JOINT LEGISLATIVE AUDIT AND REVIEW COMMISSION
OF THE VIRGINIA GENERAL ASSEMBLY

Review of Construction Costs and Time Schedules for Virginia Highway Projects

House Document No. 31
A Report in a Series on Transportation Issues in Virginia

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Preface

The Virginia Department of Transportation's (VDOT) six year transportation development plan allocates approximately $9 billion to road construction projects over the next six years. In July 2000, the Joint Legislative Audit and Review Commission (JLARC) directed staff to conduct a study of the six year plan based on concerns regarding reports that road construction projects were facing large cost overruns or were encountering delays in their completion.

This study involved an intensive data collection effort over a short period of time. JLARC staff collected and analyzed cost estimate data on approximately 300 road construction projects. This included data for all interstate, primary, and urban projects that completed design or construction in the last two years. In addition, data were collected and analyzed for all secondary projects that completed design in the last two years and most secondary projects that completed construction in the last year. JLARC staff also conducted a detailed review of 22 road construction projects that were recently completed or are close to completion.

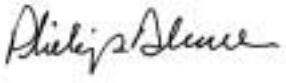
This analysis found that project cost estimates prepared during the design phase were substantially below final project costs. In addition, final construction costs for projects exceeded the amount budgeted for construction by a substantial amount.

As a result of the underestimation of project costs, JLARC staff estimate that the current six year plan may understate the cost of projects in the plan by $3.5 billion. The cost of Virginia Transportation Act projects, as a subset of the projects in the six year plan, may be understated by $2 billion. In addition, the current six year plan may overstate the amount available for road construction because of several questionable assumptions, and there may not be adequate cash flow to support the projects in the plan.

The study found that several factors appear to explain why project cost estimates are well below final design estimates. These factors include not anticipating project scope expansion, not adjusting estimates for inflation, and not consistently including amounts for contingencies. The study also found that major design errors and the failure to detect significant field conditions contribute to construction costs that exceed the amount budgeted for construction.

The study further concluded that while some projects do experience substantial time delays, it appears that projects are typically completed within a reasonable time period. Finally, the study found that the Springfield Interchange Improvement project has not experienced significant design errors or major time delays, but has increased in cost by 44 percent since July 1999.

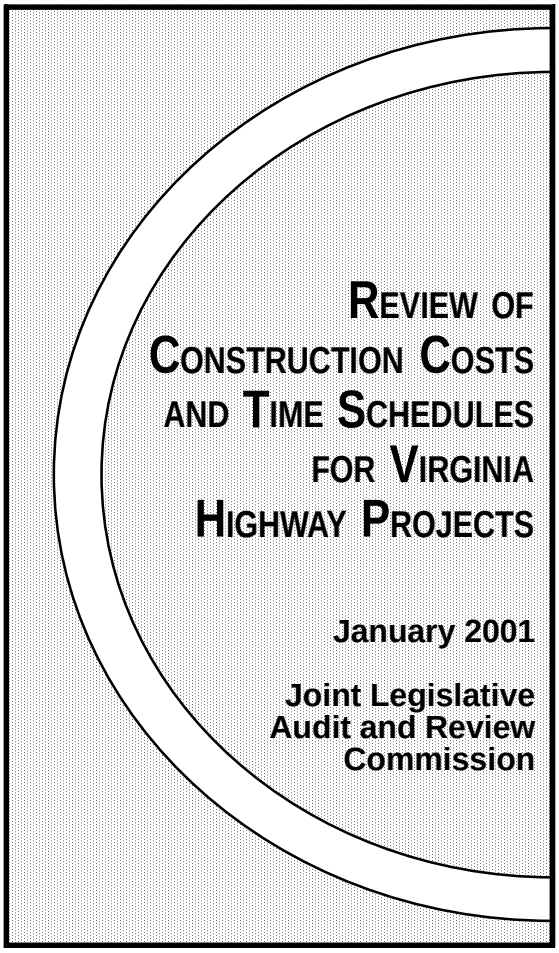
On behalf of the Commission staff, I would like to express our appreciation for the cooperation and assistance provided by VDOT staff.



Philip A. Leone
Director

January 9, 2001

JLARC Report Summary



The Virginia Department of Transportation annually develops a six year plan for transportation, referred to as the Virginia Transportation Development Plan, or six year plan. The current plan allocates approximately $9 billion to road construction projects over the next six years. One of the key assumptions on which the plan is based is the estimated cost of the projects for which funds are allocated. The plan is also based on the projected schedules for completion of design and advertisement of projects.

In July 2000, the Joint Legislative Audit and Review Commission (JLARC) directed staff to conduct a study of Virginia's highway construction program. Based on concerns regarding reports that road construction projects may be facing large cost overruns or have encountered delays in their completion dates, the Commission directed staff to undertake a study of VDOT's transportation development plan. The Commission specifically directed JLARC to assess the impact of these cost overruns on projects authorized pursuant to the Virginia Transportation Act (VTA). This report addresses the issues raised by the Commission directive.

Estimates of project costs prepared by VDOT staff during the design phase appear to underestimate substantially the final cost of road construction projects. In addition, final construction costs exceed, on average, the amount budgeted for contingencies by a substantial amount. Multiple factors have contributed to low cost estimates and higher than anticipated final construction costs, including: project scope expansion, lack of adjustments for inflation, and design errors and omissions. The Springfield Interchange Improvement project is a good case example of a project in which the final cost will far exceed initial project cost estimates.

Given the consistent underestimation of project costs, and construction expenditures that exceed budgeted allocations for projects, the current six year development plan may underestimate the cost of projects in the plan by $3.5 billion. As a result, funds currently allocated in the plan likely will be inadequate to pay for all of the projects. The plan may also overstate the amount of funds that will be available for road construction based on several questionable assumptions, and limited cash flow may further constrain implementation of the current plan.

Road Construction Costs Exceed Estimated Costs and Contract Amounts

Based on analysis of project cost estimate data for recently designed projects, VDOT project cost estimates prepared during the design phase were substantially below final project costs. As Table A shows, cost estimates prepared at the design stage for preliminary engineering, right of way, and construction were all substantially below the final design (100 percent design) cost estimates. Though initial cost estimates were low, they did grow closer to the final design estimate as projects progressed through the design process. The same general pattern emerged when analyzed by road system type, although primary and urban project construction cost estimates increased by significantly more than interstate and secondary project estimates.

While construction contract award amounts were relatively close to the estimated construction cost once the design had been completed, the final construction costs for projects exceeded the amount budgeted for construction by a substantial amount. As Table B shows, final construction costs added eleven percent, on average, to the contract award amount (including budgeted contingencies). Interstate and primary system projects exceeded the contract award amount by the greatest percentages (19 and 16 percent, respectively).

Final construction costs exceeded contract award amounts for two primary reasons. Part of the reason for the increase is that actual project construction costs exceeded the ten percent contingency budgeted for unforeseen contract costs. The other reason for higher than anticipated construction costs is that construction engineering (administra-

Table A

Average Percentage Cost Estimate Change from Project Planning Activity to 100 Percent Design

Planning Activity to 100% Design	Average Percentage Change (%)		
	Preliminary Engineering	Right of Way	Construction
Scoping to 100% Design	114.2	151.9	74.3
Preliminary Field Review to 100% Design	111.7	88.4	52.8
Field Inspection to 100% Design	44.7	65.8	35.7
Furnish Right of Way Plans to 100% Design	13.6	10.6	18.7

Table B

Average Percentage Change in Project Costs from Contract Award to Completion

Project Type	Average Percentage Change (%)
All Design Projects	11.1
Interstate Projects	18.8
Primary Projects	15.7
Secondary Projects	9.0
Urban Projects	8.1

tion and inspections) costs were higher than was budgeted for this purpose.

Several Factors Explain Low Cost Estimates and Final Construction Cost Increases

Several factors appear to explain why project cost estimates are well below final design estimates. One of the factors is that cost estimates prepared during the design phase do not usually anticipate project scope expansion that often occurs as the result of local requests. In addition, prior to this year, cost estimates were based on dollar values at the time of the estimate with no adjustment for inflation. Moreover, estimates historically have not consistently included: (1) contingencies to cover unforeseen circumstances that arise in most projects, (2) amounts for incidental items, (3) and construction and construction engineering contingencies. Finally, there are inherent incentives in the system to underestimate project costs during the design phase.

Inadequate preliminary engineering appears to be one of the reasons that final construction costs exceed the budgeted amount. Many of the projects that were reviewed as part of this study had major design errors that substantially increased project costs. This report includes several case examples in Chapter II in which documented design errors by VDOT and its consultants added substantial amounts to project costs. In several other cases reviewed, construction costs increased substantially as a result of field conditions that were not discovered until construction had begun.

VDOT has recently taken measures to improve project management, including the quality of the project cost estimates prepared during the initial stages of project design. However, it will take several years for VDOT to determine whether these changes will improve the accuracy of the project estimating process. It is unlikely that recent changes have had much impact on the current six year plan, and it will be several years before VDOT can assess the impact of these changes on subsequent six year plans.

VDOT needs to review further its cost estimation process to determine if additional measures can be taken to improve the accuracy of the process. The department should develop clear standards regarding the incorporation of incidental items and contingencies in cost estimates. The department should also review the preliminary engineering process to assess whether there are adequate procedures in place to minimize design errors and whether there is an adequate investigation of existing field conditions during the design phase. VDOT needs to also examine what measures can be taken to reduce the amount by which construction costs exceed budgeted contingencies and whether additional amounts need to be budgeted for contingencies.

Current Development Plan May Underestimate Project Costs by $3.5 Billion

Although VDOT took the positive step this year of adjusting cost estimates in the six year plan for inflation, they still appear to underestimate the cost of projects by a substantial amount. Based on a conservative application of cost growth factors developed by JLARC staff to projects in the current six year development plan with more than 70 percent of their funding allocated by 2006, the plan may underestimate the cost of these projects by $3.5 billion. As Table C shows, VDOT predicts that the projects to which growth factors were applied will cost $7.9 billion to construct. In contrast, JLARC staff estimates that this same set of projects may cost $11.4 billion, or 45 percent more than currently estimated by VDOT.

Table C

Comparison of VDOT and JLARC Estimated Costs for Road Construction Projects, by Road System
(Projects with 70 Percent of Funding Allocated by 2006)

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall	$7,856	$11,354	45
Interstate	$2,021	$ 2,911	44
Primary	$2,803	$ 4,002	43
Secondary	$1,408	$ 1,963	39
Urban	$1,624	$ 2,477	53

JLARC staff also applied the cost growth factors to road construction projects listed in the Virginia Transportation Act (VTA) only, with more than 70 percent of their funding allocated by 2006. The plan may understate the cost of these projects by $2 billion. VDOT projects that the 257 VTA projects used in the analysis will cost $4.2 billion to construct. Applying the cost growth factors, JLARC staff estimate that these projects may cost $6.2 billion, or 47 percent more than currently estimated by VDOT (Table D below).

This finding has serious implications for highway construction in Virginia over the next few years. With projects in the six year plan possibly costing $3.5 billion more than currently estimated by VDOT, the current plan does not appear to accurately reflect the level of construction that can be realistically achieved over the next six years. As project costs rise beyond the estimates and

Table D

Comparison of VDOT and JLARC Estimated Costs for Road Construction Projects in the Virginia Transportation Act of 2000, by Road System
(Projects with 70 Percent of Funding Allocated by 2006)

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall	$4,229	$6,218	47
Interstate	$1,602	$2,407	50
Primary	$2,153	$3,089	43
Secondary	$ 85	$ 120	41
Urban	$ 389	$ 602	55

the amounts budgeted, difficult choices will inevitably have to be made between which projects should proceed and which projects will have to be delayed until adequate funds can be allocated.

Six Year Plan Includes Questionable Assumptions and May Be Limited by Cash Flow Constraints

In addition to being based on low project cost estimates, the current plan appears to be based on questionable assumptions regarding maintenance expenditures. The amount allocated for maintenance over the six year period appears to be overly conservative and therefore may understate the amount that will be needed for highway maintenance by $201 million. Other questionable assumptions regarding dedication of funds to mass transit and amounts needed to repay bonds may further reduce the amount actually available for road construction.

Another concern regarding the six year plan is whether there will be sufficient cash flow to support the projects in the plan. The most recent VDOT cash flow analysis shows a shortfall by the end of the 2001 fiscal year in the construction portion of the Transportation Trust Fund, which may not be entirely eliminated, even with the recent appropriation of additional funds by the General Assembly. A cash flow shortfall will likely require VDOT to delay the advertisement of some projects.

Road Construction Projects Take More than Four Years to Design and Construct, But Appear to Be Completed Within a Reasonable Time Period

Analysis of projects that recently completed the design phase indicates that projects took approximately three years to design, on average, and 13 months to construct. The majority of projects (52 percent) completed the design phase in one to three years, while more than one-third (37 percent) took more than three years to finish design. Most construction contracts are extended beyond the initial project deadline as a result of shutdowns or extra work due to work orders or quantity overruns. While some projects do experience substantial time delays as demonstrated by some of the case examples in this report, it appears that projects are typically completed within a reasonable time period.

Cost of Springfield Interchange Improvement Project Has Increased by 44 Percent Since July 1999, and May Cost $667 Million

The Springfield Interchange Improvement project has not experienced significant design errors or major delays and appears to be on schedule to be completed by 2007. However, cost estimates for the project have steadily increased over the last several years. Since July 1999, the project has increased in cost by $174 million from $393 million to $567 million. Factors that have contributed to the recent cost increase include the inclusion of construction and construction engineering contingencies, increased right of way costs, and refined design estimates. Based on the cost growth factors developed by JLARC staff, the cost of the project may increase by an additional $100 million. As Table E on the next page demonstrates, most of the estimated increase will result from higher construction costs for phases IV through VII.

Table E

Estimated Cost of the Springfield Interchange

	VDOT Cost Estimate October 2000	JLARC Estimated Cost
Preliminary Engineering	$ 42,649,000	
Right of Way	$ 68,909,000	
Congestion Management	$ 28,000,000	
Information Store	$ 3,170,000	
Beltway Ramps	$ 689,000	
Phase I & Spring Mall Ramp	$ 4,818,000	
Cost Incurred to Date	**$ 148,235,000**	**$ 148,235,000**
Phase II & III	$ 116,603,000	$ 126,586,152
Phases IV	$ 139,270,000	$ 164,015,280
Phase V	$ 55,700,000	$ 71,862,358
Phases VI & VII	$ 107,608,000	$ 156,186,448
Projected Total Cost	**$ 567,416,000**	**$ 666,885,238**

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I: Introduction

In July 2000, the Joint Legislative Audit and Review Commission directed staff to conduct a study of Virginia's highway construction program. The Commission has expressed concern regarding reports that road construction projects may be facing large cost overruns or have encountered delays in their original completion dates. Based on these concerns, the Commission directed its staff to undertake a study of the Virginia Department of Transportation's Development Plan (six year plan). The Commission specifically directed JLARC staff to assess the impact of these cost overruns on projects authorized pursuant to the Virginia Transportation Act.

JLARC staff have reviewed several major issues related to road construction cost increases and time delays in response to the Commission's directive. The study has included an examination of the cost estimation process during the design of a project as well as the extent to which final construction costs exceed the final design estimate and contract award amount. JLARC staff also examined the time required to design and construct road projects as well as delays that may slow the process either at the design or construction phases. The review also included an examination of the current six year plan, the assumptions on which the plan is based, and the accuracy of the plan, considering a comparison of final project costs against cost estimates and contract amounts. Finally, this review included a detailed examination of the Springfield Interchange Improvement project.

HIGHWAY DEVELOPMENT PROCESS

The highway development process is a multi-stage process that begins with the prioritization of road projects and the decision regarding which projects to fund. For projects that are funded, three primary phases comprise the development process: preliminary engineering, acquisition of right of way, and construction.

Preliminary Engineering

The preliminary engineering phase is the first major stage in the road construction process and is the phase during which a road project is designed. During this phase, environmental documents are prepared, traffic analysis and planning are conducted, a survey is performed, design plans are prepared, materials data are developed, and traffic engineering is conducted. For roads being built on new locations, alternatives are required to be developed and a location hearing is held to receive input on proposed alternatives. For these projects, a subsequent design hearing is held to receive input on the proposed design of a project. With projects that are constructed in an existing corridor, one combined location and design hearing is typically held to receive input on the location and design of the project.

Scoping Stage. VDOT staff have identified several key milestones in the design process which are shown in Figure 1. The first key point in the process is scoping. At this stage in the process, VDOT convenes an interdisciplinary team from the various divisions to define the elements comprising a project, the working budget, and the schedule for designing and developing the project.

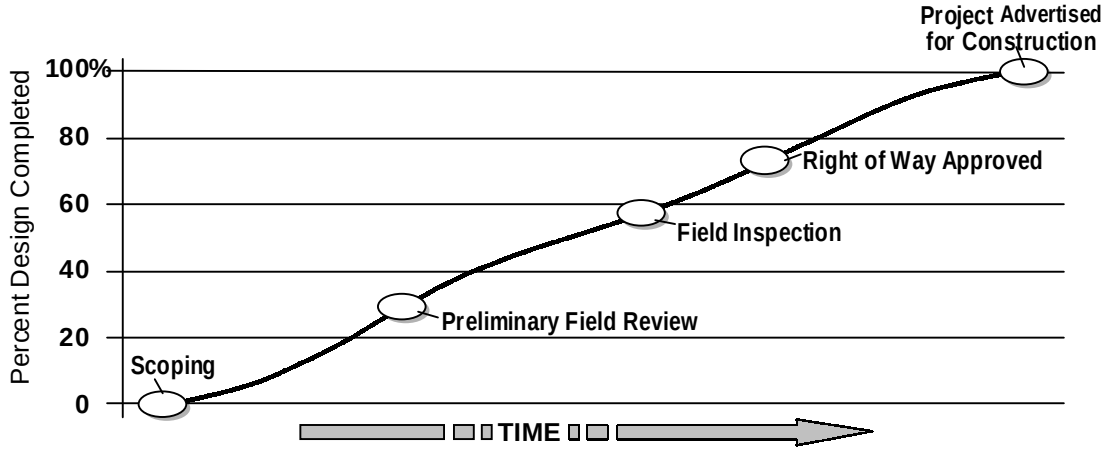
Preliminary Field Review. The next major milestone in the development of a project is the preliminary field review. At this point in the process, the same team reviews a preliminary set of plans. In addition, the project manager reviews the progress of the project, and individual team members assess the status of their own tasks in relation to the status of the project as a whole.

Field Inspection. The next major milestone is the field inspection. At this point in the process, the interdisciplinary team again reviews the set of design plans, which are between 50 and 60 percent complete. The team must give final approval to all concept plans and designs that might affect the right of way for a project. In addition, a field review of the project is conducted, which involves an on-site review of the field conditions. After this stage, a design public hearing is held to receive public input on the design. The Commonwealth Transportation Board must then vote to approve the design.

Submission of Plans to Right of Way. After the field inspection stage and the design public hearing, the design plans are submitted to the Right of Way and Utilities division to begin necessary right of way acquisition and clearance of utilities. While necessary right of way acquisition takes place, the location and design team continues with the final design of a project.

Figure 1

Project Design Process



Source: JLARC staff graphic based on VDOT data.

Right of Way and Utilities

After the field inspection approval of the design plans and the design hearing, the plans are submitted to the Right of Way division so that right of way acquisition may proceed. VDOT staff assess the fair market value of each property that needs to be acquired for the construction project and then present an offer to each affected property owner based on the determined value. If a property owner accepts an offer, then VDOT compensates the owner in the amount of the offer. A property owner may also choose to decline the offer, in which case the amount of compensation to be paid is resolved through an administrative or legal proceeding or through a negotiated settlement. VDOT may proceed with condemnation of any property if the compensation issue has not been resolved with the landowner so that the construction can proceed. In some cases, property owner claims are not finally resolved until years after the construction of a project is completed.

Along with right of way, most projects have utilities that have to be relocated as part of the construction project. Utility relocation is primarily the responsibility of the utility companies. VDOT provides the project design plans and coordinates the relocation. The utility companies develop the utility relocation plans.

Construction

After the project design is completed, the Location and Design division submits the design plans to the Construction division. The Construction division conducts a constructability review and prepares the project to be advertised for construction. At this point in the process, the Construction division can make changes or suggestions regarding the plans and may send them back to the designers to make the necessary adjustments. The design team then makes the necessary adjustments and resubmits the plans to the Construction division.

After the construction review has been completed and plan adjustments made, a project is advertised for construction. Approved contractors may then bid on the construction work. Contractors generally have between six weeks and three months to submit bids. After a contract is awarded, it is transferred to the VDOT district or residency and is administered by a designated engineer in a district or residency office. Along with a project manager, each project has one or more inspectors assigned who are responsible for overseeing the construction to ensure that the work is being performed in accordance with established standards.

SIX YEAR DEVELOPMENT PLAN

The Virginia Transportation Development Plan (known until this year as the six year improvement program and referred to in this report as the six year plan) is an annual planning document which lists the road projects that have been allocated, or

are projected to be allocated, funding during the next six years. The six year plan also details the funding that will be provided for public transit. The plan is developed annually based on input from State legislators, local governments, regional planning organizations, the Commonwealth Transportation Board, and members of the general public. For the interstate, primary, and urban system projects, the Commonwealth Transportation Board has the final authority to approve the six year plan. The secondary system plan, however, is developed by the board of supervisors in each county with the support of VDOT staff.

The current six year plan has allocations totaling $10.3 billion for roads and transit. Most of those funds will be allocated to road construction. Table 1 shows the amount allocated in the current six year plan to road construction.

The six year plan is divided by VDOT district and by road system within each district. The plan shows the projected cost of each project based on estimates provided by location and design staff. These cost estimates include separate estimates for preliminary engineering, right of way, and construction. The estimates are supposed to be updated at least annually and the updated amounts reflected in the plan.

The plan also lists the total amount of funding allocated for each project in the plan for the current fiscal year as well as how much is projected to be allocated for each project for the next five years. In addition, the plan shows how much funding a project has previously received as well as how much will remain to be allocated to the project, if any, in the years beyond the six year plan.

Table 1

Funds Allocated for Road Construction (2001-2006)

Fiscal Year	Amount
2001	$ 1,837,298,000
2002	$ 1,289,437,000
2003	$ 1,318,155,000
2004	$ 1,422,256,000
2005	$ 1,380,785,000
2006	$ 1,624,538,000
Total	$ 8,872,469,000

Note: Amounts shown do not include Congestion Mitigation and Air Quality Improvements, Special Legislative Action funds, Rail Safety and Mass Transit funds, Dulles Toll Road Improvements, U.S. Route 58 Corridor Development funds, and Transportation Enhancement projects.

Source: 2000-2001 Virginia Transportation Development Plan.

Beginning next year, VDOT plans to divide the plan into two parts. Projects that are being studied but have not received substantial funding will be listed separately and categorized as feasibility projects. Projects that are going to be funded and are progressing toward construction will be listed in the second part of the plan which will be called the Capital Improvement Program. In this year's six year plan, all of the projects are contained in one document but projects that are considered to be feasibility projects are noted.

VIRGINIA TRANSPORTATION ACT

During the 2000 Session, the General Assembly enacted the Virginia Transportation Act (VTA) to return some delayed projects back to their previous schedules and to provide funding to accelerate some high priority projects. Ninety projects had to be delayed in 1999 due to a cash flow shortage that forced VDOT to limit the number of road construction projects that it could advance to advertisement.

The VTA provided $473 million over six years to supplement projects in the six year plan that had been delayed. For projects receiving general fund dollars, the VTA designated specific amounts of general fund dollars to be received by the projects annually in each of the next six years.

In addition, the VTA established two mechanisms for accelerating high priority projects. The Act authorizes the use of federal revenue anticipation notes (FRANs). FRANs are bonds issued to raise funds for highway construction that are to be repaid from future federal highway reimbursements. The Department's financing plan anticipates the issuance of FRANS totaling $1.1 billion within six years to accelerate federal funding for highway construction. The bonds have a maximum term of ten years and federal transportation funds are intended to be used to pay the debt service. VDOT issued the first $375 million in bonds in October of this year.

