of residencies on three measures: expenditures per unit of work accomplished, manhours per unit of work accomplished, and hours of equipment use per unit of work accomplished. Workload data from DHT's Maintenance Management System for fiscal years 1979 and 1980 were used in the analysis. Simple linear regressions were used to model productivity relationships for each of six maintenance activities performed in enough residencies to provide a sufficient number of data points for the regression analysis. The work activities and coefficient of determination for each of the three productivity measures is shown in Table 1.

Table 1

RELATIONSHIP BETWEEN ACCOMPLISHMENTS AND RESOURCES

Maintenance Activity	Accomplishment Measure	Number of Residencies	Coefficient of Determination (R^2) Explaining Variation Using: Expenditures	Manhours	Equipment Hours
Spot Seal and Skin Patch	Tons of Material	45	.91	.64	.84
Premix Patch	Tons of Material	44	.94	.64	.72
Patch Non-Hard Surfaces	Tons of Material	43	.93	.80	.93
Apply Dust Palliatives	Tons of Material	41	.84	.63	.67
Machine Shoulders (Secondaryonly)	Miles Machined	41	.50	.50	.65
Repair Non-Hard Shoulders with Aggregate	Tons of Material	44	.69	.50	.70
Wedge Non-Hard Shoulders with Bituminous	Tons of Material	36	.90	.80	.90
Repair Hard Shoulders	Tons of Material	34	.89	.85	.86
Machine Ditch and Haul Spoil	Miles of Ditch	45	.69	.70	.74
Machine Ditch and Spread Spoil	Miles of Ditch	44	.76	.50	.80
Hand Clean Ditch	Feet of Ditch	45	.80	.76	.70
Clean Right of Way	Right of Way Miles	45	.83	.80	.77
Tractor Mow on:					
Secondary System	Acres Mowed	44	.51	.58	.63
Primary System	Acres Mowed	45	.52	.57	.63
Interstate System	Acres Mowed	27	.90	.90	.90
Brush Cutting	Acres Cut	45	.54	.52	.60
Repair Guard Rail	Feet of Guard Rail	41	.72	.60	.72
Paint Guidelines	Gallons of Paint	44	.90	.51	.57

Note: All correlation coefficients are significant at the .01 level.

The high coefficients for the work activities provides a basis for viewing the regression line as a reasonable estimate of achievable productivity for all residencies across the state. Those residencies that accomplished less than predicted on the basis of resources used in all three models were relatively less productive, while those that accomplished more were relatively more productive. The locations of the residencies were mapped to examine geographic variation which could account for productivity differences. Field interviews with maintenance staff confirmed that differences in procedures and operating practice were widespread and more likely to account for productivity variation than a geographic explanation.

The savings that would be realized if low productivity residencies were to improve performance to the regression line were measured for each activity. Potential savings of 8 percent were found in the 16 activities combined.

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