The VTA also established the Priority Transportation Fund (PTF). Revenue will be generated for the PTF by changing the point of collection of the motor fuels tax from the distributor to the wholesaler level. The Department of Motor Vehicles believes that this will reduce tax evasion and increase tax collections. In addition, revenue in excess of forecasts is directed to be transferred to the PTF.

The Transportation Development Plan lists 121 projects considered by the General Assembly to be priority projects, and to be funded from FRANs or the Priority Transportation Fund. In the development of the current transportation development plan, VDOT prioritized these projects in the allocation of funds.

JLARC REVIEW

The JLARC review of highway construction cost overruns and time delays has involved an assessment of the accuracy of VDOT project cost estimates, cost increases that occur during the construction phase, time delays that occur during the design and construction phases, the Springfield Interchange Improvement project, and other factors that may impact the department's ability to fund the projects in the current six year plan. A number of research activities were undertaken as part of this study in order to address these issues. These activities included: structured interviews, data collection and development of cost growth factors, application of cost growth factors to the six year development plan, review of Springfield Interchange project files as well as a site visit to the project, review of other project files, analysis of financial data and assumptions and cash flow predictions, and attendance of meetings and hearings.

Structured Interviews

Numerous structured interviews were conducted during the course of this review. Interviews were conducted with the Chief Engineer, the Assistant Commissioner for Finance, the State Construction Engineer, the State Location and Design Engineer, the Secondary and Urban Roads Engineers, the director of Programming and Scheduling, and the State Right of Way and Utilities Engineer. JLARC staff also met with VDOT staff in the Financial Planning and Debt Management, and Programming and Scheduling sections. Finally, JLARC staff interviewed the location & design and construction project managers for the Springfield Interchange project as well as several other construction project managers.

Data Collection and Development of Cost Growth Factors

JLARC staff collected extensive data on recently designed and recently completed road construction projects. Cost estimate data were collected on 86 projects that have completed the design phase in the last two years (four years for interstate system projects). The data collected included the cost estimates developed for each of the projects at several major milestones in the project design process.

In addition, JLARC staff collected construction cost data on 211 projects that have completed construction in the previous two years (one year for secondary system projects). Data collected included the estimated cost of the projects after design completion, the contract award amount for these projects, and the final cost of these projects.

Based on these data, three cost growth factors were developed. The first factor assesses how much cost estimates for projects increased on average as projects progressed through the design process. A second cost growth factor was developed to measure the average percentage change between the estimated cost at the final design stage of construction projects and the construction contract award amount. Finally,

the data collected were used to develop a third cost growth factor which measured the percentage change between the contract award amount and the final cost of construction. A more detailed discussion of the development of the cost growth factors is included in Appendix C.

Application of Cost Growth Factors

The cost growth factors were applied to the projects in the current six year development plan to show how the six year plan may understate the cost of the projects in the plan (Appendix C). Appropriate cost growth factors were applied based on the current status of each project in the six year plan. Assuming the average rate of cost growth observed in recently designed or completed road construction projects occurs in projects currently in the plan, JLARC staff estimated how much VDOT has understated the cost of each project. JLARC staff controlled for the inflation factor added to project costs in the current six year plan. Based on this analysis, JLARC staff were able to estimate the total amount by which the six year plan may understate the likely cost of the projects funded in the plan over the next six years.

Review of the Springfield Interchange Project Files and Site Visit

JLARC staff also conducted a detailed review of the Springfield Interchange Improvement project files. This included a review of the location and design files for the project, all work order and related cost data, as well as monthly cost reports prepared by the construction project engineer. Along with a detailed review of the files, JLARC staff visited the project site and received a site tour by the project engineer. JLARC staff also met with staff of the Office of Inspector General, U.S. Department of Transportation.

Review of Project Files

Along with the review of the Springfield Interchange project files, JLARC staff conducted a detailed review of the project files for 22 additional projects. This included all four of the projects completed in the last two years that have exceeded $30 million in total cost, as well as the six projects currently under construction that are more than 50 percent complete and projected to exceed $30 million. In addition, JLARC staff randomly selected for review ten smaller projects (between $5 and $15 million) that have been completed in the last year. JLARC staff also examined the files for two privately constructed projects. For each of these 22 projects, the location and design files were reviewed as well as construction data including work orders, cost overrun records, and construction summary sheets. In addition, JLARC staff conducted follow-up interviews with project managers for some of the projects reviewed to clarify findings from the file review and to obtain additional information regarding the projects.

Analysis of Financial Data and Cash Flow Projections

JLARC staff reviewed six year allocation spreadsheets which serve as the basis for the six year plan and the assumptions underlying it. Staff also reviewed historical maintenance expenditures by VDOT. Finally, JLARC staff reviewed previous cash flow analyses conducted by VDOT's financial division. The purpose of these reviews was to assess the extent to which the current six year plan is based on reasonable assumptions and whether funds projected to be allocated for projects are likely to be available.

Attendance of Meetings/Hearings

As part of this review, JLARC staff attended meetings and workshops of the Commonwealth Transportation Board as well as meetings of the Governor's Commission on Transportation Policy. In addition, JLARC staff attended several pre-allocation hearings prior to the development of the six year plan as well as a VDOT hearing to receive comments on the tentative six year plan.

REPORT ORGANIZATION

This report is organized into four chapters. Chapter I has provided an overview of the highway planning and construction process, the development of the six year plan, and the JLARC review. Chapter II discusses cost growth factors developed to estimate the extent to which VDOT cost estimates may understate the actual cost of road construction projects. The chapter also includes case examples from the file reviews that help to explain why the cost estimates developed by VDOT and the contract award amounts often do not reflect the final cost of projects. Chapter III evaluates the current six year plan, the validity of the assumptions on which it is based, and the extent to which it may underestimate the likely cost of projects funded in the plan based on the cost growth factors. Finally, Chapter IV discusses the Springfield Interchange Improvement project.

II: Construction Costs and Time Schedules

One of the important aspects of the road construction process is planning for construction. Central to this planning function are estimating how much projects will cost and setting time schedules for the design of projects. Estimates of project costs are prepared at various points during the design of a project, with the last estimate prepared prior to the advertisement of a project for construction.

Based on analyses of cost estimate and final cost data for 297 projects that have recently completed the design or construction phase, initial estimates of project costs have been well below the final construction costs for projects. These analyses indicate that initial estimates for projects are substantially less than the cost estimates developed as a project nears design completion. In addition, the final construction cost substantially exceeds the construction contract amount.

Cost estimates in the planning phase are low, and final costs are substantially higher than anticipated for a variety of reasons. Factors that result in low initial estimates include unforeseen additions to the scope of a project, not adjusting cost estimates for inflation, not including costs of incidental items such as soundwalls or guardrails, and incentives inherent in the system to underestimate project costs.

Final construction costs exceed the amount of the contract for several reasons. Factors that contribute to cost increases during the construction phase include project design errors as well as the lack of detection of field conditions that ultimately increase construction costs. Another factor that contributes to final construction costs in excess of the contract amount is unplanned costs associated with the administration of construction contracts.

The time required to design projects varies widely. Design work and construction take approximately four years on average to complete. Many projects receive time extensions during the construction phase that extend the construction deadline beyond the initial contract deadline.

VDOT DEVELOPS PROJECT COST ESTIMATES AND ESTABLISHES TIME SCHEDULES

VDOT prepares both cost estimates and time estimates when projects are first authorized, and continues to refine those estimates as projects are designed. Cost estimates made during the design phase are based largely on information available about the quantities of materials needed to construct a project and the unit prices of those quantities. While the final design estimate for projects is relatively close to the accepted construction bid generally, the final cost of road construction projects often

exceeds the final design estimate and the contract award amount. Change orders are used to adjust the cost to include additional work and materials that were not foreseen at the time of the contract award.

In addition to estimating the cost of construction projects, location and design staff also develop time schedules for the completion of the project design work. Construction division staff are responsible for setting deadlines for project construction with the flexibility to grant contract extensions based on bad weather or for extra work that was not anticipated at the time of the contract award.

Projects Costs Are Estimated at Different Milestones During Preliminary Engineering

When a project is placed in the six year development plan, and throughout the design of a project, VDOT staff prepare and refine cost estimates at major milestones during the design phase. Separate estimates are developed for the cost of preliminary engineering, right of way, and construction. An estimate is developed for a project as soon as it appears in the six year development plan, and additional estimates are prepared at the following points in the process: scoping, preliminary field review, field inspection, completion of right of way plans, and 100 percent design.

Construction cost estimates are based primarily on the calculation by the designer of the quantities of materials needed to perform the work required to construct a project. With projects designed in-house, quantities developed are then entered into a software program called the TRNS-PORT system. This system, which has historical data on prices for various materials and activities required as part of construction, can produce statewide price estimates for the various construction items. Based on these generated prices and the specified quantities, the system can then generate estimated costs for various construction activities which serve as the basis for the construction cost estimate. As a project progresses through the design phase, quantities become more clearly defined, which improves the accuracy of the TRNS-PORT-based estimates. Until recently, design consultants did not have access to the TRNS-PORT system and relied upon their own software programs to generate prices on quantities and develop cost estimates. Now, consultants have access to the TRNS-PORT system.

Initial Project Estimate. The first estimate for most projects is prepared prior to any design work on a project. This estimate is developed for the purpose of allocating funds for a project in the six year plan. In some instances, it is an estimate developed solely by local officials. In other instances, VDOT may provide input in the development of the initial estimate used in the six year plan. VDOT maintains historical data on the cost per mile of road construction which can be used to develop crude estimates of project costs. While likely the least accurate estimate for a project, this is the first estimate used in the six year program. Thus, it is often the basis for initial funding decisions.

Estimate at Scoping. The next major point at which VDOT prepares an estimate is at the scoping stage. At this stage, the estimate is based on a site visit to the project, input from VDOT staff representing the various road design and construction disciplines, and the experience of the design project manager. However, at this stage neither plans nor quantities are developed. Therefore, according to VDOT staff, the scoping estimate is a rough estimate and is still merely a guess as to the cost.

Preliminary Field Review Estimate. By the preliminary field review stage, the cost estimate can be further refined. The design plans are only 20 to 30 percent complete, but the designers have estimates for the quantities of materials needed for pavement and earthwork. These quantities can be entered in the TRNS-PORT system or, in the case of a consultant, whatever system they have available to develop construction cost estimates.

Field Inspection Estimate. The cost estimate for a project is further refined at the field inspection stage. By this point, the design plans are between 50 and 60 percent complete. Designers have developed reliable estimates for the quantities related to earthwork, pavement, and some drainage. Based on these increasingly reliable quantity estimates, the project designers can generate more accurate construction cost estimates.

Approval of Rights of Way Plans. The estimate is further refined when right of way plans are approved and furnished to the Right of Way and Utilities division. At this point, the design plans are approximately 75 percent complete, and no major design changes are anticipated. Most of the remaining design work involves the development of quantities for incidental items such as guardrails, curbs and gutters, and soundwalls.

100 Percent Design Estimate. The final project cost estimate prepared by the location and design staff is the 100 percent design estimate. At this stage, the designers have developed precise quantities and generated estimated prices for items required to construct a project.

Preliminary Engineering Cost Estimates. Along with project construction cost estimates, preliminary engineering estimates are prepared at each stage in the design process. Preliminary engineering cost estimates are based primarily on the projected number of person hours needed to perform the design work. Preliminary engineering estimates may increase during the design phase as a result of increases in scope or the discovery of factors that complicate the design.

Cost Estimate of Right of Way. Along with construction and preliminary engineering cost estimates, the Right of Way and Utilities division provides right of way cost estimates for projects beginning at the scoping stage. With no plans at this point and no clear alignment for the project, the right of way estimate is only a rough estimate. As the design plans progress and the alignment for a project becomes more clearly defined, the right of way estimates become more accurate. To account for in-

creasing land values, right of way estimates incorporate a ten percent annual increase in land value based on the number of years until right of way acquisition is scheduled to begin.

Project Costs Increase During Construction Phase

After the design plans have been submitted to the Construction division, the contract is advertised and bids are received. VDOT develops its own internal estimate, which is used to assess the accuracy and reasonableness of the bids. This estimate is more refined than the 100 percent design estimate, because prices are developed based on current price and labor conditions in the specific area of the project instead of statewide historical data. If all bids received for constructing a project exceed the control estimate by more than seven percent or are less than the control estimate by more than ten percent, the construction division investigates the possible reasons for this variance. If there is no valid explanation for the variance, the Construction division may re-advertise the project.

At this point in the process, the accepted contract bid, which does not necessarily match the 100 percent design estimate, replaces the latest project estimate as the best indicator of the ultimate cost of a construction project. In addition to the bid amount, for each construction contract VDOT budgets an additional ten percent of the bid amount to cover unexpected contingencies that arise during construction. VDOT budgets an additional amount to fund construction engineering, which includes project inspections and the administration of the contract. Construction engineering is estimated at an amount equal to 15 percent of the contract price for small projects ($100,000 or less), 12 percent for medium size projects ($100,001- $5,000,000), and eight percent for projects greater than $5 million. Therefore, VDOT plans 18 to 25 percent more on construction than indicated by the contract price.

The final cost of a project is often substantially higher than the contract amount, including the two contingencies. During the construction phase, changes are often required to address design errors or omissions, unanticipated problems, or requested modifications. Work changes are handled through change orders which must be approved by appropriate VDOT staff. Cost under- or overruns are changes in the quantity of materials needed or in the amount of work required. Costs associated with change orders and cost under- or overruns add substantially to the final cost of many construction projects.

VDOT Develops Project Time Schedules

Along with the estimation of project costs, VDOT also estimates the time required to complete road construction projects. VDOT generally estimates the time schedules at two major points. At the scoping stage, the location and design project manager estimates how long it will take to design a project and prepare it for advertisement. Then the Construction division develops a construction schedule in preparing the construction contract.

Establishing a Design Schedule. At the scoping stage, the project manager is required to develop an estimate as to how long it will take to design a project. This estimate is based on input from other VDOT staff who will be involved in the design, including the surveyor, the design engineer, and right of way personnel. Based on this input, the project manager estimates how long it will take, barring unforeseen delays, to reach the advertisement stage. A computer program then generates deadlines for reaching major milestones in the design process. As unforeseen delays occur in the process, the project manager is supposed to revise the design schedule accordingly.

Determining Construction Schedules. The Construction division develops a project schedule as part of the construction contract. The schedule developed is either a fixed date or calendar days schedule. Calendar days contracts calculate the number of days that will be required to complete a construction contract. These contracts provide more flexibility to VDOT to extend the contract beyond the initial deadline as a result of weather or other unanticipated problems that delay the completion of a contract. Initial contract deadlines are set based on the assumption that a contractor will work 45 to 50 hours a week. VDOT also assumes that the calendar days contract deadlines will have to be extended as a result of weather-related shutdowns but bases the initial contract deadline solely on the number of days estimated to be needed to complete the work. According to the State Construction Engineer, approximately 80 percent of VDOT construction contracts are calendar days contracts.

The other type of contract is a fixed date contract. A fixed date contract sets a fixed "drop-dead" date for completion of the project. Ordinarily, a contractor is not allowed any extensions under a fixed date contract unless there is an extenuating circumstance such as a major design error. Such extensions may only be granted through an approved change order. Fixed date contracts often contain financial incentives for early completion of the work and disincentives for completion after the set deadline.

ROAD CONSTRUCTION COSTS EXCEED ESTIMATED COSTS AND CONTRACT AMOUNTS

VDOT estimates of project costs prepared during the design phase do not accurately reflect the cost of road construction projects. VDOT consistently underestimates project costs during the design phase for projects in all four road systems. Similarly, final construction costs exceed substantially the construction contract award amount due to unplanned project cost increases and underestimated project administration costs.

Development of Cost Growth Estimation Factors

JLARC staff used data from recently completed projects provided by VDOT to measure how accurately the department has estimated project costs during the design

process and how much the final cost of construction projects exceeds the contract award amount. (A detailed discussion of the number of projects analyzed and calculations is provided in Appendix C.) Based on data provided by VDOT for these recently completed projects concerning project cost estimates, contract award amounts, and final construction costs, JLARC staff were able to develop cost growth factors that estimate the extent to which, on average, VDOT may underestimate the cost of projects during the design phase and the extent to which the final cost of projects exceeds the contract amount.

Development of Design Phase Cost Growth Factors. Cost growth factors were developed to measure how accurately design and right of way staff estimate the cost of construction projects at various points in the design process, from the scoping stage to 100 percent design. To achieve this, JLARC staff collected certain data for all construction projects that completed the design phase within the last two fiscal years (four years for interstate projects). Data collected included the cost estimates for the project prepared at five key points in the design process: scoping, preliminary field review, field inspection, furnishing of right of way plans, and 100 percent design. Based on the data, JLARC staff were able to calculate the extent to which project estimates at each of these stages in the process differed, on average, from the cost estimate prepared at 100 percent design. Separate cost growth factors were calculated for preliminary engineering, right of way, and construction costs because VDOT develops separate estimates for each of these phases.

Development of 100 Percent Design Estimate to Construction Award Cost Growth Factor. In addition to the design cost growth factors, JLARC staff developed a cost growth factor to measure the percentage change in cost between the 100 percent design estimate for construction and the contract award amount. This factor was calculated based on data collected for a sample of 211 projects that completed the construction phase in the last two years. The cost growth factor was calculated by measuring the percentage change from the 100 percent design estimate to the contract award amount for these projects.

Development of Contract Award to Final Construction Cost Growth Factor. A cost growth factor was developed to estimate the average percentage change from the contract award amount (including the budgeted ten percent contingency and the eight to 15 percent construction engineering contingency) to the final construction cost. This cost growth factor was developed based on data for projects that completed the construction process in the last two fiscal years. The cost growth factor was calculated by measuring the percentage change from the contract award amount to the final construction cost.

Average Percentage Change. For all of these cost growth factors, the percentage change for each project between the points being measured was calculated. Then the average percentage change for each cost growth factor was calculated based on project data from all of the projects for which data were collected. Although JLARC staff calculated the average as well as the median percentage change for each cost growth factor, the average was chosen as the preferred measure of central tendency.

By using the average percentage change, the cost growth factors take into account the cost growth for all of the projects. It appears that VDOT has recently had some construction projects with extreme cost increases that deviate from the norm and is likely to have such projects in the future.

Cost Growth Factors by Road System. In addition to developing cost growth factors for the projects analyzed as a whole, JLARC staff developed cost growth factors for each major road system type. Cost growth factors were developed for the interstate, primary, urban, and secondary systems based exclusively on data from projects in those systems.

Project Costs Are Substantially Underestimated During the Design Phase

The cost growth factors developed to measure the extent that project costs are under- or overestimated during the design phase indicate that cost estimates at this point in the process are substantially below the final cost of projects. Table 2 shows the amount by which project costs were underestimated based on all of the projects for which data were collected. As the table shows, cost estimates at the design stage for preliminary engineering, right of way, and construction were all substantially less than the final design estimate, although initial construction estimates were substantially closer to the 100 percent design cost estimate than the other two categories. With preliminary engineering and right of way, the cost estimates increased by more than 110 percent from the initial to final design cost estimate, and the construction estimates within the design phase increased by almost 75 percent. The construction and right of way design estimates at the preliminary field review stage, though substantially closer, were still much less than the final design estimate. At the field inspection stage, the preliminary engineering, right of way, and construction cost estimates continued to grow closer to the final design estimate, and by the point at which

Table 2

Average Percentage Cost Estimate Change from Project Planning Activity to 100 Percent Design

Planning Activity to 100% Design	Average Percentage Change (%)		
	PE	RW	CN
Scoping to 100% Design	114.2	151.9	74.3
Preliminary Field Review to 100% Design	111.7	88.4	52.8
Field Inspection to 100% Design	44.7	65.8	35.7
Furnish Right of Way Plans to 100% Design	13.6	10.6	18.7

Key: PE = Preliminary Engineering, RW = Right of Way, CN = Construction.

Note: See Appendix C for a discussion of number of projects analyzed.

Source: JLARC staff analysis of VDOT project cost data.

right of way plans were furnished, all three cost estimates were relatively close to the final design estimate.

In addition to calculating cost growth factors for the projects as a whole, JLARC staff also calculated cost growth factors by road system. Table 3 shows the amount by which project costs were underestimated at major points in the design process based on road system type. The same general pattern emerged when growth factors were calculated for each road system. The estimates of project costs were generally much less than the final design estimate at the scoping stage and grew closer to the final design estimate as the project progressed through the design process. Interstate construction and preliminary engineering cost estimates at the first three stages in the design process were generally more accurate than the estimates for projects in the other road systems. Primary and urban project cost estimates increased by the greatest percentage through the design process. Initial interstate and urban system right of way estimates varied more from the final design estimates than the other two road system types.

Contract Award Amount Relatively Close to 100 Percent Design Estimate

The cost growth factor developed to measure the percentage change from the final design estimate to the contract award amount for projects revealed that the 100 percent design construction estimate was on average relatively close to the contract award amount. As Table 4 (page 18) shows, the average increase from the final design construction cost estimate to the contract award amount was only three percent. When examined by road system type, both the interstate and urban system projects had substantially greater percentage changes from 100 percent design to construction award (nine percent) than primary and secondary projects, which had only small changes.

Construction Costs Exceed Construction Award Amount

The final cost growth factor developed to measure the increase from the contract award amount, which includes the budgeted ten percent contingency and eight to 15 percent amount for construction engineering, to the final construction cost indicates that project costs on average exceeded the contract award amount by a substantial margin. As Table 5 (page 18) shows, the final construction cost exceeded the contract award amount by 11 percent on average. Table 5 further shows the extent to which final construction costs exceeded the construction award amount by road system type. Interstate and primary system projects exceeded the contract award amount by the greatest percentages (19 and 16 percent, respectively). Secondary and urban projects exceeded the amount budgeted for construction by nine and eight percent, respectively.

The amount by which final construction costs exceeded the contract award amount consists of two principal parts. The first part of the increase over the contract award amount was the amount that actual project construction costs exceeded the contract price in excess of the ten percent contingency budgeted for each construction

Table 3

Average Percentage Cost Estimate Change from Project Planning Activity to 100 Percent Design By Road System

Interstate Projects			
Planning Activity to 100% Design	**Average Percentage Change (%)**		
	PE	RW	CN
Scoping to 100% Design	39.7	221.7	64.9
Preliminary Field Review to 100% Design	29.5	235.7	20.1
Field Inspection to 100% Design	11.1	154.5	12.5
Furnish Right of Way Plans to 100% Design	1.1	1.6	3.4
Primary Projects			
Planning Activity to 100% Design	**Average Percentage Change (%)**		
	PE	RW	CN
Scoping to 100% Design	104.2	127.8	91.8
Preliminary Field Review to 100% Design	96.5	110.1	59.7
Field Inspection to 100% Design	70.0	76.8	39.1
Furnish Right of Way Plans to 100% Design	24.1	0.8	19.1
Secondary Projects			
Planning Activity to 100% Design	**Average Percentage Change (%)**		
	PE	RW	CN
Scoping to 100% Design	125.6	121.0	56.3
Preliminary Field Review to 100% Design	137.1	44.3	52.5
Field Inspection to 100% Design	27.6	33.6	41.6
Furnish Right of Way Plans to 100% Design	5.3	25.9	14.8
Urban Projects			
Planning Activity to 100% Design	**Average Percentage Change (%)**		
	PE	RW	CN
Scoping to 100% Design	157.7	258.1	97.4
Preliminary Field Review to 100% Design	139.7	60.7	59.6
Field Inspection to 100% Design	55.0	56.0	26.5
Furnish Right of Way Plans to 100% Design	20.1	1.5	39.4

KEY: PE = Preliminary Engineering, RW = Right of Way, CN = Construction.

Note: See Appendix C for a discussion of the number of projects analyzed.

Source: VDOT project cost data.

Table 4

Average Percentage Change in Project Costs From 100 Percent Design to Contract Award

Project Type	Average Percentage Change (%)
All Design Projects	3.2
Interstate Projects	8.6
Primary Projects	-2.4
Secondary Projects	3.9
Urban Projects	8.6

Note: See Appendix C for a discussion of the number of projects analyzed.

Source: VDOT project cost data.

Table 5

Average Percentage Change in Project Costs From Contract Award to Completion

Project Type	Average Percentage Change (%)
All Design Projects	11.1
Interstate Projects	18.8
Primary Projects	15.7
Secondary Projects	9.0
Urban Projects	8.1

Note: See Appendix C for a discussion of the number of projects analyzed.

Source: VDOT project cost data.

project. The second part is the amount by which the cost of construction engineering (construction inspections and administration) exceeded the amount allocated for construction engineering, which varied by project. A project may have other small expenditures that contribute to higher construction costs, which were not included in this analysis.

As Table 6 shows, the amount by which the construction costs tended to exceed the contract award amount was the result of higher than anticipated project construction and construction engineering costs. With the exception of primary system projects, unplanned construction costs were distributed relatively evenly between project costs in excess of the ten percent contingency and construction engineering costs in excess of the amount budgeted. Interstate system construction engineering costs exceeded the amount budgeted for such costs by a greater percentage than other road systems (ten percent).

Table 6

Percentage Difference Between Budgeted and Actual Amounts for Project Cost and Construction Engineering

Project Type	Percentage Project Cost Over Contract Price In Excess of Ten Percent Contingency	Percentage Project Cost Over Contract Price In Excess of Construction Engineering
All Design Projects	7.8	5.0
Interstate Projects	10.5	10.0
Primary Projects	11.8	5.9
Secondary Projects	6.6	4.2
Urban Projects	4.3	4.8

Notes: See Appendix C for a discussion of the number of projects analyzed.
Percentages listed for project costs and construction engineering do not sum to the growth factors shown in Table 5 because the percentages calculated in the middle column do not include projects that were completed for less than the contract award amount.

Source: VDOT project cost data.

ROAD CONSTRUCTION PROJECTS TAKE MORE THAN FOUR YEARS TO DESIGN AND CONSTRUCT

JLARC staff also performed analyses of the length of time required to complete the design and construction processes. Analysis of recently completed projects indicates that projects took three years to design on average and approximately 13 months to construct. Project construction generally takes substantially longer than the time established in the initial construction contract, but it appears that projects are typically completed within a reasonable time period.

Majority of Projects Required Three Years to Complete Design Process

JLARC staff analyzed 86 road construction projects that recently completed the design process and found that on average projects took three years to design (Table 7). The majority of projects (52 percent) completed the design phase in one to three years, while more than one-third (37 percent) took more than three years to finish design. The length of time required to complete the design process for projects analyzed by JLARC staff ranged from one month to 137.8 months (more than 11 years).

As Table 7 also illustrates, urban system projects took about twice as long on average to design as projects in the other three road systems. On average, urban system projects required five-and-a-half years to complete design, or more than two years longer than the average for the other systems. Interstate projects were designed in two years on average, while primary and secondary projects took closer to three years to design.

Table 7

Average Years to Complete Design Process

Project Type	Average Years	Minimum Number of Months	Maximum Number of Months
All Design Projects	3.0	1.0	137.8
Interstate	2.0	1.0	49.3
Primary	2.5	6.1	115.8
Secondary	2.9	9.4	137.8
Urban	5.5	12.5	87.2

Note: Includes all interstate projects that completed design in the last four fiscal years and all primary, secondary, and urban projects that completed design in the last two fiscal years. See Appendix C for a discussion of the number of projects analyzed.

Source: JLARC staff analysis of data provided by VDOT.

Project Construction Takes 13 Months on Average

An analysis of projects for which construction was completed in the last two fiscal years shows that these projects took more than 13 months on average to construct (Table 8). The majority of projects (59 percent) completed construction within one year. The time required to complete construction ranged from one week to 64 months.

The time to construct projects appears to vary substantially by road system type. Interstate projects took the longest time to complete construction – approximately 22 months on average (Table 9). Urban and primary system projects took 20 and 18 months, respectively, to complete on average, and secondary system projects took only nine months.

Table 8

Average Number of Months to Complete Construction

	Average Number of Months
Original Time Limit:	7.0
Extended Time Limit:	6.8
Due to VDOT Approved Shutdowns	4.9
Due to VDOT Approved Extra Construction (Work Orders and Overruns)	2.8
Total Months Approved for Construction:	13.8
Months to Complete Construction:	13.2

Note: Shutdown days occur only in calendar days contracts. The sum of shutdowns and extra construction may not equal extended time limit because shutdowns for fixed date contracts are set to missing for the shutdown analysis and zero for the extended time limit analysis. See Appendix C for a discussion of the number of projects analyzed.

Source: VDOT project time data.

Table 9

Average Number of Months to Complete Construction by Road System

Interstate Projects	Average Number of Months
Original Time Limit	12.0
Extended Time Limit	8.9
VDOT Approved Shutdowns	7.0
VDOT Approved Extra Construction (Work Orders and Overruns)	6.3
Total Months Approved for Construction	21.0
Months to Complete Construction	21.9

Primary Projects	Average Number of Months
Original Time Limit	9.8
Extended Time Limit	8.5
VDOT Approved Shutdowns	6.0
VDOT Approved Extra Construction (Work Orders and Overruns)	4.7
Total Months Approved for Construction	18.3
Months to Complete Construction	18.3

Secondary Projects	Average Number of Months
Original Time Limit	4.7
Extended Time Limit	5.3
VDOT Approved Shutdowns	4.3
VDOT Approved Extra Construction (Work Orders and Overruns)	1.2
Total Months Approved for Construction	9.9
Months to Complete Construction	9.0

Urban Projects	Average Number of Months
Original Time Limit	10.8
Extended Time Limit	10.1
VDOT Approved Shutdowns	5.9
VDOT Approved Extra Construction (Work Orders and Overruns)	5.6
Total Months Approved for Construction	20.9
Months to Complete Construction	20.4

Note: For an explanation of how shutdowns and approved extra days relate to the extended time limit in this analysis see note in Table 8. See Appendix C for a discussion of the number of projects analyzed.

Source: VDOT project time data.

Projects Exceed Original Time Limit

JLARC staff analysis demonstrates that 70 percent of construction projects received contract extensions that extended the projects at least three months or more beyond the initial contract deadline. Contract extensions are granted for a variety of reasons. The most common reason for extensions is weather-related shutdowns. VDOT approved approximately five months on average for shutdowns, which extended the average project time by more than half the average original period of time allowed (Table 8). The other principal reason for contract extensions is to handle work changes or cost overruns. On average, work orders and overruns added about three months, or 39 percent more time, to the average original project length (Table 8).

With the extended deadlines, work on most construction contracts was completed prior to the extended deadline. Contracts were completed 15 days on average prior to the extended contract deadline, and one-quarter of the projects analyzed did not meet the extended contract deadline.

Delays beyond the initial contract deadline varied substantially by road type. Urban project contracts were extended beyond the initial deadline by the longest average time period, approximately ten months (Table 9). In contrast, secondary road project time extensions averaged only five months beyond the initial contract deadline. With primary, secondary, and urban system projects, the time extensions approximately doubled the time needed to complete the construction work. Time extensions granted for secondary projects were primarily for shutdowns. For interstate and urban projects, time extensions were granted almost evenly for change orders and overruns, and for shutdowns.

Differences Between Calendar Days and Fixed Date Contracts

As part of the time analysis, JLARC staff compared the time required to complete construction of calendar days and fixed date contacts to determine whether the nature of the contract impacted the timeliness of the construction work. The analysis demonstrated some time differences between calendar days and fixed date contracts. Eighty-one percent of the contracts analyzed were calendar days contracts and the remainder were fixed date. Fixed date contracts are usually reserved for major projects where there is strong interest in expediting the construction process. Fixed date contracts are generally used for larger projects and, therefore, for longer periods. As Table 10 shows, calendar days contracts had initial schedules of five months on average, whereas fixed date contracts were scheduled to take 15 months on average.

For projects reviewed by JLARC staff, calendar days contracts were extended an average of six-and-a-half months, which more than doubled the original contract period. In contrast, fixed date contracts were extended eight months beyond the initial contract deadline, on average, which is approximately half as long as the initial contract period. These differences are consistent with the fact that VDOT is more flexible in adjusting calendar days contracts and recognizes that initial contract deadlines will

Table 10

Average Number of Months to Complete Construction

	Calendar Days Contract	Fixed Date Contract
Original Time Limit	5.1	15.0
Extended Time Limit	6.5	8.2
VDOT Approved Shutdowns	4.9	----*
VDOT Approved Extra Construction (Work Orders and Overruns)	1.5	8.2
Total Months Approved for Construction	11.6	23.2
Months to Complete Construction	10.7	23.9

* For an explanation of how shutdowns and approved extra days relate to the extended time limit in this analysis see note in Table 8. See Appendix C for a discussion of the number of projects analyzed. Numbers may not add due to rounding.

Source: VDOT project time data.

have to be extended due to shutdowns as well as other factors. However, it does indicate that there remains some flexibility even with fixed date contracts to extend contract deadlines.

SEVERAL FACTORS EXPLAIN LOW COST ESTIMATES

Several factors appear to contribute to the low estimates of project costs developed during the design phase. Initial design estimates do not appear to take into account scope increases that usually result from local input. Other factors that appear to contribute to low cost estimates include the lack of inflation adjustments, no contingency for unforeseen costs, a failure to budget for incidental costs, and inherent incentives to underestimate project costs.

Local Requests Increase Project Costs and Cause Delays

Based on JLARC staff's detailed file review of 22 projects, one of the factors that appears to explain why initial project cost estimates underestimate the construction cost of projects is that these estimates do not anticipate project additions that result from local requests (referred to by VDOT as "scope creep"). The additions requested range from relatively small additions, such as landscaping, to additional interchanges or bridges. Scope creep often occurs during the design phase. The following are two examples of scope creep:

> *At the request of a local government, VDOT incorporated an additional interchange into the design of the Manassas Bypass, a primary system project. The cost of the preliminary engineering for this addi-*

tion was $100,000. VDOT was not able to provide an estimate as to the construction cost of the additional interchange.

* * *

During the design phase of the Interstate 81 interchange at Route 460 in southwest Virginia, a local government requested that soundwalls be incorporated in the project. VDOT agreed to add the soundwalls to the project at a cost of $3.7 million.

The Springfield Interchange Improvement project is an additional example of a project that increased substantially in scope as a result of local requests for modification during the design phase. Changes included major design revisions and improvements to the local secondary road network. The project additions resulting from locality requests have increased the cost of the project by approximately $46.7 million. This project is discussed in greater detail in Chapter IV.

Other Factors that Contribute to Low Project Cost Estimates

Several other factors also contribute to low initial estimates that do not adequately reflect the final design estimate or ultimate project cost. Until this year, project cost estimates were based on the dollar value at the time of the estimate with no adjustment for inflation. As a result, projects that take several years to progress to construction from the time of the estimate have invariably increased in cost partly as a result of inflation.

Another factor that appears to contribute to low estimates is that estimates do not include an amount to cover the costs associated with unforeseen circumstances discovered as preliminary engineering progresses or, in some cases, after construction has begun. Most projects appear to have such complications that ultimately raise the cost of projects. Examples of unforeseen circumstances include: environmental issues, unsuitable soil in the project area, and existing structures that need to be replaced instead of repaired.

Another factor contributing to low estimates is that project managers do not necessarily include in the cost estimates an amount to cover the cost of incidental items such as soundwalls, guardrails, and lighting. While it is known that the project expenditures will ultimately include amounts for these items, project managers sometimes choose not to include costs for these items in initial estimates because the design plans do not provide detailed plans for these items until late in the design process.

An additional factor that contributes to low design estimates is the decision by some project managers not to incorporate in cost estimates prepared during the design phase an amount to cover construction contingencies and construction engineering costs. The 100 percent design estimate includes an additional ten percent to pay for unanticipated costs incurred during construction. Similarly, the final design

estimate includes an additional eight to 15 percent, depending on the dollar amount of the project, to pay for construction inspections and administration of the construction contract. According to the State Location and Design Engineer and other location and design staff, inclusion of the ten percent contingency and construction engineering percentages has not been consistent. Some design cost estimates apparently include amounts to cover these items while others do not. A good example of this is the Springfield Interchange Improvement project, discussed in more detail in Chapter IV. These contingencies were not included in initial cost estimates for the project. Not including these cost items in design estimates exacerbates the underestimation problem.

Another factor that likely compounds the underestimation problem is the inherent incentives in the system to underestimate projects during the design stage. It appears that projects with lower cost estimates have a greater chance for approval at the various stages in the process than projects perceived to be expensive. In addition, historically, projects would not be authorized to be advertised for construction until 70 percent of the funding was allocated for the projects. The lower the cost estimate for a project, the less funding would be necessary to meet the 70 percent requirement, and the sooner a project could be advertised.

Finally, a factor that contributes to low right of way estimates early in the project development process is the significant increase in property values caused by the development of a project. Therefore, property values may increase substantially from scoping to the right of way acquisition stage because the prospect of the new road has significantly increased the commercial value of the property. In such instances, the initial right of way estimates may be well below the ultimate right of way costs because the Right of Way division does not speculate at the time of the initial estimates as to the potential growth in value of the property resulting from a new road.

VDOT Appears to Be Taking Steps to Improve the Estimation Process

According to the State Location and Design Engineer, the division has recently taken some steps to improve the accuracy of the estimation process. The Location and Design division is now seeking greater staff involvement from individuals in the various disciplines that will be involved in the design. In addition, the Location and Design division plans to improve the estimate prepared at the 40 percent design stage and hold the design hearing closer to this point in the process. The department is also considering the inclusion of a contingency in early construction estimates to cover unknown or unanticipated items.

Recommendation (1). **The Virginia Department of Transportation should review the cost estimation process to determine if additional measures can be taken to improve the accuracy of the process. This should include the development of clear standards regarding the incorporation of incidental items and contingencies in cost estimates in order to improve the consistency of the estimation process.**

INADEQUATE PRELIMINARY ENGINEERING CONTRIBUTES TO COST INCREASES AND TIME DELAYS

The analysis of cost and time data revealed that project costs increase substantially from the contract award amount, and that projects extend beyond the initial contract deadline partly as a result of change orders and cost overruns. Based on a detailed file review of 20 VDOT projects, one of the primary reasons for the cost increases and time delays during project construction appears to be inadequate preliminary engineering during the design phase of a project. Many of the projects examined as part of this review had major design errors that increased costs and delayed projects. In addition, several of the projects reviewed experienced major cost increases and delays during the construction phase as a result of field conditions not discovered during the preliminary engineering work.

Design Errors Have Led to Increased Costs and Lengthy Delays

Eleven of these 20 VDOT projects reviewed by JLARC staff had design errors that resulted in substantial cost increases above the contract amount. Design errors were made by consultants retained by VDOT to perform the design work and by in-house designers. The following are case examples in which design errors led to substantial cost increases and lengthy delays in projects after the projects went to construction.

> *A project to construct high occupancy vehicle lanes on Interstate 264 in the Hampton Roads area experienced work orders and cost overruns totaling $16.5 million over the $35.6 million contract amount, and has been delayed by 537 days. Much of the increased cost was due to numerous design errors, many of which resulted from the in-house design engineer's decision not to conduct a field survey, but to rely instead upon a survey performed more than 30 years earlier. There were numerous elevation errors, inadequate plans for drainage, failure to include necessary materials, underestimates of quantities needed, and failure to include other major elements of the project in the plans. In addition, the design consultant for the bridges failed to include in the design work plans for removal of asbestos in existing bridge structures even though the asbestos was shown on the original bridge plans. The failure to include plans for the removal of asbestos resulted in $2 million in additional costs and a 180 day delay.*
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> *An Interstate 81 widening project in Bristol has exceeded the contract amount ($40.4 million) by $14.7 million and could be delayed by more than three years. Much of the cost increase and delay is the result of design errors by the design consultant. Design errors have included*

incorrect application of geotechnical data, improperly designed retaining walls, and failure to include notes in the design plans regarding bridge overhangs. The file includes several letters from the Federal Highway Administration stating that certain change orders were "due to the carelessness" of the design consultant.

* * *

An Interstate 64 widening project in Chesapeake had 48 work orders, exceeded the contract amount ($24 million) by $4 million, and was delayed by almost two years. According to VDOT staff in the district office, most of the work orders and cost overruns were the result of design plan errors and omissions.

* * *

The reconstruction of the Route 460 and Route 29 interchange in Lynchburg has exceeded the $14.6 million contract amount by $2.2 million and has been delayed by 304 days. Award of the contract was delayed because of design errors discovered by contractors bidding on the project. Most of the change orders and cost overruns have resulted from design plan revisions and missed quantities. According to VDOT staff, in one instance the district discovered a design error prior to construction and notified the VDOT central staff, but the central office staff did not notify the design consultant of the needed adjustment. As a result, a ramp was improperly constructed, resulting in change orders totaling $466,000. In reference to one of the change orders which was for $619,486, the Federal Highway Administration wrote that the change order was required "due to the carelessness of the design consultant."

In at least one instance, a project was advertised for construction even though it was known to have major design deficiencies:

Several months prior to the advertisement of two construction phases of the Manassas Bypass, the State Construction Engineer expressed concern that the consultant's design plans were inadequate. Yet the decision was made to advertise the project for construction without complete design plans. The State Construction Engineer wrote that the project was advertised "with numerous discrepancies between the plans and the bidding proposal. It is obvious that the design was not complete when submitted and continued without proper authorization." A month after the project was advertised, the State Construction Engineer expressed "concern with this project and deficiencies in the design documents, finding no way to condone what occurred given the history of the project."

The preceding cases provide some examples of projects with major design errors that have adversely impacted project construction. Many of these errors have substantially increased the cost of construction and delayed project completion. In some instances in which consultants make design errors, VDOT is able to recoup some portion of the cost of such errors.

Cost Increases and Time Delays Result from Failure to Detect Potential Problems During Preliminary Engineering Work

Along with design errors, some of the work orders and cost overruns appear to have been detectable through a more thorough review at the design stage. The review of projects revealed several instances in which costs increased substantially, and projects were delayed, as the result of problems that were discovered during the construction phase. The following case examples involve projects in which the failure to detect major field conditions during the design phase resulted in substantial increased costs and time delays during construction:

> *The widening of Interstate 64 in Newport News exceeded the construction contract amount ($33.5 million) by $24 million and was delayed 538 days. One of the major factors contributing to the increased expense and time delays was the discovery of unsuitable soil after the construction phase of the project began. The geotechnical assessment conducted during the design phase, which was conducted by VDOT staff, did not reveal the problematic soil conditions. VDOT spent an additional $8.5 million in excess of the contract amount to address the soil problem.*
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> *The reconstruction of the southern approach to the Hampton Roads Bridge Tunnel exceeded the $28.4 million contract amount by $8.5 million and was delayed by almost two years. One of the primary factors contributing to the added cost and delay was the discovery during the construction phase that bridge bearings, which were known to be more than 40 years old, needed to be replaced. The need to replace the bearings was identified during the construction phase when they were cleaned and inspected. The worn bearings had not been discovered during the design phase. The replacement of the bearings cost $5.6 million and delayed the construction project by 590 days.*
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> *Construction of the Walthall Interchange on Interstate 95 in Chesterfield County had change orders and cost overruns totaling $2.1 million in excess of the contract amount ($16.3 million). More than half of the cost increase was to pay costs associated with unsuitable soil at*

the construction site that was not discovered during the preliminary engineering work.

Each of these projects is an example in which field conditions discovered during the construction phase added substantial unanticipated costs and time delays to projects. One VDOT project engineer stated that many of the field inspections during the design phase of projects appear to be taking place in the central office instead of the field where they should be taking place. According to this engineer, existing conditions are much more likely to be detected from detailed on-site field reviews, and VDOT needs to take the time to conduct them during this phase. Another construction engineer reported that the failure to discover unsuitable soil prior to construction appears to be a more frequent problem. This engineer has recommended that the location and design staff take measures to improve the subsurface investigative process during the design phase, but noted that it continues to be a problem. According to the State Location and Design Engineer, a directive was issued by the Chief Engineer in 1998 to increase the level of soil tests performed during the preliminary engineering phase.

VDOT Needs to Reduce Design Errors and Omissions

With the substantial cost overruns and time delays that appear to result from design errors, and the failure to discover and plan for relevant field conditions during the design stage, VDOT needs to evaluate the process to determine why design errors are occurring and how they can be minimized. Given the proportion of projects with serious design errors being made by consultants, VDOT needs to examine the project management process and determine whether projects are being adequately managed. VDOT also needs to assess whether design consultants are being held sufficiently accountable for the design of these projects. Likewise, VDOT needs to have procedures in place to ensure that in-house designers are adequately designing projects and being held accountable for the quality of their work.

Similarly, VDOT should examine how the field inspection process can be improved to ensure that detectable conditions which would impact the design plans are discovered before projects advance to the construction phase. Central office management needs to ensure that field inspections are being conducted in the field instead of in offices, and that they are sufficiently thorough to detect conditions that may significantly impact project construction.

Utility Relocation Contributes to Cost Increases and Time Delays

Another factor that often contributes to construction cost increases and time delays is the relocation of utilities. Utility relocation is handled primarily by utility companies, and the relocation is, for the most part, out of VDOT's control. According to VDOT staff, utility companies have been reluctant to proceed with utility relocation, including ordering the necessary materials, until project plans are final and a project has been advertised. The process of relocation often takes as long as six to nine months,

including time to order and receive the necessary materials. Therefore, many construction projects have been delayed because a utility has not completed its relocation work, and the contractor cannot proceed with project construction. The following are case examples in which projects were delayed because of utility relocation work:

> *A secondary road project in Chesterfield County was delayed by a year because of lengthy utility relocation delays that resulted in additional construction costs totaling almost $200,000.*
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> *** * ***
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> *An urban project in the City of Portsmouth was delayed by four-and-a-half months and resulted in additional construction costs of approximately $700,000 because of delays in relocating a 16 inch water main as well as other utilities.*

Based on concerns with delay caused by utility relocations, the Chief Engineer has instituted a policy, effective July 2002, which requires that utilities be relocated prior to advertisement of a project so that construction contractors will not be delayed by utility relocations during the construction phase.

Recommendation (2). **The Virginia Department of Transportation should review the preliminary engineering process to assess whether there is adequate management of project design contracts and whether there are adequate procedures in place to minimize errors made in the design of road construction projects. In addition, the department should review whether the preliminary engineering performed for highway construction projects includes an adequate examination of subsurface as well as other field conditions to ensure that all detectable conditions that may impact construction are discovered during the design phase.**

Recommendation (3). **The Virginia Department of Transportation should examine why project construction and construction engineering costs exceed the budgeted contingencies and what measures can be taken to reduce the amount by which contingency amounts are exceeded. Additionally, the department should review whether it adequately budgets for construction contingencies, construction engineering, and other miscellaneous construction expenditures.**

III: Current Six Year Development Plan

One of the key assumptions on which the six year development plan is based is the estimate of project costs. Underestimates of engineering costs and construction costs that exceed budgeted contingencies diminish the accuracy of the six year development plan. Application of the cost growth factors discussed in Chapter II to projects funded in the current six year development plan indicates that the current plan may underestimate substantially the cost of the projects. Based on JLARC staff analysis, the six year plan may understate the cost of the projects in the plan by $3.5 billion. Project costs for the Virginia Transportation Act projects may exceed the department's estimates by 47 percent or $2 billion.

In addition, the six year development plan appears to overstate the amount of funds available for new road construction because of several questionable assumptions used. The plan appears to underestimate maintenance costs over six years, assumes that certain funds will not be dedicated to mass transit in the future despite language in the current Appropriation Act directing such dedication, and allocates an insufficient amount for repayment of principal on outstanding bonds.

Underestimation of costs and questionable assumptions underlying the plan means that there will be inadequate funds for the projects in the six year plan. Therefore, the current plan does not accurately reflect the construction program that VDOT will be able to undertake over the next six years. With more projects than funds, difficult choices will have to be made regarding allocation of the available resources.

Another factor that may adversely impact the implementation of the current six year plan is the lack of cash available to fund all of the projects on the schedule projected in the plan. The last cash forecast projected a future shortfall for the construction portion of the Transportation Trust Fund, which may not be entirely eliminated, even with the recent appropriation of additional funds by the General Assembly.

CURRENT DEVELOPMENT PLAN MAY UNDERESTIMATE PROJECT COSTS BY $3.5 BILLION

As discussed in Chapter II, cost growth factors were developed based on the actual experience of the department in recent years. These growth factors were applied to projects in the current six year plan in order to develop an estimate of how much the present plan may be understating the cost of projects in the plan. As a result of the likely underestimation of project costs and unanticipated cost increases during construction, the current six year development program appears to understate the cost of the projects in the plan by a substantial amount. Therefore, to be fully funded, the projects in the plan will likely require significantly more funds than have been allocated.

Application of Cost Growth Factors to Current Six Year Plan

The cost growth factors were applied to road construction projects in the current six year development plan that have not yet been completed. The cost growth factors were applied based on road system type because of differences between the factors developed for each system. For example, the factors applied to interstate projects in the current plan were based on factors that were derived solely from data on interstate projects. In addition, application of the factors was based on the current status of the project. Therefore, for each project, JLARC staff determined where in the design or construction process the project currently stood and applied the applicable cost growth factors.

Factors Applied to Projects in the Design Stage. The applicable factors were selected based on the status of the project (Table 11). For projects in the plan still in the design phase, three cost growth factors were applied to the cost estimate in the current six year plan. JLARC staff applied the first growth factor, depending on a project's status within the design process, to estimate what the project's cost estimates for the three phases (preliminary engineering, right of way, and construction) was likely to be at the 100 percent design stage. For purposes of this analysis, JLARC staff considered the preliminary engineering and right of way cost estimates to be final after a project reached 100 percent design.

The remaining growth factors were applied to the construction estimate only. A second cost growth factor was applied to these projects to determine how much the construction cost estimate was likely to grow from the point of 100 percent design to the point of contract award. Finally, a third growth factor was applied to the esti-

Table 11

Application of Growth Factors to Development Plan Projects Based on Project Status

Growth Factor	1	2	3
Status of Development Plan Project	**Location and Design Activity to 100 Percent Design**	**100 Percent Design to Contract Award**	**Contract Award to Final Cost**
Location and Design Activities			
Scoping	●	●	●
Preliminary Field Review	●	●	●
Field Inspection	●	●	●
Furnish Right of Way	●	●	●
Construction Activities			
100 Percent Design		●	●
Contract Award			●

Note: Location and design growth factors include separate factors applied to preliminary engineering, right of way, and construction estimates.

Source: JLARC staff analysis.

mated contract award amount in order to estimate the final cost of the project, based on the amount it was likely to exceed the contract award amount.

Factors Applied to Projects Between Design and Contract Award. For projects in the six year development plan that had completed the design phase but not yet reached the construction phase, only the second and third cost growth factors were applied. The second growth factor was applied to estimate the increase in cost of the project from the point of 100 percent design to contract award. The third cost growth factor was then applied to estimate the final construction cost, based on how much recently completed projects exceeded the contract award amount.

Factor Applied to Projects Beyond Contract Award. Finally, for projects in the plan for which the construction contract has been awarded, only the third cost growth factor was applied. The factor was applied to estimate how much the final construction cost might exceed the contract award amount. Projects shown in the plan with construction already complete were not included in the analysis.

Analysis of Projected Costs Summed. JLARC staff then summed the estimated final cost of each project to which the cost growth factors were applied in order to estimate the total estimated cost of the projects in the plan. This amount was then compared with the sum of the cost estimates developed by VDOT for each of these projects shown in the plan (including inflation).

VDOT Inflation Adjustment Subtracted from Project Cost Estimates Prior to Application of Growth Factors. This year, for the first time in several years, VDOT incorporated an inflation/project expansion factor in its project cost estimates in the six year development plan. For projects not scheduled to begin work on any phase (preliminary engineering, right of way acquisition, or construction) until 2002 or beyond, an inflation factor of 3.89 percent was included by VDOT in the projected cost estimate for each year until the work was scheduled to begin. For example, if construction was not scheduled to begin until 2004, the construction cost estimate included an inflation factor of 11.67 percent (3.89 x 3). In addition, for projects not scheduled to begin some phase of the road construction process until 2004, an additional scope expansion factor was included for each year beginning in 2004. The scope expansion factor started at three percent for 2004, and increased by one percent each year for the next two years. VDOT did not include compounding in its inflation adjustment.

JLARC staff subtracted the amount of the VDOT inflation/project expansion adjustment included in the six year plan cost estimates for each project prior to application of the cost growth factors. This was done because the cost growth factors were developed based on project estimate data that did not include any adjustment for inflation.

Analysis Limited to Projects 70 Percent Funded. JLARC staff also limited the projects analyzed in the plan to those that had least 70 percent of the total

project cost funded or allocated by 2006. Some projects in the plan are scheduled to extend well beyond the current plan, and only a portion of the funds for the project are allocated in the current six year plan. The focus of the analysis for this report is on projects that have most of their funding allocated by the end of the plan period. Seventy percent was selected as the amount of funding required for inclusion in the analysis because VDOT has historically required that 70 percent of funding for each phase of a project be allocated before work can proceed. A more detailed discussion of the methodology for application of the cost growth factors is contained in Appendix C.

Six Year Plan May Understate Project Costs by $3.5 Billion

Based on application of the cost growth factors to projects in the current six year development plan with more than 70 percent of their funding allocated by 2006, it appears that the plan may understate the cost of the projects by $3.5 billion. VDOT predicts that the 1,907 uncompleted projects analyzed in the plan will cost $7.9 billion to construct. Applying the cost growth factors, JLARC staff estimate that these projects may cost $11.4 billion, or 45 percent more than currently projected by VDOT.

As Table 12 indicates, the difference in estimated cost varies to some extent by road system type. Urban system projects are estimated to exceed the VDOT cost estimates by the greatest amount (53 percent) and secondary road projects by the smallest percentage (39 percent). Interstate and primary projects are estimated to exceed VDOT cost estimates by 44 and 43 percent, respectively.

Table 12

Comparison of VDOT and JLARC Estimated Costs for Road Construction Projects, by Road System (Projects with 70 Percent of Funding Allocated by 2006)

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall	$7,856	$11,354	45
Interstate	$2,021	$ 2,911	44
Primary	$2,803	$ 4,002	43
Secondary	$1,408	$ 1,963	39
Urban	$1,624	$ 2,477	53

Source: JLARC staff analysis of VDOT cost estimate data.

CURRENT DEVELOPMENT PLAN MAY UNDERESTIMATE VTA PROJECT COSTS BY $2 BILLION

JLARC staff also conducted a separate analysis of projects listed in the Virginia Transportation Act. Application of the cost growth factors to VTA projects reveals that the cost of these projects, as a group, may have been underestimated substantially. These projects are at various stages in the development process, with many not planned for construction for several years.

VTA Projects Are Likely to Cost Substantially More than Estimated

JLARC staff also applied the cost growth factors to VTA road construction projects with more than 70 percent of their funding allocated by 2006. It appears that the plan may understate the cost of these projects by $2 billion. VDOT projects that the 257 VTA projects will cost $4.2 billion to construct. Applying the cost growth factors, JLARC staff estimate that these projects may cost $6.2 billion, or 47 percent more than currently estimated by VDOT (Table 13). As with the analysis of all projects, urban projects are estimated to exceed VDOT cost estimates by the greatest percentage (55 percent) and secondary projects by the smallest percentage (41 percent).

Status of VTA Projects

The projects identified in the VTA are at various stages in the development process. As Table 14 demonstrates, 27 percent of the projects have either completed

Table 13

Comparison of VDOT and JLARC Estimated Costs for Road Construction Projects in the Virginia Transportation Act of 2000 by Road System (Projects with 70 Percent of Funding Allocated by 2006)

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall	$4,229	$6,218	47
Interstate	$1,602	$2,407	50
Primary	$2,153	$3,089	43
Secondary	$ 85	$ 120	41
Urban	$ 389	$ 602	55

Note: JLARC staff excluded from the VTA analysis all transit projects and projects that have completed construction.

Source: JLARC analysis of VDOT data.

Table 14

Percentage of VTA Projects by Most Recently Completed Activity

Most Recently Completed Planning or Construction Activity	Percentage of VTA Projects (%)
Construction Complete	11
Construction Underway	16
Project in the Location and Design Phase	46
Project not yet Initiated	26
Project Status Unknown	1

Source: JLARC staff analysis of VDOT data.

construction or are currently under construction. Forty-six percent of the projects are in the design phase. Finally, 26 percent of the VTA projects have not begun the design process. Appendix B shows the current status of each VTA project.

SIX YEAR DEVELOPMENT PLAN INCLUDES QUESTIONABLE ASSUMPTIONS

The current six year development plan appears to be based on several questionable assumptions. As a result of these assumptions, the plan appears to overstate the amount of funds that will be available for highway construction over the next six years. The questionable assumptions include those regarding maintenance costs for the next six years, dedication of federal funds to mass transit, and additional bond principal repayments that will be required.

Development Plan Underestimates Maintenance Costs

The six year development plan appears to overstate the amount of funds that will be available for new highway construction because the financial assumption regarding maintenance costs over the next five years appears to be overly conservative. The amount that will be required for maintenance is directly linked to the amount that will be available for new construction, because of statutory requirements regarding maintenance. The *Code of Virginia* requires the Commonwealth Transportation Board to allocate funds deemed to be "reasonable and necessary" each year for maintenance prior to the allocation of funds for new highway construction. Therefore, if maintenance is underestimated, then the amount available for construction is overstated.

Based on maintenance expenditure data for the most recently completed six fiscal years, it does not appear that VDOT has fully budgeted for the likely cost of maintenance for the period of the current development plan. As Table 15 shows, the

new six year development plan assumes that maintenance will increase by 3.2 percent from 2001 to 2002, and then will remain constant over the succeeding four fiscal years. This assumption is not consistent with the history of maintenance expenditures over the last six fiscal years. From 1995 to 2000, maintenance expenditures increased by 2.71 percent compounded annually. If maintenance expenditures increase by this amount over the next five years, then maintenance will cost at least $242 million more than is assumed in the projections developed for the current six year development plan (Table 15).

VDOT is likely to receive some reimbursements for past maintenance expenditures from the Federal Emergency Management Agency (FEMA) over the next five years, which can be used to supplement highway maintenance allocations. VDOT received $41 million from FEMA over the last five years. However, even if with the assumption that VDOT will receive a similar amount from FEMA over the next five years, there still is at least $201 million shown in the current six year plan as allocated to new road construction that will, instead, likely be needed for maintenance.

Other Questionable Assumptions in the Plan

The six year development plan is built on two other questionable assumptions which have been identified by Senate Finance Committee staff. These assumptions together may overstate the amount of funds available by an additional $178 million.

Dedication of Federal Highway Funds to Mass Transit. The current Appropriation Act requires the Secretary of Transportation to allocate ten percent of the federal Surface Transportation program funds received by the State for public transit purposes. In addition, the Act requires the Secretary to allocate six percent of the

Table 15

Projected VDOT Road Maintenance Costs (Millions)

Fiscal Year	Six Year Plan Projected Annual Maintenance Cost	Projected Annual Maintenance Cost Based on Average Rate of Increase Over the Previous Six Years
2001	$ 827	$ 827
2002	$ 848	$ 849
2003	$ 848	$ 872
2004	$ 848	$ 896
2005	$ 848	$ 920
2006	$ 848	$ 945
Total	$5,067	$5,309

Note: Amounts do not add up to the total due to rounding.

Source: VDOT six year development plan spreadsheets and historical maintenance expenditure data.

funds received by Virginia pursuant to the federal Minimum Guarantee equity program to transit projects. According to Senate Finance staff, it is reasonable to assume, based on the historical practice of allocating federal transportation funds through the Appropriation Act, that the General Assembly will continue to provide for this funding in future biennia.

VDOT, however, has not made such an assumption, and instead has assumed that the dedication of this revenue will cease after the current biennium. VDOT contends that the Appropriation Act is limited to a two year period and that the department has no basis for assuming that this dedication to mass transit was intended to continue beyond the current biennium.

The six year development plan includes the required allocations for the first two years of the six year development plan as required by the Appropriation Act. However, the plan does not show any of the Surface Transportation Program funds or Minimum Guarantee funds allocated to mass transit over the last four years of the plan. The amount that would be dedicated to mass transit in the last four years of the program would be $71 million if the same percentages of the two federal fund sources were dedicated as directed by the current Appropriation Act. Therefore, the decision to assume that this dedication of funds to mass transit would not continue after this biennium represents an additional $71 million that may not be available for road construction.

Funds Allocated for Principal Repayments. Finally, the current six year development plan does not include sufficient funds for repayment of federal revenue anticipation notes (FRANs). The Virginia Transportation Act requires that FRANs have a maximum term of ten years, requiring that the principal be repaid over that period. For most of the outstanding bond amount, the six year development plan shows funds allocated to pay one tenth of the amount outstanding beginning in the year after the bond issuance. However, analysis of the required repayments to meet the ten year bond repayment schedule shows that VDOT has allocated $107 million less than needed to meet the scheduled principal repayments.

It also appears that VDOT has not properly allocated FRAN funds to projects that do not qualify under law to receive FRAN funding. The Virginia Transportation Act authorizes the Commonwealth Transportation Board to issue FRANs only for 121 specific projects named in the Act. Yet the six year development plan allocates $254 million in FRANs funds for work on 237 projects not designated in the VTA. The insufficient FRANs principal repayments and the allocation of FRANs to unauthorized projects in the six year plan apparently was the result of a last minute decision by VDOT to show an additional $415 million of FRANs issued in the final six year plan to cover a shortfall in the plan between revenue and allocations. According to the Assistant Commissioner for Finance, this was done simply as a "stop gap" measure that he knew would need to be corrected in subsequent six year plans.

As a result of the these assumptions, it appears that the current six year development plan may overstate the amount of funds that will be available for road

construction in the plan by as much as $379 million, not including the $254 million in FRANs funds inappropriately allocated. This raises concerns about the ability of VDOT to construct the projects proposed in the plan.

IMPLICATIONS FOR FUTURE HIGHWAY CONSTRUCTION

The findings of this report have serious implications for highway construction in the State over the next few years. With projects likely to cost as much as $3.5 billion more than currently estimated by VDOT, and with as much as $379 million allocated for road construction based on questionable assumptions, the current six year plan does not appear to accurately reflect the level of construction that can be achieved over the next six years.

As project costs rise beyond the estimates and the amounts budgeted, difficult choices will inevitably have to be made between which projects should proceed and which projects will have to be delayed until adequate funds can be allocated. Moreover, with existing projects requiring greater allocations than projected, there will be less funding available to allocate to new projects.

This year VDOT took a step toward improving the accuracy of the cost estimates in the six year development plan by incorporating an inflation/project expansion factor. While this is a positive step, VDOT needs to take additional measures to develop a six year plan that presents a more realistic program for road construction. The plan needs to include more accurate project cost estimates. In addition, VDOT needs to base the plan on sound assumptions so that the plan accurately reflects the amount that will be available for new road construction.

VDOT has recently taken measures to improve project management, including the quality of the project cost estimates prepared during the initial stages of project design. However, it will take several years for VDOT to determine whether these changes will improve the accuracy of the project estimating process. It is unlikely that recent changes have had much impact on the current six year plan, and it will be several years before VDOT can assess the impact of these changes on subsequent six year plans.

In the short term, VDOT asserts that two fund sources may help to pay for unanticipated cost increases on projects. One source of potential funding is money received from localities to pay for project additions that were incorporated as a result of local requests. According to VDOT data, the department received approximately $200 million over the last six years from localities to pay for items requested by localities. In addition, VDOT asserts that some portion of the funds allocated in the six year plan for "districtwide" projects can be used to supplement amounts allocated for projects in the plan that have unplanned cost increases. The amount of districtwide funds allocated in the current six year plan is $82.6 million. While these two fund sources may help to fund some of the unanticipated cost increases for projects, the amounts

potentially available from these sources is relatively small in comparison to the amount by which JLARC staff estimate plan project costs may be understated.

CASH FLOW MAY IMPACT PROGRAM

Another concern regarding the six year plan is whether there will be sufficient cash flow to support the construction of the projects in the program. The program is constrained by the amount of incoming cash available to fund projects, regardless of how much revenue has been allocated for projects in the six year plan.

In 1999, 90 projects had to be delayed because there was insufficient incoming cash to pay for their construction. The underlying cash flow problem ultimately contributed to the need for the General Assembly to provide substantial additional funding. This was done through the Virginia Transportation Act of 2000 (VTA). VTA funding helped to address the cash flow shortage in the short term and restore the 90 delayed projects to the construction schedule.

As of December 1, 2000, VDOT had not yet completed a cash flow forecast that incorporates the additional funds provided pursuant to the VTA. VDOT has provided JLARC staff with a tentative analysis that shows an ending cash balance of $374 million for FY 2001 and $434 million for FY 2002. However, VDOT has not yet provided an analysis which shows a breakdown of future cash available by the six major fund areas: (1) Highway Maintenance & Operating Fund, (2) Transportation Trust Fund - Construction (TTF construction fund), (3) FRANs, (4) Priority Trust Fund, (5) General Fund, and (6) Tolls Facility Revolving Fund.

The primary concern at this point appears to be a potential shortfall in the TTF construction fund. The most recent cash flow analysis was performed by VDOT in August of this year. That analysis, which did not include the new funds provided by the VTA, showed the TTF construction fund (the primary fund for new road construction) having a cash shortfall of $254.6 million by June 2001 and a shortfall of $604 million by June 2002.

With $307 million in general funds to be appropriated over the next two years pursuant to the VTA, the TTF construction fund deficit can be offset to some extent. However, under current law, general funds appropriated through the VTA are required to be allocated to certain designated transportation projects, which may limit the extent to which these funds can be used to alleviate the TTF deficit. The vast majority of projects in the six year plan may only be funded through the TTF construction fund under current law. The Assistant Commissioner for Finance has told JLARC staff that there may be a shortfall in the TTF construction fund which will need to be addressed during the next session of the General Assembly.

If the cash flow analysis continues to show a future shortfall, VDOT will likely have to make adjustments in the six year program to address the issue. VDOT would

likely be required to delay the advertisement of some projects that are to be funded through the TTF construction fund in order to address the cash flow shortage. Legislative action giving VDOT flexibility to spend FRANs and general funds on additional projects is another potential option that could help to alleviate the problem. Given the recent problems with cash flow and the prospect of future deficits, the General Assembly may want to take a more active role in monitoring the cash flow situation.

Recommendation (4). **The General Assembly may wish to consider directing the Virginia Department of Transportation to submit the most recent cash flow forecast, along with assumptions on which the forecast is based, to the Senate Finance and House Appropriations committees on a quarterly basis. The General Assembly may also wish to require the department to regularly report to the committees any projects for which advertisement has been delayed because of cash flow shortages.**

IV: Springfield Interchange Improvement Project

The Springfield Interchange Improvement project, also known as the "Mixing Bowl," is a major construction project at the intersection of Interstates 95, 395, and 495 in Fairfax County, from the Franconia-Springfield Parkway through the Capital Beltway. When completed, the Springfield Interchange will include 24 lanes at its widest point, have 50 bridges, and consist of more than 41 miles of roadway.

While this project was initially planned as an interstate construction project designed to improve safety and enhance traffic operations from Springfield through the interstate interchange area, the scope of the project has expanded to include improvements to the local road network. This project has been in development for almost ten years, and is scheduled to be completed by 2007. The project appears to be on schedule and has not experienced any significant design errors or major delays.

Cost estimates for the project have risen substantially since the project was authorized. Increasing cost estimates have resulted from scope expansion due to local input, design enhancements, inclusion of contingency costs, inflation, and rising land values.

The cost estimate for the project has increased at a greater rate since July 1999 — 44 percent — than at any time in the last six years. Moreover, based on the application of cost growth factors developed by JLARC staff, the final cost of the project may reach $667 million, exceeding the current VDOT estimate by almost $100 million.

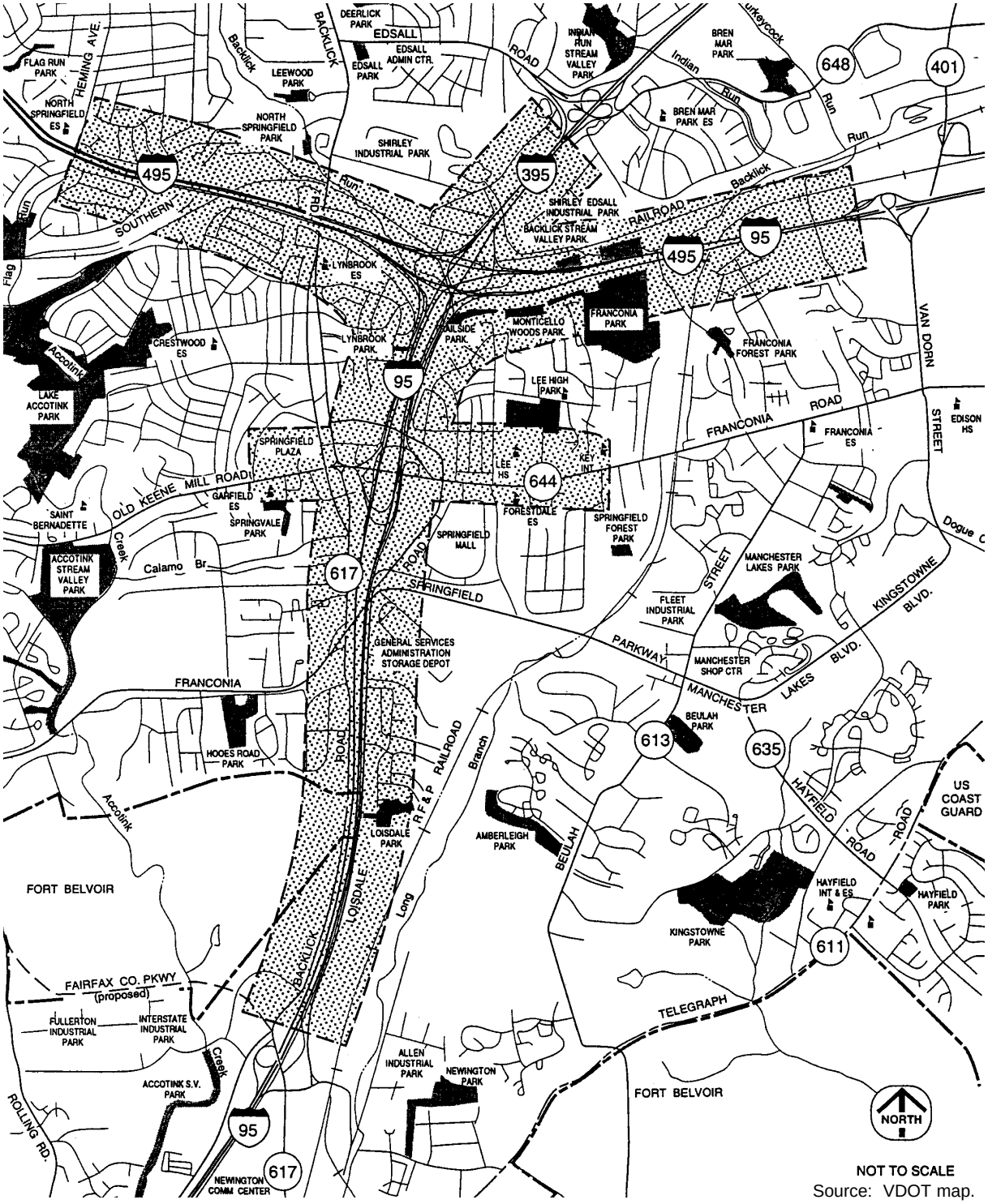
BACKGROUND ON THE SPRINGFIELD INTERCHANGE

The Springfield Interchange Improvement project is a major interstate construction project located at the intersection of Interstates 95, 395, and 495 in southeastern Fairfax County. Less than a mile south of this interchange is another interchange linking Interstate 95 (I-95) with Route 644 (Old Keene Mill Road to the west and Franconia Road to the east) at Springfield. The project construction area begins south of Springfield at the Newington interchange on I-95 and continues north to the Edsall Road interchange on Interstate 395 (I-395). Additionally, the project area includes improvements to the Capital Beltway (Interstate 495) from Hemming Avenue to Van Dorn Street (see Figure 2).

The primary purpose of this project is to relieve the bottlenecks at these two interchanges by building highway improvements that will reduce congestion, enhance traffic operations, and improve safety in the project area. These improvements include the elimination of objectionable merging and weaving movements, a reconfiguration of interchange ramps, and the physical separation of local and through traffic.

Figure 2

Springfield Interchange Project Area



Source: VDOT map.

In December of 1991, VDOT entered into a contract to provide a comprehensive study identifying and evaluating alternative design concepts to improve both traffic operations and safety at the two interchanges. Starting primarily as an interstate construction project, the actual construction work associated with this project has grown to encompass connections to several secondary roads in the Springfield area. Included in these secondary improvements are connections to Route 644 (Franconia and Old Keene Mill Roads), access to the Franconia-Springfield Metro Station, the widening of Loisdale Road and Commerce Street, and improvements to a number of bridges located throughout the project area.

Phased Construction Approach

Given the magnitude of the project, VDOT initially decided to advertise and construct the project in eight phases. The initial impetus behind the phased construction approach was a desire to limit the total value of each construction contract to less than $50 million in order to increase the number of contractors eligible to bid on each contract. During the course of the project, the construction phases have been modified a number of times. In September of this year, construction of the eighth phase was removed from the project.

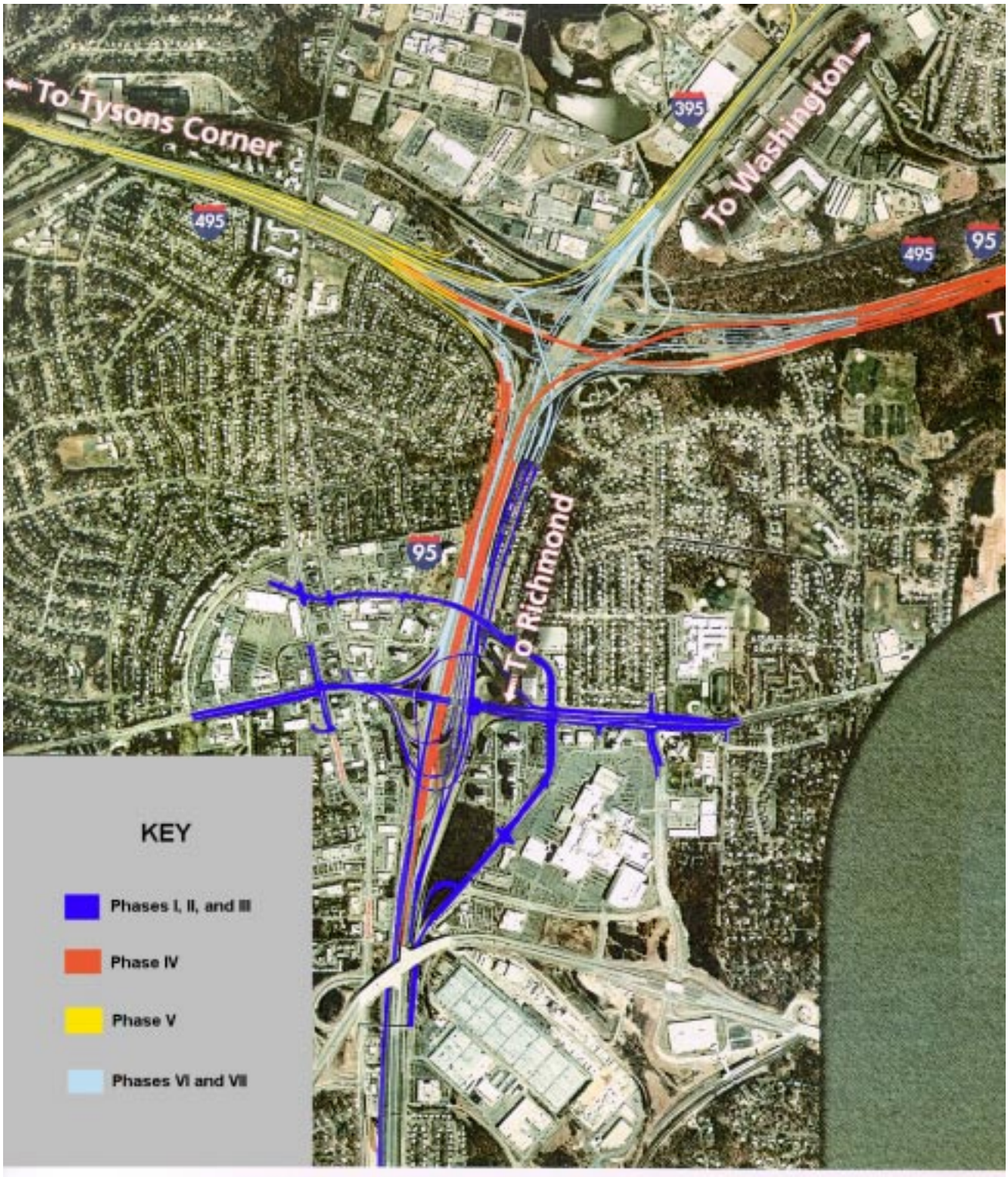
Phase I. Prior to beginning construction of the major interchange improvements in Springfield, VDOT initiated construction of phase I of the project, which involved adding a fourth lane on southbound I-95 from Springfield to the Newington interchange. Construction of this lane was needed to improve the flow of traffic through the construction zone in the southbound lanes of I-95 north of the Franconia Springfield Parkway (see Figure 3). Construction of phase I took place between February 1995 and August 1996 and cost $2.8 million.

In addition to the construction of a fourth lane on southbound I-95 through the project area, a second project was undertaken in 1997 which is also considered to be part of phase I. VDOT constructed an additional exit ramp on northbound I-95 at Spring Mall Drive in order to eliminate a weave situation occurring at Franconia Road and to provide access to the Franconia-Springfield Metro Station (see Figure 3). This project was constructed between April 1997 and June 1998 at a total cost for construction of approximately $2 million.

Phases II & III. These phases involve major improvements to the interchange of I-95 and Route 644 (Old Keene Mill Road / Franconia Road). The primary purpose of this construction is to eliminate a dangerous traffic weave that vehicles encounter when entering I-95 at Route 644, attempting to access northbound I-395 and westbound I-495 (see Figure 3). Phases II and III also include improvements to the local road network throughout the Springfield area. Construction work being performed under phases II and III includes rebuilding the I-95 and Route 644 interchange, widening Route 644, improving Franconia Road, constructing a new bridge at Commerce Street, and rebuilding the Amherst Avenue bridge. This phase also includes

Figure 3

Springfield Interchange Construction Phases



other improvements to the local road network. In addition, all right of way needed for the entire project was acquired as part of phases II and III.

Work on phases II and III began in March 1999, with a fixed completion date of June 1, 2002. The contract amount for phases II and III is $90.3 million, excluding contingencies. The total amount currently budgeted for this phase is $106.6 million. In addition, the contract provides a $10 million incentive bonus to the contractor if the project is completed by August 2001, and $5 million if it is completed by December 2001. Receiving this bonus, however, prohibits the contractor from filing any claim for damages against VDOT following completion of this phase.

Phase IV. Phase IV of the Interchange Improvement project includes the construction of additional travel lanes on southbound I-95 from I-495 south to the Franconia-Springfield Parkway. Construction work under this contract includes the relocation of the existing eastbound I-495 "outer loop" roadway as well as the construction of a direct flyover bridge connecting westbound I-495 to southbound I-95 (see Figure 3). This construction is needed in order to eliminate dangerous weaving and merging occurring in the interchange area and provide for a more direct connection to I-95 from the Capital Beltway to improve the flow of traffic.

Originally, phases IV and V were to be advertised together. However, in June 2000, the decision was made to separate the contracts and move the work on I-495 from Hemming Road to the I-95 interchange from phase IV to phase V in order to limit the contract award amount for phase IV. The contract for phase IV was awarded in November 2000 for $117 million, excluding contingencies. The total amount currently budgeted for this phase is $139.3 million. Construction of this phase began in December 2000, with an estimated completion date of August 2003.

Phase V. Construction work included under the proposed phase V contract includes a ramp from southbound I-395 south to westbound I-495 and improvements to the Capital Beltway west of the interchange to Hemming Avenue (see Figure 3). Design work on Phase V is near completion, and the construction contract is expected to go to advertisement in April 2001. Construction of this phase is scheduled to begin in the summer of 2001, with an expected completion date of summer 2003. The current estimated construction cost for phase V is $55.7 million.

Phases VI & VII. Phases VI and VII construction includes major improvements to the interchange of Interstates 95, 395, and 495. Proposed construction work under this phase includes improvements to I-95 northbound from the Franconia-Springfield Parkway through the Edsall Road interchange on I-395 as well as all remaining local and through ramps and high occupancy vehicle lanes (see Figure 3). This construction will improve the flow of traffic through the Springfield area and will tie in to interchange connections constructed under the previous phases. Design of these phases is 65 percent complete with an expected advertisement date of July 2002. Construction of this phase is scheduled to be complete in spring 2007. Based on the most current design plans, the estimated cost for construction of these phases is $107.6 million.

Phase VIII. Phase VIII construction was designed to include the connection of high occupancy vehicle ramps to the Capital Beltway, provided that the decision is made to construct HOV lanes on the Beltway. However, given the delay in the Beltway widening project, the Commonwealth Transportation Board (CTB) decided in September of this year to remove this phase from the Springfield Interchange project and include it as part of the Beltway widening project. The most recent engineer's estimate for the final cost of construction for this phase was $53.4 million. The current six year plan lists the cost for this phase as $71.5 million because the plan estimate has been adjusted for inflation.

Project Design History

Planning for this project began in the summer of 1991. In December 1991, a design consultant was retained to provide a study of alternative design concepts to address the traffic and safety concerns in the area. The consultant developed various alternatives that were presented for public comment at three citizen information meetings held between March 1992 and June 1993. Based on public input and additional design work, the consultant recommended two alternatives (Alternatives 11 and 12) which were presented at a location public hearing held in January 1994. In March 1994, the Fairfax County Board of Supervisors adopted a resolution supporting design Alternative 12 with some modifications. In June 1994, the CTB approved Alternative 12 with the proposed modifications. Between June 1994 and June 1997 design work continued. In June 1997, a design public hearing was held to receive public comment regarding phases II through VIII. In August 1997, the Commonwealth Transportation Board approved the design for the last seven phases. As discussed in the previous section, phase I construction has been completed, and phases II and III are currently under construction. Exhibit 1 provides a chronology of key dates in the history of the project.

PROJECT COST ESTIMATES HAVE INCREASED SUBSTANTIALLY

The estimated cost of constructing the Springfield Interchange Improvement project has risen substantially since the initial estimate in 1992. A variety of factors have contributed to the increasing estimates. Additional project requests by Fairfax County have increased the scope of the project. In addition, design enhancements and a congestion management program have also contributed to the growing cost. Other factors that have significantly increased the cost include inflation, design refinement, and the inclusion of construction contingencies.

Project Cost Estimates Have Increased Steadily Over Time

The estimated cost of the Springfield Interchange Improvement project has increased steadily over the last eight years. Table 16 shows the project cost estimate

Exhibit 1

Springfield Interchange Key Dates

December 1991	VDOT hires consultant to develop alternative design concepts
March 1992 – June 1993	Public information meetings are held to present design concepts
January 1994	Location public hearing
June 1994	CTB approval of Alternative 12 location and resolution directing secondary road improvements and SOV study
November 1994	Phase I advertised for construction
August 1996	Phase I construction completed
February 1997	Spring Mall Drive advertised for construction
June 1997	Design public hearing for phases II through VIII
August 1997	CTB approves final design
June 1998	Construction of Spring Mall Drive completed
September 1998	Phases II and III advertised for construction
March 1999	Construction of phases II and III begins
September 2000	Phase IV advertised for construction
December 2000	Phase IV construction begins
April 2001	Phase V scheduled to be advertised for construction
June 2002	Deadline for completion of phases II and III
July 2002	Phases VI and VII scheduled to be advertised for construction
Summer 2003	Anticipated completion of phases IV and V
Spring 2007	Anticipated completion of phases VI and VII

Source: JLARC staff review of VDOT design and construction files.

Table 16

Springfield Interchange
VDOT Six Year Improvement Plan Estimates

Six Year Improvement Plan (Fiscal Year)	Total Estimated Cost	Adjusted Estimate Without Phase VIII
1993	$ 111,000,000	$ 111,000,000
1994	$ 111,000,000	$ 111,000,000
1995	$ 289,650,000	$ 253,150,000
1996	$ 289,850,000	$ 253,350,000
1997	$ 309,152,000	$ 272,652,000
1998	$ 351,959,000	$ 315,459,000
1999	$ 394,389,000	$ 357,889,000
2000	$ 433,550,000	$ 393,550,000
2001	$ 563,295,000	$ 563,295,000

Source: VDOT six year development plans and historical cost estimate data.

listed in the six year development plan for each of the last nine years. The cost estimate for the project has increased by 407 percent ($111,000,000 to $563,295,000) since it was first listed in the six year plan. Between fiscal years 1995 and 2000 the cost estimate increased each year, but by no more than 16 percent. However, as indicated in Table 16, the cost estimate shown in the six year plan (adjusted for phase VIII) increased by 43 percent between the 1999-2000 and 2000-2001 plans. The six year plan estimate is $4.1 million less than the latest VDOT project estimate because the plan estimate does not include the cost of phase I, which has already been completed. The recent sharp increase in the cost estimate is discussed in more detail in the last section of this chapter.

Locality Requests Added to the Cost

The scope of the project has been expanded to include several additional construction projects requested by Fairfax County and the community of Springfield since 1994. The additional work has included several improvements to secondary roads in the Springfield area, additional design work required so as not to preclude the future construction of access from I-95 to the Franconia-Springfield Parkway, and aesthetic improvements. The total cost of this additional work is approximately $46.7 million. Table 17 lists the additional construction work that has been added to the project based on local requests since 1994.

Table 17

Springfield Interchange
Locality-Requested Improvements

Requested Improvement	Estimated Cost
SOV Access to Franconia-Springfield Parkway	$ 19,700,000*
Ramp from Franconia Road to SB I-95	$ 9,400,000
Spring Mall Drive	$ 7,900,000**
Improvements to Loisdale Road	$ 3,000,000*
Grade Separation of Franconia Road	$ 2,700,000**
Amherst Street Bridge	$ 2,600,000
Fire Suppression System	$ 900,000**
Lee High School Improvements	$ 500,000
Total	**$ 46,700,000**

Notes: * Includes right of way and preliminary engineering costs.
** Includes right of way costs.

Source: VDOT cost analysis of locality requests and supplemental design contracts.

Secondary Road Construction. A number of additional secondary improvements were requested by Fairfax County and added to the project. Among the secondary improvements were: an additional flyover from westbound Franconia Road to southbound I-95 ($9.4 million), the Spring Mall Drive exit ($7.9 million), the grade separation of Franconia Road over Frontier Drive ($2.7 million) and an additional travel lane and bicycle path on Loisdale Road ($3 million).

These additional projects were added to the overall project despite objections from VDOT and the Federal Highway Administration (FHWA). FHWA contended that the work would be considered "scope creep" and would delay the approval process for the project. VDOT took the position that the purpose of the interchange project was to facilitate interstate to interstate movement, and that these secondary road improvements needed to be funded as secondary road projects. However, the Commonwealth Transportation Board decided to approve these secondary projects as part of the interchange project.

"Not to Preclude" Decision. Based on a request by Fairfax County, the CTB in 1994 directed VDOT to study the possibility of constructing single occupancy vehicle (SOV) access from I-95 to the Franconia-Springfield Parkway. The department concluded that this would increase the cost of the Interchange project by $58 to $61 million, was beyond the scope of the project, and would be more appropriately addressed through the Northern Virginia secondary road plan. Fairfax County continued to express support for this SOV access. In November 1996, the Commonwealth Transportation Board decided not to include the construction of this access in the In-

terchange project but directed VDOT to design the Interchange project so as not to preclude future SOV access to the Franconia-Springfield Parkway.

The total cost of the "not to preclude" decision was $19.7 million. This included $10.2 million for additional right of way needed as a result of the redesign. This total also included $8 million in construction costs to construct three additional bridges that were necessitated by redesigning the Interchange project not to preclude this access in the future.

Aesthetic Improvements. At the request of the Central Springfield Area Revitalization Committee and Fairfax County, the department was asked to provide aesthetic improvements as part of the construction along Amherst Avenue and Old Keene Mill Road. The requests included wider sidewalks, smaller travel lanes, aesthetic treatments to bridge walls, and the installation of decorative lighting. These aesthetic improvements will cost an additional $2.6 million.

Additional Locality Requests. In addition to improvements to the local road network and a number of bridges requested by Fairfax County, an additional request was made by the Fairfax County Public School Board to include improvements to several schools impacted by the construction of the project. As a result of the additional widening of Franconia Road, there were additional right of way impacts to several public schools located along the corridor. VDOT agreed to the replacement of athletic fields, tennis courts, and a stadium press box for Lee High School. These school improvements added $500,000 to the cost of the interchange project.

Design Enhancements Contributed to Increased Project Costs

Since the location public hearing in January 1994, there have been a number of significant design enhancements requested by the department, the design consultant, and FHWA that have raised the project costs. These design enhancements included the replacement of several bridges and soundwalls in the project area which will cost approximately $62 million. Table 18 lists the costs for each of these additional items.

Additional Bridge Work Has Increased Project Costs. One of the assumptions of the initial design work was that the existing bridges included in the project area could simply be redecked and would not have to be replaced. However, as the design work progressed, the design consultant determined that the existing bridges in the last four phases of the project would have to be replaced. The total cost of these bridge replacements is projected to be $18.2 million.

Soundwalls Were Not Included in Initial Cost Estimates. Another design enhancement that has increased the cost of the project is the replacement of some existing soundwalls as well as the construction of some new soundwalls for residential areas impacted by the redesigned interchange. The need for soundwalls was identified in the initial environmental assessment in 1994 and was estimated to cost $10 million.

Table 18

Springfield Interchange Design Enhancements

Enhancement	Estimated Cost
Additional Bridge Work	$ 18,200,000*
Soundwalls	$ 14,900,000
Retaining Walls	$ 10,000,000
Ramp from SB I-395 to NB I-95	$ 9,000,000
Utilities	$ 5,300,000
Widen I-95 Bridges (FHWA requested)	$ 3,200,000
Additional Lane I-395	$ 1,100,000*
Widen Old Keene Mill Road	$ 900,000
Widen Amherst Avenue Bridge	$ 300,000
Total	**$ 62,900,000**

Note: * Includes right of way costs.

Source: VDOT cost analysis of design enhancements.

However, the soundwall cost was not included in the cost estimates for the project until this year. According to the project manager, the decision was made not to include the cost of soundwalls in previous estimates because the soundwalls had not been approved by the Federal Highway Administration, and there remained uncertainty as to the number of walls that would need to be constructed and their cost. The projected cost of the soundwalls is currently $14.9 million. Other design enhancements that have increased the cost of the project include an additional ramp from southbound I-395 to northbound I-95, additional retaining walls, additional utilities work, and widening of I-95 bridges.

Congestion Management Has Increased Cost by $28 Million

Another item that has increased the cost of the project is the congestion management program. The establishment of a congestion management program (CMP) for this project was approved by the CTB in June 1994, and has been a contentious issue throughout the design of the interchange project. The total amount that has been allocated for congestion management is $28 million.

A CMP is required under federal law for localities with a population of 200,000 or more for the purpose of informing the public of planned construction, managing congestion in the project area, and encouraging the use of other means of transporta-

tion. Federal guidelines for establishing a CMP are broad and the amount of funding provided to these programs is in the discretion of the department. Items provided under the Springfield Interchange CMP include: expanded bus and transit services, additional State Police and incident management personnel, emergency and hazardous materials equipment, improvements to the local road network, purchase of additional Virginia Railway Express service from Fredericksburg to Washington, and funding for the communication of construction information to the public. Also included under the CMP was the design cost for four commuter parking lots along I-95.

The estimated cost for the CMP significantly increased as congestion management strategies were developed. The design consultant's initial estimate for congestion management in 1996 was $500,000 to $1 million. Following further study of the congestion management needs, the Springfield CMP was estimated to cost between $2 million and $11 million. In March 1996, VDOT's Chief Engineer wrote that "it would not be in the interest of VDOT to develop a detailed congestion management plan at a cost of $2 million to $11 million," because of doubts about the effectiveness of such programs historically.

A congestion management steering committee was formed in order to develop various strategies for the CMP. Based on the committee's proposed CMP strategies and budget, VDOT and the FHWA decided to allocate $28 million for congestion management. This amount included $10.1 million for traffic management and transit enhancements, $9 million for incident management, $7.9 million for communications and advertising, and $847,000 for additional improvements to local roads. To date the program has spent $7.7 million and has committed to spend an additional $10 million.

The congestion management steering committee initially recommended that four commuter parking lots be constructed as part of the CMP at an estimated cost of $6 million. These lots were to be constructed at I-95 and Prince William Parkway, Route 234 and Route 1, the Fairfax County Parkway and Sydenstricker Road, and I-95 and Route 610 in Stafford County. The Chief Engineer denied approval for these lots out of the CMP because of concerns that it would adversely impact overall project funding, which was not fully in place at the time of the request. As a result, only the design engineering costs for these lots are being paid for out of the CMP funds (approximately $1 million). In January 1999, the governor mandated that these lots be funded, and the decision has been made to fund them from Fredericksburg and Northern Virginia district allocations.

Although not funded through the congestion management program, the department also operates the Springfield Information Store in the Springfield Mall to assist with congestion management. Funding for the Information Store is included as a separate line item in the six year development plan and is funded at $3.1 million through 2001. The Information Store supplements the CMP communications strategies by providing the public with information about the project. Funding for the Information Store expires in 2001, which will require VDOT to find a new revenue source to fund its operation or terminate it.

Other Factors Contributing to Increased Project Costs

A number of other factors have increased the cost of the project over time. One of those factors is inflation. Estimates in previous years were not adjusted for inflation despite the fact that most of the phases were several years away from advertisement. Inflation has clearly increased the cost of the project over time. Increasing land values in Northern Virginia have especially impacted the cost of property required to be obtained for right of way.

In addition, earlier estimates did not include major known cost items. The ten percent construction and eight percent construction engineering contingencies that are budgeted for construction projects were not included in the cost estimate for the project until this year. These contingencies total approximately $69.3 million. Additionally, some earlier cost estimates did not include the design costs, now totaling $42.6 million. Similarly, some of the overall cost estimates have not included the construction costs for phase I of the project.

CHANGING TIME SCHEDULES

While there has been some confusion as to the schedule for completion of the Springfield Interchange Improvement project, the project appears to be on schedule overall and has not experienced any major delays. However, with a phased approach there are several project schedules which have been adjusted several times, making it difficult to determine whether the individual phases are on schedule.

Construction Project Appears to Be on Schedule Overall

The project currently appears to be on schedule for completion in the spring of 2007. This is four years earlier than the initial projected advertisement date for the final construction phase of July 2011. In 1996, the decision was made to modify the schedule by combining work phases IV and V, and VI and VII (IV and V were subsequently separated back into two contracts). Phase I has been completed, and phases II and III appear to be on schedule for completion by the contract deadline. Phase IV began construction in December 2000, and phase V is scheduled to be advertised for construction in April of 2001. The design for phases VI and VII is more than 60 percent complete and, according to VDOT, is on schedule to meet their July 2002 advertisement date. However, with four phases remaining to be constructed, it is difficult to predict with much certainty at this point whether these projects will ultimately be completed within the current project schedule. Exhibit 2 shows the current schedule for the remaining phases.

Exhibit 2

Current Springfield Interchange Project Schedule

Phase	Advertisement Date	Completion Date
IA	November 1994	August 1996
1B	February 1997	June 1998
II & III	September 1998	June 2002
IV	September 2000	August 2003
V	April 2001	Summer 2003
VI & VII	July 2002	Spring 2007

Source: VDOT published project schedule.

Phase Construction Schedules Have Been Adjusted

With multiple phases and several revisions to the schedule, it is difficult to assess whether the various phases are on schedule. Initial time schedules showed the advertisement of the eight phases spanning 17 years, with the first phase being advertised in November 1994 and the last phase not advertised until July 2011. In 1996 the decision was made to accelerate the schedule by combining phases VI and VII and also phases IV and V into single contracts. The advertisement dates for phases VI and VII were moved up seven and nine years, respectively, to September 2000. Similarly, the advertisement schedules for phases IV and V were moved up four and six years, respectively, to September 1999. At the same time, the advertisement date for phases II and III was moved back more than a year to September 1998. Exhibit 3 shows major schedule revisions by phase.

Over the next two-and-a-half years, the time schedules were adjusted two more times. In July 1999, the published schedule moved back the advertisement of phases IV and V to March 2001, and the advertisement date for phases VI and VII was moved to March 2003. However, in March 2000 the schedule was again revised. Phases IV and V were separated into contracts with advertisement of phase IV moved up to September 2000 and phase V moved back a month to April 2001. Phases IV and V were separated because of concerns that the contract for both phases combined was estimated to be $165 million, which would limit the number of contractors eligible to bid on the project. The latest schedule also moved up the advertisement of phases VI and VII by eight months to July 2002.

Exhibit 3

Springfield Interchange Schedule Revisions

Phase	Advertisement Date			
	September 1994	**April 1998**	**July 1999**	**March 2000**
I	11/94	11/ 94	11/94	11/94
II / III	7/97	9/98	9/98	9/98
IV	7/03	9/99	3/01	9/00
V	7/05	9/99	3/01	4/01
VI	7/07	9/00	3/03	7/02
VII	7/09	9/00	3/03	7/02

Source: JLARC staff review of VDOT design and construction files.

RECENT AND ESTIMATED COST INCREASES

While cost estimates for the Springfield Interchange Improvement project have steadily increased over the last several years, the cost estimate for the project has increased at a more accelerated rate since July 1999. In addition, based on the cost growth factors developed by JLARC staff, the total cost of the project may increase by $100 million over the current cost estimate.

Cost Estimate Has Increased by 44 Percent Since July 1999

Since July 1999, VDOT's estimated cost of the Interchange project has increased by $174 million from $393 million (excluding the estimated cost of phase VIII) to $567 million. This is an increase of 44 percent, and is by the far the largest increase for any comparable period of time since 1994.

Several factors have contributed to the rise in the projected cost of the project over this period. Projected construction and construction engineering contingencies (18 percent of the contract price for each phase) were not included in the cost estimate until 1999. This added $69.3 million to the cost of the project. In addition, the right of way cost estimate rose by $34 million over this period. Refined design estimates for projects not yet under construction also increased the cost estimate by $60 million. Finally, adjustment of the cost estimate to include inflation added another $8 million to the cost.

Total Construction Cost May Reach $667 Million

As part of the analysis for this report, JLARC staff applied the cost growth factors discussed in detail in Chapter II in order to take VDOT's past cost growth experience into account. JLARC staff applied the cost growth factors developed based on historical interstate project data to the contract award amounts for phases II – IV, and to the current cost estimates for phases V - VII. Based on application of the growth factors, each of the phases is estimated to increase in cost. As Table 19 demonstrates, phases II and III are estimated to increase by almost $10 million, phase IV by $24.7 million, phase V by $16.2 million, and phases VI and VII by $48.6 million. Most of the estimated increase results from estimated cost increases at the construction stage. The total increase in cost of the Interchange project over the current estimate is estimated to be $99.5 million. Based on this increase, the total cost of the Springfield Interchange Improvement project is estimated to increase to $666.9 million.

Table 19

Estimated Cost of the Springfield Interchange

	VDOT Cost Estimate October 2000	JLARC Estimated Cost
Preliminary Engineering	$ 42,649,000	
Right of Way	$ 68,909,000	
Congestion Management	$ 28,000,000	
Information Store	$ 3,170,000	
Beltway Ramps	$ 689,000	
Phase I & Spring Mall Ramp	$ 4,818,000	
Cost Incurred to Date	**$ 148,235,000**	**$ 148,235,000**
Phase II & III	$ 116,603,000	$ 126,586,152
Phases IV	$ 139,270,000	$ 164,015,280
Phase V	$ 55,700,000	$ 71,862,358
Phases VI & VII	$ 107,608,000	$ 156,186,448
Projected Total Cost	**$ 567,416,000**	**$ 666,885,238**

Note: JLARC cost growth factors applied to VDOT data.

Source: VDOT project cost estimates.

Appendixes

Appendix A

Letter Requesting JLARC Study

COMMONWEALTH OF VIRGINIA
HOUSE OF DELEGATES
RICHMOND

APPROPRIATIONS COMMITTEE
9TH FLOOR, GENERAL ASSEMBLY BUILDING
CAPITOL SQUARE
POST OFFICE BOX 406
RICHMOND, VIRGINIA 23218
804-698-1590

VINCENT F. CALLAHAN, JR., CO-CHAIRMAN
V. EARL DICKINSON, CO-CHAIRMAN

July 10, 2000

Mr. Philip A. Leone
Director
Joint Legislative Audit and Review Commission
Suite 1100
General Assembly Building
Richmond, Virginia 23219

Dear Phil:

Recent newspaper articles have reported that a number of road construction projects are either facing large cost overruns or have encountered delays in their original completion date. Given these concerns, we are requesting that the Commission undertake a study of the Department of Transportation's six-year plan and the impact that these cost overruns will have on projects authorized and funded in House Bill 608 and Senate Bill 33, (Virginia Transportation Act of 2000).

It is extremely important that this study be completed in time for the 2001 Session of the General Assembly.

Thank you for your assistance in this matter.

Sincerely,

Vincent F. Callahan, Jr.

V. Earl Dickinson

Harry J. Parrish

John A. Rollison, III

Appendix B

Status of Projects in the Virginia Transportation Act

Bristol District

PPMS	Route	Work Description	Project Status
233	460	Widening from 2 to 4 Lanes	Construction Complete
17748	58 Alt.	Parallel Lane	Construction Underway
9825	81	Widening from 4 to 6 Lanes and Interchange Improvements	Construction Underway
9826	81	Widening from 4 to 6 Lanes and Interchange Improvements	Construction Underway
54737	91	Relocation	Construction Underway
18906	City Wide	Signal Replacement	Construction Underway
55179	19/460	Intersection Improvement	Location and Design Phase
13505	460	Floodproofing	Location and Design Phase
56228	460	PH. I - Widening	Location and Design Phase
56230	460	PH. II - New Location	Location and Design Phase
56231	460	PH. III - New Location	Location and Design Phase
15163	58	New Location	Location and Design Phase
15165	58	New Location	Location and Design Phase
15166	58	New Location	Location and Design Phase
16384	58	Parallel Lane	Location and Design Phase
16382	58	Parallel Lane	Location and Design Phase
16383	58	Parallel Lane	Location and Design Phase
17747	58	Construct Interchange	Location and Design Phase
53059	58 Alt	Parallel Lane	Location and Design Phase
12764	72	Construct 2 & 4 Lanes on New Location	Location and Design Phase
12501	725	Reconstruction	Location and Design Phase
17745	81	Interchange Improvements	Location and Design Phase
17752	83	Construct Left Turn Lane EB	Location and Design Phase
260	91	Reconstruct Existing 2 Lanes	Location and Design Phase
9918	Ben Bolt Ave.	2 Lane	Location and Design Phase
17508	Hockman Pike	Bridge Replacement 2 Lane	Location and Design Phase
17817	Norton Road	3 Lane	Location and Design Phase
16492	Park Ave.	4 Lane	Location and Design Phase
14621	Virginia Ave.	Bridge Replacement 2 Lane	Location and Design Phase
861	460	Widening from 2 to 4 Lanes	Not Started

Bristol District
(Continued)

PPMS	Route	Work Description	Project Status
14884	81	Interchange Improvements and Widening from 4 to 6	Not Started
14799	81	Widen from 4 to 6 Lanes	Not Started
17639	Front Street	Bridge Replacement	Not Started
18922	77	Construct Sewer Lines	Don't Know
14810	Coalfields Expressway		Don't Know

Culpeper District

PPMS	Route	Work Description	Project Status
17019	15	Bridge Rehabilitation	Construction Complete
15997	28	Improve Curve	Construction Complete
2304	29	Widen From 4 to 6 Lanes with Cont. Right Turn Lane	Construction Complete
13348	29	Widen from 4 to 6 Lanes with Cont. Right Turn Lane	Construction Complete
18900	29	Complete Third Lane Northbound and Southbound	Construction Complete
50033	29	Improve Sight Distance Northbound	Construction Complete
15424	29 Business	4 Lanes on New Location	Construction Complete
2523	33	4 Lanes on New Location	Construction Complete
15247	33	4 Lanes on New Location	Construction Complete
12768	15	Bridge Replacement	Construction Underway
15998	29	Bridge Replacement	Construction Underway
18967	Old Rixeyville Road	Bridge Replacement	Construction Underway
16536	15	Intersection Improvements and Widening	Location and Design Phase
15984	15 & 29	Intersection Improvements	Location and Design Phase
2459	15 Business -	Parallel Lane	Location and Design Phase

Culpeper District
(Continued)

PPMS	Route	Work Description	Project Status
15996	20	Bridge Replacement	Location and Design Phase
16522	208	3 Lanes with Curb & Gutter on New Location	Location and Design Phase
16419	215	Improve Intersection	Location and Design Phase
18901	231	Bridge Replacement	Location and Design Phase
56131	28	4 Lane Reconstruction Including Interchange	Location and Design Phase
16420	29	Improve Vertical Alignment on SBL	Location and Design Phase
14657	3	Parallel Lanes (2 to 4 Lanes)	Location and Design Phase
14658	3	Parallel Lanes (2 to 4 Lanes)	Location and Design Phase
52339	3	Parallel Lane (2 to 4 Lanes)	Location and Design Phase
18897	53	Bridge Replacement	Location and Design Phase
56195	208	Reconstruction	Not Started
56130	28	Bridge Replacement	Not Started
3160	29	Widen from 4 to 6 Lanes	Not Started

Fredericksburg District

PPMS	Route	Work Description	Project Status
10067	3	Deck Rehabilitation Phases I,II & III	Construction Complete
14774	3	Rehabilitation Phase IV & V	Construction Complete
11768	33	Parallel Lane (2 to 4 lanes)	Construction Complete
2295	218	New Railroad Grade Separation	Construction Underway
14780	17	Bridge Replacement	Location and Design Phase
56942	17	Construct 2nd Left Turn Lane on SBL	Location and Design Phase
18875	17	Construct Left Turn Lane on NBL	Location and Design Phase
56186	17	Safety/ Spot Improvements	Location and Design Phase
18115	208	2 Lanes on 4-Lane Right of Way	Location and Design Phase
11766	3	Parallel Lane	Location and Design Phase
13564	3	Add Through & Right Turn Lanes E.B.L. & W.B.L	Location and Design Phase

FREDERICKSBURG DISTRICT
(Continued)

PPMS	Route	Work Description	Project Status
16022	95	Construct Diamond Interchange	Location and Design Phase
17785	95	Construct Bridge	Location and Design Phase
56934	17	Install Raised Concrete Median	Not Started
52299	208	4 Lanes on New Location	Not Started
18205	33	Replace Bridge & Approaches	Not Started
18206	33	Replace Bridge and Approcahes	Not Started
13557	95	Construct Interchange	Not Started
56183	95	Interchange Improvement - 2 Lane Ramps, Signals &	Not Started
56184	95	Interchange Improvement - Phase I - Construct Acce	Not Started
56838	95	Reconstruct Interchange - Phase II	Not Started

Hampton Roads District

PPMS	Route	Work Description	Project Status
16049	199	Construct Interchange and Approaches	Construction Complete
16050	199	Construct Interchange (Full Cloverleaf)	Construction Complete
9799	199 Extension	4 Lanes on New Location	Construction Complete
15636	199 Extension	4 Lanes on New Location	Construction Complete
15637	199 Extension	4 Lanes on New Location (Including Inter. at Route	Construction Complete
2024	264	HOV Lanes	Construction Complete
4464	64	Widen to 6 Lanes plus HOV Lanes	Construction Complete
12402	64	Bridge Widening and Widen from 4 to 6 Lanes	Construction Complete
12403	64	Widen from 4 to 6 Lanes Including Noise Abatement	Construction Complete
14701	17	Construct Third Through Lane with Right Turn Lanes	Construction Underway
13731	264	HOV Lanes	Construction Underway
13732	264	Bridge Widening and Necessary Roadwork	Construction Underway

Hampton Roads District
(Continued)

PPMS	Route	Work Description	Project Status
16045	264	Traffic Management System	Construction Underway
16046	464	Traffic Management System	Construction Underway
2058	64	Construct Interchange	Construction Underway
4466	64	Widen from 6 to 8 Lanes with Peak HOV Lanes	Construction Underway
12827	64	Bridge Deck Rehabilitation	Construction Underway
15128	64	Widen from 4 to 6 Lanes Including Noise Abatement	Construction Underway
12829	64	Replace Suspended Tunnel Ceiling	Construction Underway
13272	64	Traffic Management System	Construction Underway
13738	64	Traffic Management Systems	Construction Underway
13740	64	Traffic Management System	Construction Underway
13743	64	Traffic Management System	Construction Underway
16042	64	Traffic Management System	Construction Underway
16043	64	Traffic Management System	Construction Underway
17066	64	Smart Traffic Center Operations Facility Addition	Construction Underway
13744	664	Traffic Management System	Construction Underway
16047	664	Traffic Management System	Construction Underway
12543	Kempsville Rd.	6 Lane	Construction Underway
4388	Shore Dr.	4 Lane Bridge Replacement	Construction Underway
18968			Location and Design Phase
17628	10	Widen to Improve Sight Distance	Location and Design Phase
1869	125	2-Lane Bridge and Approaches	Location and Design Phase
3180	17	Parallel Structure (2 to 4 Lanes)	Location and Design Phase
3181	17	Bridge and Approaches (2 to 4 Lanes	Location and Design Phase
12836	17	Widening from 4 to 6 Lanes	Location and Design Phase
1730	17	4 Lanes on New Location	Location and Design Phase
1890	17	Develop from 2 to 4 Lanes	Location and Design Phase
11077	17	Develop from 2 to 4 Lanes	Location and Design Phase
1896	175	Replace Structures on New Location	Location and Design Phase

Hampton Roads District
(Continued)

PPMS	Route	Work Description	Project Status
18972	199	Parallel Lane (Phase I)	Location and Design Phase
18973	199	Parallel Lane (Phase II)	Location and Design Phase
15791	264	HOV Lanes	Location and Design Phase
18978	460	Construct Fifth Lane	Location and Design Phase
17728	58 -	Construct Interchange	Location and Design Phase
9865	58/258 Conn. (Route	2 Lanes on 4-Lane R/W on New Location	Location and Design Phase
12379	64	Widening to 6 Lanes plus HOV Lanes	Location and Design Phase
12920	64	Widen from 4 to 6 Lanes	Location and Design Phase
17368	64	Widen from 6 to 8 Lanes with Peak HOV Lanes	Location and Design Phase
17825	64	Interchange Improvements	Location and Design Phase
12834	64	3rd Crossing	Location and Design Phase
13114	64	Widen from 4 to 6 Lanes	Location and Design Phase
17545	Clifford Street	Bridge Replacement	Location and Design Phase
19028	Commander Shepard Bl	4 Lane Divided	Location and Design Phase
14606	Deep Hole Road	2 Lane	Location and Design Phase
14672	Hampton Blvd.	Railroad Underpass NIT/Greenbrier	Location and Design Phase
13429	Jefferson Ave.	6 Lane	Location and Design Phase
17568	Nansemond Pkwy	4 Lane	Location and Design Phase
11750	Pinner's Point Inter	4 & 6 Lane	Location and Design Phase
18591	Portsmouth Blvd.	4 Lane	Location and Design Phase
1904	S. Military Hwy.	4 Lane Bridge Replacement	Location and Design Phase
17544	Sunnyside Rd.	Bridge Replacement	Location and Design Phase
3950	Turnpike Rd.	4 Lane	Location and Design Phase
56187	104	Bridge Replacement over South Branch Elizabeth Riv	Not Started
54868	17	Develop 2 to 4 Lanes & 4 Lanes on New Location	Not Started

Hampton Roads District
(Continued)

PPMS	Route	Work Description	Project Status
56642	258 -	Intersection Improvements at Various Locations	Not Started
57048	264	Interchange Improvements - 64 WB Ramp to 264 EB	Not Started
17630	264 (44)	Interchange Improvement	Not Started
18970	264 (44)	Interchange Improvement	Not Started
19005	264 (44)	Interchange Improvement (Phase II)	Not Started
18974	40	Bridge Replacement	Not Started
52303	460	Construct Turn Lanes	Not Started
56638	460 -	Location Study & Environmental Studies	Not Started
12835	64	Widen from 4 to 6 Lanes	Not Started
13113	64	Widen from 4 to 6 Lanes	Not Started
51865	Great Neck Road	Interchange	Not Started
16557	Hampton Blvd.	Interchange with International Terminal Blvd.	Not Started
56466	London Boulevard	Bridge Painting and Repair	Not Started
9786	S. Church St.	3 Lane	Not Started
16556	South-eastern Parkway	4 Lane	Not Started
51863	Victory Boulevard	4 Lane	Not Started

Lynchburg District

PPMS	Route	Work Description	Project Status
14835	360	Bridge Replacement	Construction Complete
12790	15	Bridge Replacement	Construction Underway
15843	29	4 Lanes on New Location	Construction Underway
15844	29 -	4 Lanes on New Location Incl. James River Br/Apr	Construction Underway
10185	29/460	Reconstruct to Full Interchange	Construction Underway

Lynchburg District
(Continued)

PPMS	Route	Work Description	Project Status
13534	East Third Street	4 Lane	Construction Underway
11914	130	4 Lanes on New Location	Location and Design Phase
52390	15	Parallel Lane	Location and Design Phase
16039	151	Bridge Replacement	Location and Design Phase
11913	210	4 Lanes on New Location	Location and Design Phase
11813	29	4 Lanes on New Location	Location and Design Phase
11912	29	4 Lanes on New Location	Location and Design Phase
15842	29	Construct Interchange	Location and Design Phase
18086	29	Realign to Remove Curve	Location and Design Phase
18877	29	Interchange Improvements Ph. II	Location and Design Phase
52242	29 Business	Construct Left and Right Turn Lanes	Location and Design Phase
983	360	Develop to 4 Lanes Including Bridge	Location and Design Phase
18879	360	Intersection Improvement	Location and Design Phase
18878	360	Bridge Replacement	Location and Design Phase
13511	41/265	4 Lanes on New Location	Location and Design Phase
17723	45	Reconstruction	Location and Design Phase
18229	501	Intersection Improvements	Location and Design Phase
16038	60	Bridge Replacement	Location and Design Phase
52248	501	New Location	Not Started

Northern Virginia District

PPMS	Route	Work Description	Project Status
15292		County Parkway Construct Interchange	Construction Complete
9027	234	4 Lanes on 6-Lane R/W (RW & Constr.)	Construction Complete
16213	234	Signing, Lighting & Pavement Markers	Construction Complete
11780	66	Interchange Modification	Construction Complete
13475	66	Additional Lane, HOV Lanes and Noise Walls	Construction Complete

Northern Virginia District
(Continued)

PPMS	Route	Work Description	Project Status
10407	95	Extension of HOV Lanes	Construction Complete
17038	95	Electrical and Mechanical Work	Construction Complete
17154	95	Repave Existing Lanes	Construction Complete
18516	95	Interchange Modification Phases II and III	Construction Complete
52337	95	Congestion Management Construct Park and Ride Lot	Construction Complete
52402	95	Congestion Management Construct Park and Ride Lot	Construction Complete
11679		County Parkway	Construction Underway
16627		County Parkway Construct Interchange	Construction Underway
14688	29	Reconstruct Bridge and Approaches	Construction Underway
14869	29	Construct Interchange	Construction Underway
18603	66	Bridge Replacement and Turn Lane for Ramp	Construction Underway
13267	66	Traffic Management System	Construction Underway
16003	66	Construct Commuter Lot	Construction Underway
18029	95	Replace and Widen BridgeSuperstructures	Construction Underway
15	95	Traffic Management System	Construction Underway
4700		County Parkway	Location and Design Phase
17671		Additional Thru and Turn Lanes	Location and Design Phase
55843			Location and Design Phase
12906	1	Widening	Location and Design Phase
16422	1	Replace Bridge and Approaches 6 Lane	Location and Design Phase
14693	123	Construct Interchange	Location and Design Phase
3789	234	Parallel Lane (2 to 4 Lanes)	Location and Design Phase
3790	234	(2 to 4 Lanes)	Location and Design Phase
8415	234	Parallel Lane	Location and Design Phase
11718	234	Parallel Lane (2 to 4 Lanes)	Location and Design Phase
13525	234		Location and Design Phase
17848	28	Construct Interchange	Location and Design Phase
52458	28	Construct Interchange	Location and Design Phase

Northern Virginia District
(Continued)

PPMS	Route	Work Description	Project Status
11424	29	Widen from 4 to 6 Lanes	Location and Design Phase
14682	495	Interchange Modification Phase VIII	Location and Design Phase
16625	495	Interim Roadway Lighting	Location and Design Phase
16000	66	Additional Lane and HOV Lanes	Location and Design Phase
52326	66	Reconstruction of Interchange	Location and Design Phase
16623	66	Roadway Lighting	Location and Design Phase
56986	7	Construct Additional Turn Lane on SBL	Location and Design Phase
56987	7	Extend Left Turn Lane on WBL	Location and Design Phase
56989	7	Extend Left Turn Lane on NBL	Location and Design Phase
56990	7	Extend Left Turn Lane	Location and Design Phase
14680	95	Interchange Modification Phases VI and VII	Location and Design Phase
57017	95	Provide Fourth Lane	Location and Design Phase
52336	95	Congestion Management Expand Park and Ride Lot	Location and Design Phase
52929	Nokesville Road and	Phase I	Location and Design Phase
52404	- -	Construct Interchange	Not Started
18857	1	Location Study & PE for Widening	Not Started
56981	1	Widening	Not Started
52331	123	Widening	Not Started
11395	29	Widen to 5 and 6 Lanes	Not Started
56356	66	Interchange Improvements	Not Started
16629	66	Traffic Management System	Not Started
54911	66	Widening and Rail Extension Location Study & EIS	Not Started
56988	7	Close Median	Not Started
56991	7	Spot Improvements	Not Started
56334	95	Woodrow Wilson Bridge Replacement (VA's Share)	Not Started
18993	Digital Drive/ West	2 Lane	Not Started

Northern Virginia District
(Continued)

PPMS	Route	Work Description	Project Status
57067	Monroe Street Route	Bridge Replacement	Not Started
55770		Expansion of Park & Ride Facility	Don't Know

Richmond District

PPMS	Route	Work Description	Project Status
1347	1	Replace Existing Bridge	Construction Complete
15974	288	2 Lanes on 6-Ln. Right of Way on New LocationPhase	Construction Complete
13794	95	Bridge Rehabilitation	Construction Complete
13798	95	Bridge Rehabilitation	Construction Complete
13801	95	Bridge Rehabilitation	Construction Complete
19041	95	Bridge Rehabilitation	Construction Complete
18085	288	4 Lanes on New Location	Construction Underway
18460	288	4 Lanes on New Location	Construction Underway
1423	2nd St.	Bridge Replacement	Construction Underway
17770	460	Construct Left Turn Lane and Modify Signal	Construction Underway
15980	5	Construct Left Turn Lane on Eastbound Lane and Ch	Construction Underway
13802	95	Bridge Rehabilitation	Construction Underway
14760	95	Interchange Improvements	Construction Underway
16559	95	Construct New Interchange	Construction Underway
4594	Boulevard	4 Lane	Construction Underway
15428	1	Widen from 4 to 6 Lanes	Location and Design Phase
15988	1	Bridge Replacement & Extend Left Turn Lane	Location and Design Phase
50028	13	Drainage Improvements & Sidewalk	Location and Design Phase
14767	156	Replace 1-Lane Bridge	Location and Design Phase

Richmond District
(Continued)

PPMS	Route	Work Description	Project Status
12921	250	Widening to 6 Lanes and Intersection Realignment	Location and Design Phase
13547	288	2 Lanes on 6-Lane R/W on New Location	Location and Design Phase
17155	288	2 Lanes on 6-Lane R/W on New Location	Location and Design Phase
17782	288	4 Lanes on 6-Lane R/W on New Location	Location and Design Phase
17784	288	4 Lanes on 6-Lane R/W on New Location	Location and Design Phase
18956	288	4 Lanes on 6-Lane R/W on New Location	Location and Design Phase
18959	288	4 Lanes of 6-Lane Right of Way on New Location	Location and Design Phase
50139	288	Mitigation Sites	Location and Design Phase
18204	33	Replace Bridge & Approaches	Location and Design Phase
15990	360	6 Lanes	Location and Design Phase
17768	360	Widening from 4 to 6 & 8 Lanes	Location and Design Phase
18962	360	Relocation	Location and Design Phase
18963	360	Widening from 4 to 6 Lanes	Location and Design Phase
50029	360	8 Lanes	Location and Design Phase
13551	360 -	Intersection Improvements	Location and Design Phase
11314	58	Develop 4 Lanes	Location and Design Phase
12799	64	Pavement Rehabilitation and Widening to 6 Lanes	Location and Design Phase
17756	64	4 Lanes on 6 Lane Right of Way on New Location	Location and Design Phase
50122	64	Modify Interchange	Location and Design Phase
15835	German School Road	4 Lane	Location and Design Phase
8651	Route 1	Reconstruction	Location and Design Phase
8652	Route 1	Reconstruction	Location and Design Phase
13548	288	New Location 4 Lanes on New Location	Not Started
56865	288	Complete Mainline	Not Started
56181	33	Widening to 4 Lanes	Not Started
18964	460 Business	Bridge Replacement	Not Started

Richmond District
(Continued)

PPMS	Route	Work Description	Project Status
56177	6	Proposed Parham/Patterson Interchange	Not Started
11802	64	Pavement Rehabilitation and Widening to 6 Lanes	Not Started
17757	64	Bridge Widening and Superstructure Replacement	Not Started
52443	64	Pavement Rehabilitation and Widening to 8 Lanes	Not Started
56331	Airport Connector		Not Started
15957	Graham Road	4 Lane	Not Started
19037	Raleigh Ave. Extensi	2 Lane	Not Started
15832	Rives Road	2 Lane	Not Started
15954	Whitehead Road	4 Lane	Not Started
56695	460	Location Study & Environmental Studies	Don't Know

Salem District

PPMS	Route	Work Description	Project Status
3167	220	Reconstruct 2 Lanes Southbound	Construction Complete
17702	460	Bridge Replacement	Construction Complete
18156	460	Widening and Relocation	Construction Complete
686	100	Develop from 2 to 4 Lanes	Construction Underway
16035	460	Bridge Replacement	Construction Underway
18512	460	Widening and Relocation	Construction Underway
16389	81	Construct Interchange and CD Roads	Construction Underway
16112	94	Relocation and Widening	Construction Underway
8749	Riverview St., Main	2 Lane	Construction Underway
18422	11	Bridge Replacement	Location and Design Phase
17698	11/460	Widen to 4 Lanes w/Continuous RTL on both sides	Location and Design Phase

Salem District
(Continued)

PPMS	Route	Work Description	Project Status
13508	220	2 Lanes on New Location on 4-Lane Right of Way	Location and Design Phase
17313	220	widen to 4 lanes	Location and Design Phase
8880	221	Develop from 2 to 4 Lanes	Location and Design Phase
18427	460	Lighting	Location and Design Phase
17535	58	Develop to 4 Lanes	Location and Design Phase
56352	58	Develop 4 Lanes	Location and Design Phase
17536	58 -	Develop to 4 Lanes	Location and Design Phase
18107	669	Reconstruction	Location and Design Phase
56178	81	Extend Accel Lanes	Location and Design Phase
56188	81	Widen Northbound Lane Bridge	Location and Design Phase
56194	81	Extend Substandard Accel Lanes	Location and Design Phase
52453	81	Lighting	Location and Design Phase
17680	Duncan Avenue	2 Lane Bridge Replacement	Location and Design Phase
15838	East Main Street Rou	4 Lane	Location and Design Phase
15839	East Main Street Rou	4 Lane	Location and Design Phase
14613	Henson Ave.	2 Lane	Location and Design Phase
17686	Route 11	Bridge Replacement	Location and Design Phase
56363	100	widen to 4 lanes	Not Started
17314	220	2 Lanes on New Location on 4-Lane Right of Way	Not Started
17315	220	4 lanes	Not Started
16591	81	Widen from 4 to 8 Lanes	Not Started
16593	81	Widen from 4 to 8 Lanes	Not Started
53094	81	Widen from 4 to 8 Lanes	Not Started
53095	81	Widen from 4 to 8 Lanes	Not Started
53097	81	Widen from 4 to 8 Lanes	Not Started
56193	81	Repave Deteriorated Shoulders & Install Rumble Str	Not Started

Salem District
(Continued)

PPMS	Route	Work Description	Project Status
53096	81	Widen from 4 to 8 Lanes	Not Started
56179	81	Install Guardrail	Not Started
56180	81	Median Grading	Not Started
56189	81	Install ITS Signs	Not Started
56191	81	Continue Highway Advisory Radio Installations	Not Started
56192	81	Scale Earth/Rock Slopes & Install Rock Fencing	Not Started
56470	81	Purchase of Incident Management Signs & Equipment	Not Started
16596	Proposed I-73 Corrid	Location Alignment	Not Started
52076	Route 11 Apperson Dr	Intersection Improvement	Not Started

Staunton District

PPMS	Route	Work Description	Project Status
18893	250	2-Lane Relocation & Truck Climbing Lane	Construction Complete
2771	262	2 Lanes on 4-Lane Right of Way on New Location	Construction Underway
3830	340	Widen from 2 to 5 Lanes	Construction Underway
16019	522	Bridge Replacement	Construction Underway
4463	64	Ramp Modification	Construction Underway
2773	262	2 lanes on 4-Lane Right of Way on New Location	Location and Design Phase
12823	262	2 Lanes on 4-Lane Right of Way on New Location	Location and Design Phase
9192	340	Provide Left Turn Lanes and Improve Sight Distance	Location and Design Phase
9820	340	Develop from 2 to 4 Lanes	Location and Design Phase

Staunton District
(Continued)

PPMS	Route	Work Description	Project Status
11090	340	Replace Bridge & Necessary Approaches 2 Lns.on 4-L	Location and Design Phase
11091	340	Replace Bridge & Necessary Approaches 2 Lns.on 4-L	Location and Design Phase
11092	340	Replace Bridge & Necessary Approaches 2 Lns.on 4-L	Location and Design Phase
16018	340	Bridge Replacement	Location and Design Phase
18989	340	Replace Bridge & Necessary Approaches 2 Lns. on 4-	Location and Design Phase
12825	340/522	New 5 Lane Structure	Location and Design Phase
12822	37	Interchange Modifications	Location and Design Phase
14796	64	Median Barrier and Guardrail Update	Location and Design Phase
12326	81	Provide Climbing Lane NBL	Location and Design Phase
19018	81	Increase Rest Room & Parking Capacity, Improve Lig	Location and Design Phase
56372	81	Extend Box Culvert	Location and Design Phase
4491	Lime Kiln Rd.	2 Lane	Location and Design Phase
14653	Sycamore Ave.	2 Lane	Location and Design Phase
55638		4 Lanes on new Location	Not Started
52564	220 -	Truck Access Road	Not Started
19017	340	Reconstruct to 4 Lanes	Not Started
56707	64	Interchange Modification for Truck Access Route	Not Started
12325	81	Widening and Reconstruction NBL	Not Started
18888	81	Reconstruction and Widening SBL	Not Started
18889	81	Bridge and Approaches North and Southbound	Not Started
18890	81	Bridge and Approaches North and Southbound	Not Started
56376	81	Widen and Rehabilitate Bridges	Not Started
56379	81	Bridge Replacement	Not Started
56381	81	Widen & Rehabilitate Bridges	Not Started
56382	81	Bridge Widening (4-Lane) & Replacement	Not Started

Staunton District
(Continued)

PPMS	Route	Work Description	Project Status
56383	81	Bridge Widening	Not Started
56384	81	Move Crossover & Extend Accel Lane	Not Started
56385	81	Bridge Replacement	Not Started
56386	81	Widen SBL Off Ramp to 2 Lanes	Not Started
56387	81	Bridge Widening	Not Started
56388	81	Widen Bridges and Extend Accel/Decel Lanes	Not Started
52318	81	Building and Site Renovation	Not Started
56380	81	ITS Applications	Not Started
9821	Commerce Ave.	Bridge Replacement	Not Started
16445	Main Street	Intersection Improvement	Not Started
57023	Truck Access Road/Ro		Not Started

Appendix C

Technical Appendix

JLARC staff collected data from VDOT related to project costs and time for projects that had recently completed the design and construction processes. Using the project cost data, cost growth factors were developed to measure the average percentage change during the design and construction phases. JLARC staff then applied those growth factors to projects in VDOT's final 2001 development plan in order to determine the amount by which the plan understates actual costs. In addition, JLARC staff measured the amount of time recently completed projects have taken to complete the design and construction phases.

COST DATA COLLECTION

All of the data necessary for this analysis was available from VDOT through the department's automated systems, project files, and contract files. JLARC staff collected cost estimates used to develop growth factors and also six year plan data to which the growth factors were applied.

Collection of Cost Estimate Data Used to Develop Growth Factors

Cost estimate data for two separate groups of projects were collected from VDOT. The first group included projects that had recently completed the location and design phase. The cost estimates for these projects were used to develop growth factors that measure the change in the cost estimate from the point of each major location and design activity to 100 percent design. The

second group included projects for which construction was recently completed. The cost estimates for these projects were used to develop growth factors that measured the change in cost from the 100 percent design cost estimate to the final cost of the project.

Location and Design Cost Estimate Data. The sample of projects used to develop location and design cost growth factors included only those road construction projects that had recently completed location and design and that had no job number changes during the location and design process. A job number change indicates that a project has been either split up into two or more smaller projects or grouped into a larger project. In order to develop an accurate assessment of cost growth, it was necessary that the cost estimates over time referred to the same project. Therefore, projects with job number changes were removed from the analysis. In addition, projects were eliminated if actual road construction activities were not involved.

There were 86 total road construction projects used in this analysis, as illustrated in Table 1. Road system type was defined by VDOT. All projects in the primary, secondary, and urban systems that completed location and design within the last two years were included. Because there were so few relevant interstate projects completed in the last two years, JLARC staff included in the analysis relevant interstate projects from the last four years.

Table 1

Projects Used to Develop Location and Design Cost Growth Factors

Project Type	Projects	Source of Relevant Projects*
All Projects	86	See below
Interstate Projects	10	All relevant projects within the last 4 years
Primary Projects	26	All relevant projects within the last 2 years
Secondary Projects	39	All relevant projects within the last 2 years
Urban Projects	11	All relevant projects within the last 2 years

* Relevant projects are those that completed location and design and had no job number changes and were considered road construction projects.

Source: JLARC staff analysis.

For each of the 86 projects, the Location and Design division provided JLARC staff with the cost estimates made at five key activities in the design process: scoping, preliminary field review, field inspection, furnishing right of way plans, and 100 percent design. At each activity, cost estimates were developed for each of the three main phases of design: preliminary engineering, right of way, and construction. As Table 2 shows, the cost estimates were unavailable for some of the activities in the process because the project did not include that activity or phase, or VDOT did not provide the cost estimate. For example, some

Table 2

Number of Relevant Road Construction Projects for Which Data Were Available at Each Activity and Phase of the Design Process

Activity	Preliminary Engineering	Right of Way	Construction
Scoping Stage	82	68	79
Preliminary Field Review	69	59	68
Field Inspection	78	68	79
Furnish Right of Way Plans	76	71	77
100 Percent Design	78	67	82

Source: JLARC staff analysis.

projects do not require right of way acquisition and therefore do not have a cost estimate for right of way. The following section, which addresses the growth factor methodology, will further discuss the number of projects used to develop each factor, including a breakdown by road system type.

Construction Cost Estimate Data. The construction projects used to develop growth factors included only projects for which construction had been completed and for which there were no job number changes after the 100 percent design was completed. Projects were considered complete when the final voucher was submitted to the Fiscal division. A job number change indicates that a project is either split up into several smaller projects or grouped into a larger project. In order to have an accurate assessment of cost growth, it was necessary that the cost estimates over time referred to the same project. Therefore, projects with job number changes were removed from the analysis. In addition, projects were eliminated if actual road construction activities were not involved.

Completed construction projects used to develop growth factors included 211 projects, as illustrated in Table 3. All relevant interstate, primary, and urban projects that completed in fiscal years 1999 and 2000 were included in the analysis. There were a large number of secondary projects completed in this timeframe; therefore, a random sample of secondary projects was chosen for the analysis. As a result, 124 of the 183 secondary projects completing construction during FY 2000 were randomly selected.

Table 3

Projects Used to Develop Construction Cost Growth Factors

Project Type	Number of Projects	Source of Relevant Projects
All Projects	211	See below
Interstate Projects	12	All relevant projects in fiscal years 1999 and 2000
Primary Projects	51	All relevant projects in fiscal years 1999 and 2000
Secondary Projects	124	Sample of relevant projects in fiscal year 1999
Urban Projects	24	All relevant projects in fiscal years 1999 and 2000

* Relevant projects are those that completed construction and had no job number changes and were considered road construction projects.

Source: JLARC staff analysis.

The cost estimates for several stages of construction were obtained from three sources. The 100 percent design cost estimate was obtained from the Location and Design division, the contract award was obtained from the Construction division, and data on the final cost of the project (including the construction engineering payments) was obtained from both the Construction and Fiscal divisions.

Collection of Six Year Plan Projects to Which Growth Factors Were Applied

Growth factors were applied to projects that were included by VDOT in the department's current six year plan that had not completed construction. VDOT provided to JLARC staff electronic copies of the final six year plan and the secondary road development plans maintained by each county. After JLARC staff eliminated entries that did not have identifying numbers and collapsed similar data into unique projects, there were a total of 4,945 projects, as illustrated in Table 4. According to VDOT staff, entries in the six year plans

Table 4

Number of Projects in the Six Year Plan

	Virginia Transportation Development Plan	Development Plans for Secondary Roads
Total number of entries in each plan	3,996	4,153
Entries with no identifying number (PPMS)	- 685	- 1,321
Duplicate project entries	- 863	- 335
Total number of projects in each plan	2,448	2,497
Total number of Project in the Six Year Plans*	**4,945**	

* There are 132 projects that are in both the six year plan and the secondary roads plan.

Source: Virginia Transportation Development Plan and the development plans for secondary roads.

without an identifying number were most likely placed in the plan for accounting purposes and do not refer to specific projects.

JLARC staff also received access to the department's PPMS data system, which allowed staff to directly obtain other information regarding the projects in the six year plans, including more detailed project descriptions and project status.

DEVELOPMENT OF COST GROWTH FACTORS

To examine cost overruns on construction projects, JLARC staff developed growth factors based on projects that recently completed either the design or construction phase. The first group of growth factors measured the average percent change from cost estimates made during different design activities to the cost estimate made when the project was considered 100 percent designed. Projects used to develop these factors had recently completed the location and design process. The second cost growth factor measured the

average percent change from the cost estimate at 100 percent design to contract award. The third cost growth factor measured the average percent change from the contract award to the final project cost. Projects used to develop the second and third growth factors had recently completed construction.

Development of Growth Factors Measuring the Percent Change in Cost Estimates During Design

JLARC staff calculated the first growth factors using cost estimates from 86 construction projects that had recently completed the design process. The growth factors were developed by measuring the percent change in the cost estimate from each design activity to the cost estimate at 100 percent design. Cost estimates were separately calculated for preliminary engineering, right of way, and construction. The average percent change for each activity and phase is the growth factor. Because there are four measures and three phases, 12 growth factors were calculated for design activities. Table 5 summarizes the results of this analysis for the entire population and by road system type (designated by VDOT). Table 6 summarizes the growth factors using the median instead of the average, and Table 7 shows the number of projects used by JLARC staff to calculate the growth factors.

Table 5

Average Growth Factors from Location and Design Activity to 100 Percent Design

ALL PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	114.2	151.9	74.3
2) Preliminary Field Review to 100 Percent Design	111.7	88.4	52.8
3) Field Inspection to 100 Percent Design	44.7	65.8	35.7
4) Furnish Right of Way Plans to 100 Percent Design	13.6	10.6	18.7

INTERSTATE PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	39.7	221.7	64.9
2) Preliminary Field Review to 100 Percent Design	29.5	235.7	20.1
3) Field Inspection to 100 Percent Design	11.1	154.5	12.5
4) Furnish Right of Way Plans to 100 Percent Design	1.1	1.6	3.4

PRIMARY PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	104.2	127.8	91.8
2) Preliminary Field Review to 100 Percent Design	96.5	110.1	59.7
3) Field Inspection to 100 Percent Design	70.0	76.8	39.1
4) Furnish Right of Way Plans to 100 Percent Design	24.1	0.8	19.1

SECONDARY PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	125.6	121.0	56.3
2) Preliminary Field Review to 100 Percent Design	137.1	44.3	52.5
3) Field Inspection to 100 Percent Design	27.6	33.6	41.6
4) Furnish Right of Way Plans to 100 Percent Design	5.3	25.9	14.8

URBAN PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	157.7	258.1	97.4
2) Preliminary Field Review to 100 Percent Design	139.7	60.7	59.6
3) Field Inspection to 100 Percent Design	55.0	56.0	26.5
4) Furnish Right of Way Plans to 100 Percent Design	20.1	1.5	39.4

Source: JLARC staff analysis.

Table 6

Median Growth Factors from Location and Design Activity to 100 Percent Design

ALL PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	58.7	24.0	48.3
2) Preliminary Field Review to 100 Percent Design	31.6	10.3	32.7
3) Field Inspection to 100 Percent Design	25.0	10.4	20.0
4) Furnish Right of Way Plans to 100 Percent Design	0.0	0.0	8.1

INTERSTATE PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	47.8	104.3	45.5
2) Preliminary Field Review to 100 Percent Design	10.0	56.7	12.3
3) Field Inspection to 100 Percent Design	0.0	14.3	4.3
4) Furnish Right of Way Plans to 100 Percent Design	0.0	0.0	3.3

PRIMARY PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	71.4	34.9	62.5
2) Preliminary Field Review to 100 Percent Design	51.9	0.0	47.7
3) Field Inspection to 100 Percent Design	40.0	16.6	25.6
4) Furnish Right of Way Plans to 100 Percent Design	5.5	0.0	18.9

SECONDARY PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	20.0	41.4	33.6
2) Preliminary Field Review to 100 Percent Design	12.5	7.1	43.7
3) Field Inspection to 100 Percent Design	2.7	1.5	29.5
4) Furnish Right of Way Plans to 100 Percent Design	0.0	0.0	4.9

URBAN PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	75.1	4.9	75.9
2) Preliminary Field Review to 100 Percent Design	75.1	10.6	12.4
3) Field Inspection to 100 Percent Design	48.7	34.6	0.0
4) Furnish Right of Way Plans to 100 Percent Design	21.8	0.0	27.8

Source: JLARC staff analysis.

Table 7

Number of Construction Projects Used to Calculate the Growth Factors

ALL PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	76	60	78
2) Preliminary Field Review to 100 Percent Design	67	56	66
3) Field Inspection to 100 Percent Design	72	61	77
4) Furnish Right of Way Plans to 100 Percent Design	72	65	75

INTERSTATE PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	8	6	8
2) Preliminary Field Review to 100 Percent Design	7	5	7
3) Field Inspection to 100 Percent Design	8	6	8
4) Furnish Right of Way Plans to 100 Percent Design	8	7	8

PRIMARY PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	25	22	25
2) Preliminary Field Review to 100 Percent Design	24	21	23
3) Field Inspection to 100 Percent Design	25	24	24
4) Furnish Right of Way Plans to 100 Percent Design	25	24	26

SECONDARY PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	32	24	34
2) Preliminary Field Review to 100 Percent Design	25	22	25
3) Field Inspection to 100 Percent Design	28	22	34
4) Furnish Right of Way Plans to 100 Percent Design	28	25	30

URBAN PROJECTS

Location and Design Growth Factors	Preliminary Engineering	Right of Way	Construction
1) Scoping to 100 Percent Design	11	8	11
2) Preliminary Field Review to 100 Percent Design	11	8	11
3) Field Inspection to 100 Percent Design	11	9	11
4) Furnish Right of Way Plans to 100 Percent Design	11	9	11

Note: There were 86 projects, but some of the projects were missing information for one or more of the activities or phases.

Source: JLARC staff analysis.

Development of Growth Factors Measuring the Percent Change from 100 Percent Design to Contract Award

The second growth factor measured the change in the cost estimate from 100 percent design to the awarded contract amount. For each project, JLARC staff calculated the percent change from the final design estimate to the awarded contract amount. The average percent change across these projects represented the growth factor (Table 8).

Table 8

Growth Factor from 100 Percent Design to Contract Award

Project Type	Average Growth Factor (percent)	Median Growth Factor (percent)	Number of Projects included in Analysis (N)
All Projects	3.2	-8.4	188
Interstate Projects	8.6	16.2	8
Primary Projects	-2.4	-2.7	41
Secondary Projects	3.9*	-12.7	118
Urban Projects	8.6	-6.5	21

*The sampling error for secondary roads is 7.9 percent.

Source: JLARC staff analysis.

Development of Growth Factors Measuring the Percent Change from Contract Award to Final Project Cost

The third growth factor measures the average change in the cost of a project from contract award to project completion. VDOT anticipates that the final cost of a project will be higher than the price of the original contract and budgets an additional ten percent of the contract price for contingency costs above the contract amount. In addition, VDOT estimates that construction engineering (costs associated with administration and inspection of the contract)

will cost an additional amount equal to 8, 12, or 15 percent of the contract amount, depending on the contract's dollar value.

For each project, JLARC staff calculated the percent change from the contract award (including VDOT's budgeted amounts for contingency and construction engineering) to the final cost of the project. The resulting average percent change is the growth factor applied to the six year plan. Table 9 presents the equations used to calculate the growth factor and the equations used to measure whether the cost growth was due to overruns in contingency or due to overruns in construction engineering.

Table 9

Equations Used to Determine the Percent Change for the Third Growth Factor Measuring Cost Change from Contract Award to Final Project Cost

GROWTH FACTOR FROM CONTRACT AWARD TO FINAL COST

$$\text{Percent Change from Contract Award to Final Project Cost *} = \frac{\text{Final Cost of Project} - \text{Amount Budgeted for Project}}{\text{Amount Budgeted for Project}}$$

CONTINGENCY OVERRUN

$$\text{Contingency In Excess of Budgeted Amount} = \frac{\text{Actual Amount Spent for Contingency} - \text{Budgeted Amount Spent for Contingency}}{\text{Contract Award Amount Including Estimated Contingency Costs}}$$

CONSTRUCTION ENGINEERING OVERRUN

$$\text{Construction Engineering In Excess of Budgeted Amount} = \frac{\text{Actual Amount Spent for Construction Engineering} - \text{Budgeted Amount Spent for Construction Engineering}}{\text{Contract Award Amount Including Budgeted Construction Engineering Costs}}$$

* Construction engineering and contingency are included in all of the numbers.

Source: JLARC staff analysis.

Table 10 shows the third cost growth factor, developed using the average and the median. The amounts greater than those budgeted for construction engineering and contingency do not sum to the growth factor as a result of some completed projects costing less than the awarded contract. For projects that were completed for less than the contract award amount, contingency values were set to zero for purposes of project cost analysis. Table 11 shows the results of the analysis, broken down by system road type.

Table 10

Average and Median Growth Factors Measuring Cost Change from Contract Award to Final Project Cost

Construction Growth Factor	Average Growth Factor (percent)	Median Growth Factor (percent)
Contract Award to Final Project Cost	11.1	6.5
Contingency in excess of the budgeted 10 percent	7.8	2.0
Construction Engineering in excess of the budgeted 8,12, or 15 percent	5.0	3.4

Source: JLARC staff analysis.

Table 11

Average and Median Growth Factors by Road System Measuring Cost Change from Contract Award to Final Project Cost

INTERSTATE PROJECTS

Construction Growth Factor	Average Growth Factor (percent)	Median Growth Factor (percent)
Contract Award to Final Project Cost (n=12)	18.8	13.6
Contingency in excess of the budgeted 10 percent	10.5	5.0
Construction Engineering in excess of the budgeted 8,12, or 15 percent	10.0	7.0

PRIMARY PROJECTS

Construction Growth Factor	Average Growth Factor (percent)	Median Growth Factor (percent)
Contract Award to Final Project Cost (n=51)	15.7	8.2
Contingency in excess of the budgeted 10 percent	11.8	3.5
Construction Engineering in excess of the budgeted 8,12, or 15 percent	5.9	4.0

SECONDARY PROJECTS *

Construction Growth Factor	Average Growth Factor (percent)	Median Growth Factor (percent)
Contract Award to Final Project Cost (n=124)	9.0	4.8
Contingency in excess of the budgeted 10 percent	6.6	1.4
Construction Engineering in excess of the budgeted 8,12, or 15 percent	4.2	1.8

URBAN PROJECTS

Construction Growth Factor	Average Growth Factor (percent)	Median Growth Factor (percent)
Contract Award to Final Project Cost (n=24)	8.1	6.5
Contingency in excess of the budgeted 10 percent	4.3	2.7
Construction Engineering in excess of the budgeted 8,12, or 15 percent	4.8	3.6

* The sampling error for secondary roads for contract award to final cost, contingency overrun and construction engineering overruns is 2.2 percent, 1.9 percent and 1.1 percent respectively.

Source: JLARC staff analysis.

APPLYING GROWTH FACTORS TO THE SIX YEAR PLAN

In order to meet the requirements of the mandate for this study, JLARC staff examined the extent to which the six year plan underestimates the cost of projects in the plan based on the developed cost growth factors. The growth factors were applied to relevant road construction projects in the six year plan that have not yet been completed. The cost estimates used in the analysis were also adjusted to account for inflation and project costs for which VDOT plans to allocate funds after fiscal year 2006. The growth cost factors applied to each project depended on the status of a project in the design or construction process.

JLARC Staff Determined the Set of Six Year Plan Projects to Which Cost Growth Factors Would Be Applied

The cost growth factors developed by JLARC were applied only to road construction projects that have not yet been completed. The set of relevant road construction projects to which the cost growth factors were applied was drawn from VDOT's two planning documents, the six year plan (maintained by the central office) and the secondary roads development plans (maintained by each county). Through direct access to the PPMS data system and with VDOT staff assistance, JLARC staff determined where each project was in the design or construction process.

Determination of Relevant Projects to Which Growth Factors Were Applied. As explained earlier in this appendix, there were 4,945 projects in the six year plan and the secondary road development plans. JLARC staff removed 2,609 projects from the analysis because construction was complete or the projects were not road construction projects. Table 12 lists the various criteria by

which these projects were removed from the analysis and the number of projects in the two data sources that met the criteria. Because some projects met more than one criterion, the columns do not sum to the total number of projects dropped from the analysis. An additional nine projects were then combined because they were in both the six year and the secondary development plans.

Table 12

Criteria for Removing From the Analysis

Criteria for Removing Projects from the Analysis	**Explanation of Criteria**	**Number of Projects that Meet the Criteria ***	
		Six Year Plan (1,797 Projects)	**Secondary Roads Plan (812 Projects)**
Construction complete	Final cost of the project is known	446	283
No estimate for PE, RW, or CN	No estimates to which growth factors could be applied	66	4
Feasibility study	Project may never be designed or constructed	149	0
Enhancement project	Not road construction projects, but contribute to an aesthetically pleasing environment	341	0
No money is allocated in the six years	Not relevant to scope of study	1160	581
The PPMS System indicated that the PPMS number is invalid	No useable data	15	3
Other non-road construction projects	Projects for landscaping, drainage, etc. that are not considered road construction	164	100
Study only	Projects may never be designed or constructed	15	1
Statewide or countywide project	Projects may have occurred in more than one location	0	9
Railroad Force Authority project	Projects administered by the Railroad Force Authority and not VDOT	1	31

* Projects may meet more than one of the criteria presented in this table.

Source: JLARC staff analysis.

After removing the completed projects and the non-road construction projects, there were 2,327 projects relevant to the analysis. Table 13 summarizes the projects by road system type.

Table 13

Uncompleted Road Construction Projects

Road System Type	Projects
All Projects	2,327
Interstate	94
Primary	289
Secondary	1,704
Urban	237
Unknown*	3

* These are Congestion Mitigation and Air Quality projects for which the PPMS system did not provide the relevant road system type.

Source: JLARC staff analysis.

Determination of Project Status. JLARC staff determined the project status of the 2,327 relevant projects at the time of the analysis. Project status was defined as: not yet initiated, scoping, preliminary field review, plan design, furnishing right of way plans, 100 percent design, or contract awarded. Project status was obtained from several sources, including the PPMS data system, the six year plan, the secondary road development plans, the "Virginia Transportation Act Implementation Status Report," and VDOT staff. If there was conflicting status information, the source indicating that the project was furthest along in the process was used to determine project status.

Table 14 shows the number of projects in each phase by VDOT road type designation. For projects just beginning the location and design phase, the PPMS system did not distinguish between projects that completed scoping and projects that completed preliminary field review. Therefore, JLARC staff

Table 14

Status of Six Year Plan Projects to Which the Growth Factors were Applied

	Number of Projects				
	All	**Interstate**	**Primary**	**Secondary**	**Urban**
Projects Not Yet Started	1141	38	65	962	76
Projects in Location and Design Phase					
Completed Scoping	42	6	10	23	3
Completed Preliminary Field Review	396	8	59	286	43
Completed Field Inspection	129	4	33	64	28
Completed Furnish Right of Way	150	3	51	71	25
Projects in Construction Phase					
Completed 100 Percent Design	118	7	22	71	18
Contract Awarded	191	22	44	96	29
Projects for Which Status Could Not Be Determined	160*	6	7	131	15

Note: There was one project for which road type designation was unknown.

Source: JLARC staff analysis.

requested that VDOT provide the actual status for these projects. The projects for which VDOT could not determine the actual status were conservatively assumed to have completed preliminary field review. There were an additional 160 projects for which JLARC staff could not determine the status from the PPMS system, and VDOT was unable to provide the status. As a result, these projects were dropped from the analysis, leaving 2,167 projects to which growth factors were applied.

Any projects for which the PPMS system indicated that no activities existed were considered pre-scope projects. This assumption can be made because once a project is initiated, VDOT staff in the Programming and Scheduling division enter the relevant activities with projected beginning and

ending dates into the PPMS system. Since there were no activities in the system for these projects, the assumption can be made that the projects had not yet been initiated. Also, for a few projects, there was more than one PPMS number associated with the project and the different PPMS numbers showed the projects to be at different stages of the design or construction process. The PPMS number that was furthest along in the process was used as the indicator for project status.

Growth Factors Only Applied to Projects with 70 Percent or More Funding Allocated in Next Six Years. JLARC staff only applied the cost growth factors to projects in the plan that had more than 70 percent of their total funding allocated by 2006. Historically, VDOT has required that projects have 70 percent of their allocations in place for each phase (preliminary engineering, right of way, and construction) before work on that phase can proceed.

Because some projects in the current plan were scheduled to extend well beyond the six years for which funds are allocated in the current plan, JLARC staff decided to impose a 70 percent rule and include in the analysis only those projects that have at least 70 percent of their total funding allocated by the end of the plan period. Two-hundred and sixty projects were omitted from the analysis based on this decision rule. Results of analyses using only projects with 70 percent of funding allocated by 2006 and using all projects appear later in this section.

Cost Estimates Used in the Analysis Were Adjusted to Remove Costs Not Accounted for in the Current Six Year Plan and for Inflation

In order to address cost growth only in the current six year plan, those costs that VDOT plans to allocate funds to in subsequent years were removed from the analysis. In addition, the inflation factor was removed from the JLARC staff analysis because the data used to create the cost growth factors did not include inflation.

Removing Project Costs for Which VDOT Plans to Allocate Funds Beyond Fiscal Year 2006. VDOT may not have allocated funds in the current six year plan to cover expected costs on projects the department believes will extend beyond the six year plan time frame. This amount, referred to as the "balance to complete," was subtracted from the VDOT estimate of the project cost prior to application of the growth factors.

Removing Inflation from the Six Year Plan Estimates. For the six year plan, VDOT began adding inflation to the cost estimates in the plan based on when each phase was scheduled to begin. The inflation factor was removed from the JLARC staff analysis because the data used to create the cost growth factors did not include inflation, and thus capture cost increases due to inflation. Based on the start date for preliminary engineering, right of way and construction, inflation was removed from cost estimates for each phase using the factors summarized in Table 15. Cost estimates for secondary roads do not include inflation and, as a result, were not adjusted. The VDOT cost estimate

Table 15

Removing Inflation from the Cost Estimates in the Six Year Plan

Start Date for the Phase	VDOT Inflation Factor Multiplied by the Original Cost Estimate to Add Inflation	JLARC Factor Multiplied by the Cost Estimate to Remove Inflation
No Start Date	1	1
Before July 1, 2001	1	1
July 1, 2001 to June 30, 2002	1.0389	.9626
July 1, 2002 to June 30, 2003	1.0778	.9278
July 1, 2003 to June 30, 2004	1.1428	.8750
July 1, 2004 to June 30, 2005	1.2178	.8212
July 1, 2005 to June 30, 2006	1.3028	.7676

Source: JLARC staff analysis of Virginia Department of Transportation inflation factors.

from the six year plan to which JLARC cost estimates are compared, include inflation.

Growth Factors Were Applied to the Six Year Plan Projects

The first set of growth factors (from design activities to 100 percent design) was applied to the cost estimates for preliminary engineering, right of way, and construction for those projects in the plan currently in the location and design phase, as summarized in Table 16. The growth factor applied to these projects depended on which design activity was most recently completed. For projects not yet initiated, the scoping activity growth factors were applied. This was a conservative application because cost estimates developed before scoping are generally lower than cost estimates developed at the scoping stage. At 100 percent design, JLARC staff considered the preliminary engineering and right of way cost estimates to be final. Although VDOT staff indicate that those estimates could grow during the construction phase, they are considered final for

Table 16

Application of Growth Factors to Development Plan Projects Based on Project Status

Growth Factor	1	2	3
Status of Development Plan Project	**Location and Design Activity to 100 Percent Design***	**100 Percent Design to Contract Award**	**Contract Award to Final Cost**
Location and Design Activities			
Scoping	●	●	●
Preliminary Field Review	●	●	●
Field Inspection	●	●	●
Furnish Right of Way	●	●	●
Construction Activities			
100 Percent Design		●	●
Contract Award			●

*The first growth factors are applied to the cost estimates for preliminary engineering, right of way and construction

Source: JLARC staff analysis.

this analysis. The remaining growth factors were then applied only to the construction cost estimates.

The second growth factor (from 100 percent design to contract award) was applied to the cost estimate for construction only (Table 16). For those projects still in the design phase, the second growth factor was applied to the JLARC estimate of 100 percent design calculated by applying the first growth factor. For those projects that had already completed 100 percent design but the contract had not been awarded, the second growth factor was applied to the construction cost estimate in the six year plan. If a project did not have a design plan or only minimum plans but the contract had not been awarded, the project was treated as if it had already completed 100 percent design.

The third growth factor (from contract award to final cost) was applied to all projects (Table 16). With projects for which the contract had not yet been awarded, the third growth factor was applied to the JLARC estimate of the contract amount found by applying the second growth factor. Projects for which the contract had already been awarded, the third growth factor was applied to the actual contract award amount obtained from the Construction division. Table 17 summarizes the number of projects that received each set of growth factors by road system.

The total estimated cost of a project developed by JLARC staff was found by adding together the final construction cost, the final preliminary engineering cost (at 100 percent design) and the final right of way cost (at 100 percent design). This total JLARC cost estimate was compared to the total VDOT cost estimate found in the six year plan (after inflation had been added

Table 17

Number of Development Plan Projects to Which Growth Factors were Applied, by Road System Type

Growth Factors Applied	All Projects	Interstate Projects	Primary Projects	Secondary Projects	Urban Projects
Projects in the Location and Design Phase Growth Factors 1, 2, and 3	884	55	191	466	172
Projects at 100 Percent Design Growth Factors 2 and 3	1092	11	49	1011	21
Projects at Contract Award Growth Factor 3	191	22	44	96	29

Source: JLARC staff analysis.

back in). Table 18 shows the results of the analysis using the average growth factors. Table 19 shows the results of the analysis using the median growth factors. The application of growth factors was also separated by the funding source for the project. Table 20 shows the results of the analysis for projects funded through the Virginia Transportation Act using the average growth factors. Table 21 shows the results for Virginia Transportation Act projects using the median growth factors.

Table 18

Comparison of VDOT Estimated and JLARC Estimated Costs for Road Construction Projects by Road System Using Average Growth Factors

Projects with 70 Percent of Funding Allocated by 2006*

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=1907)	$7,856	$11,354	45
Interstate (n=80)	$2,021	$ 2,911	44
Primary (n=265)	$2,803	$ 4,002	43
Secondary (n=1377)	$1,408	$ 1,963	39
Urban (n=185)	$1,624	$ 2,477	53

All Projects *

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=2167)	$10,427	$16,005	53
Interstate (n=88)	$2,913	$ 4,489	54
Primary (n=284)	$3,297	$ 4,811	46
Secondary (n=1573)	$1,859	$ 2,693	45
Urban (n=222)	$2,357	$ 4,011	70

* The balance to complete dollars were backed out of those projects that were at least 70 percent funded in the six year allocations.

Source: JLARC staff analysis of VDOT cost estimate data.

Table 19

Comparison of VDOT Estimated and JLARC Estimated Costs for Road Construction Projects by Road System Using Median Growth Factors

Projects with 70 Percent of Funding Allocated by 2006*

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=1907)	$7,856	$9,326	19
Interstate (n=80)	$2,021	$2,631	30
Primary (n=265)	$2,803	$3,391	21
Secondary (n=1377)	$1,408	$1,520	8
Urban (n=185)	$1,624	$1,785	10

All Projects *

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors (Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=2167)	$10,427	$12,928	24
Interstate (n=88)	$2,913	$ 4,078	40
Primary (n=284)	$3,297	$ 4,046	23
Secondary (n=1573)	$1,859	$ 2,040	10
Urban (n=222)	$2,357	$ 2,764	17

* The balance to complete dollars were backed out of those projects that were at least 70 percent funded in the six year allocations.

Source: JLARC staff analysis of VDOT cost estimate data.

Table 20

Comparison of VDOT Estimated and JLARC Estimated Costs for Road Construction Projects in the Virginia Transportation Act of 2000 by Road System Using the Average Growth Factors

VTA Projects with 70 Percent of Funding Allocated by 2006*

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors ($ Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=257)	$4,229	$6,218	47
Interstate (n=61)	$1,602	$2,407	50
Primary (n=147)	$2,153	$3,089	43
Secondary (n=4)	$ 85	$ 120	41
Urban (n=45)	$ 389	$ 602	55

All VTA Projects*

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors ($ Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=278)	$5,680	$8,780	55
Interstate (n=67)	$2,304	$3,662	59
Primary (n=157)	$2,598	$3,812	47
Secondary (n=4)	$ 85	$ 120	41
Urban (n=50)	$ 692	$1,185	71

* The balance to complete dollars were backed out of those projects that were at least 70 percent funded in the six year allocations.

Note: JLARC staff excluded from the VTA analysis all transit projects and projects that have completed construction.

Source : JLARC staff analysis of VDOT data.

Table 21

Comparison of VDOT Estimated and JLARC Estimated Costs for Road Construction Projects in the Virginia Transportation Act of 2000 by Road System Using the Median Growth Factors

VTA Projects with 70 Percent of Funding Allocated by 2006*

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors ($ Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=257)	$4,229	$5,286	25
Interstate (n=61)	$1,602	$2,144	34
Primary (n=147)	$2,153	$2,610	21
Secondary (n=4)	$ 85	$ 96	13
Urban (n=45)	$ 389	$ 436	12

All VTA Projects*

Road System	Project Costs Identified in the 2001 Development Plan (Millions)	Project Costs Calculated Using JLARC Cost Growth Factors ($ Millions)	Percentage Increase in Costs Based on JLARC Cost Growth Factors (%)
Overall (n=278)	$5,680	$7,410	30
Interstate (n=67)	$2,304	$3,291	43
Primary (n=157)	$2,598	$3,194	23
Secondary (n=4)	$ 85	$ 96	13
Urban (n=50)	$ 692	$ 829	20

* The balance to complete dollars were backed out of those projects that were at least 70 percent funded in the six year allocations.

Note: JLARC staff excluded from the VTA analysis all transit projects and projects that have completed construction.

Source: JLARC analysis of VDOT data.

TIME ANALYSIS

JLARC staff also examined the time needed to design and complete road construction projects. This analysis was based on data from the same projects used to conduct the cost analysis. The first analysis examined the time

needed to complete the design process. The second analysis examined the time required to complete construction.

Analysis of Time Needed to Complete the Design Phase

In analyzing the time needed to complete the design phase, JLARC staff used the same road construction projects used to develop the location and design cost growth factors. Time information was available for 82 of the 86 road construction projects. Using this information, JLARC staff calculated the average number of years it took for these projects to progress from scoping to 100 percent design (Table 22).

Table 22

Average Years to Complete Design Process

Road System	Average Years	Minimum Number of Months	Maximum Number of Months
All Design Projects (n=82)	3.0	1.0	137.8
Interstate (n=6)	2.0	1.0	49.3
Primary (n=28)	2.5	6.1	115.8
Secondary (n=38)	2.9	9.4	137.8
Urban (n=10)	5.5	12.5	87.2

Note: Includes all interstate projects that completed design in the last four fiscal years and all primary, secondary, and urban projects that completed design in the last two fiscal years for which data were available.

Source: JLARC staff analysis.

Analysis of Time Needed to Complete Construction

JLARC staff also performed an analysis of the time needed for projects to complete construction once that process had started. The data used for this analysis were from the same projects used in developing the construction cost growth factors (there was one construction project for which VDOT did not provide time data). Using this information, JLARC staff calculated several

measures, including the original, extended, and overall number of months required to complete projects.

Table 23 indicates the type of time data that was collected from the VDOT Construction division for this analysis. JLARC staff used the data provided by VDOT to develop several time measures. For example, the original number of months approved to complete construction was calculated separately for calendar days and fixed date contracts. For calendar days contracts, the number of months available for the contract was simply the calendar contract limit in days, as provided by VDOT, and converted to months. For fixed date contracts, the number of months available for the contract was determined by subtracting the actual date the contractor proceeded with the contract from the fixed contract limit date of expected completion and converted to months.

The number of months contracts were extended was determined by calculating the difference between the date of the extended contract limit and the

Table 23

Construction Data Collected Concerning Length of Time to Complete Projects

Construction Activity
Actual Date Contractor Proceeded
Whether Project was a Calendar or Fixed Date Contract
Calendar Contract Limit in Days
Fixed Contract Limit Date of Expected Completion
Date of Extended Contract Limit
Date Construction Was Actually Completed
Approved Overruns in Days
Approved Work Orders in Days
Approved Shutdowns in Days (For Calendar Date Projects Only)

Note: Data supplied by VDOT were converted from days into months by JLARC staff using 30.4 as the average number of days per month.

Source: JLARC staff analysis.

original number of months approved to complete construction. Approved extra months represent the sum of work orders, shutdowns, and overruns. Total months approved for construction equals the sum of original and extended months approved for construction. Finally, months to actually complete construction were calculated by subtracting the actual date the contractor proceeded with work from the date the construction was actually completed.

Because fixed date contracts do not provide extra time for shutdowns (presumably that is built into the original time limit), those values were set as missing for purposes of calculating approved shutdown days. As a result, the number of projects analyzed in this category was fewer than 210. However, in order to calculate the overall extended time limit, these same values were set as zero. Adding zeros into the mean equation for extended time has the effect of reducing the average. For this reason, the sum of the average VDOT approved shutdown and extra construction months does not equal the extended time limit in Tables 24 through 26.

Table 24 indicates the average length of time needed for each activity as well as the number of projects analyzed. Table 25 reflects the time needed to complete construction based on whether the contract is calendar days or fixed date. Finally, Table 26 indicates construction time by road system in number of months.

Table 24

Average Number of Months to Complete Construction

Measurement of Time	Average Months to Complete	Number of Projects
Original Time Limit	7.0	210
Extended Time Limit	6.8	210
VDOT Approved Shutdowns	4.9	170
VDOT Approved Extra Construction (Work Orders and Overruns)	2.8	210
Total Months Approved for Construction	13.8	210
Months to Complete Construction	13.2	210

Source: JLARC staff analysis of Virginia Department of Transportation construction completed project data.

Table 25

Average Number of Months to Complete Construction by Contract Type

Measurement of Time	Average Months to Complete Calendar Day Contracts (n=170)	Average Months to Complete Fixed Date Contracts (n=40)
Original Time Limit	5.1	15.0
Extended Time Limit	6.5	8.2
VDOT Approved Shutdowns	4.9	NA*
VDOT Approved Extra Construction (Work Orders and Overruns)	1.5	8.2
Total Months Approved for Construction	11.6	23.2
Months to Complete Construction	10.7	23.9

* Fixed date contracts do not provide extra time for shutdowns.

Source: JLARC staff analysis of Virginia Department of Transportation construction completed project data.

Table 26

Average Number of Months to Complete Construction by Road System

Interstate System

Measurement of Time	Average Months to Complete	Number of Projects
Original Time Limit	12.0	11
Extended Time Limit	8.9	11
VDOT Approved Shutdowns	7.0	4
VDOT Approved Extra Construction (Work Orders and Overruns)	6.3	11
Total Months Approved for Construction	21.0	11
Months to Complete Construction	21.9	11

Primary System

Measurement of Time	Average Months to Complete	Number of Projects
Original Time Limit	9.8	51
Extended Time Limit	8.5	51
VDOT Approved Shutdowns	6.0	32
VDOT Approved Extra Construction (Work Orders and Overruns)	4.7	51
Total Months Approved for Construction	18.3	51
Months to Complete Construction	18.3	51

Secondary System*

Measurement of Time	Average Months to Complete	Number of Projects
Original Time Limit	4.7	124
Extended Time Limit	5.3	124
VDOT Approved Shutdowns	4.3	116
VDOT Approved Extra Construction (Work Orders and Overruns)	1.2	124
Total Months Approved for Construction	9.9	124
Months to Complete Construction	9.0	124

Urban System

Measurement of Time	Average Months to Complete	Number of Projects
Original Time Limit	10.8	24
Extended Time Limit	10.1	24
VDOT Approved Shutdowns	5.9	18
VDOT Approved Extra Construction (Work Orders and Overruns)	5.6	24
Total Months Approved for Construction	20.9	24
Months to Complete Construction	20.4	24

*The sampling error for secondary roads averages in the order they appear above are 1.6 percent, 1.8 percent, 1.5 percent, 0.4 percent, 3.3 percent, and 3 percent.

Source: JLARC staff analysis of Virginia Department of Transportation construction completed project data.

Appendix D

Agency Responses

As part of the extensive data validation process, State agencies involved in a JLARC assessment effort are given the opportunity to comment on an exposure draft of the report. Appropriate technical corrections resulting from written comments have been made in this version of the report. This appendix contains the response from the Commissioner of Transportation.

DEC 14 2000

COMMONWEALTH of VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, 23219-2000

CHARLES D. NOTTINGHAM
COMMISSIONER

December 14, 2000

Mr. Philip A. Leone, Director
Joint Legislative Audit and Review Committee
Suite 100
General Assembly Building
Richmond, Virginia 23219

Dear Phil:

Although we appreciate the work and efforts of your staff, we take serious issue with the analysis and conclusions in this report that continue to perpetuate the old way of viewing transportation planning and programming in the Commonwealth. Due to the extremely limited amount of time that we were afforded to review this lengthy report, I am only able to expound on the most obvious and glaring problems.

In the past few years many changes have taken place in the policies and procedures that govern transportation in Virginia. Through the use of the Public Private Transportation Act we are planning, designing and building certain key transportation projects using new and innovative methods quite different from the past. These changes have allowed projects to be built faster and under different financing mechanisms reaping the benefits of cost savings and other efficiencies for the taxpayers of Virginia.

Many of the recommendations of the Governor's Commission on Transportation Policy have been implemented to bring more credibility into the planning and programming process through the use of a new divided planning and programming format, using a Feasibility phase and a Capital Improvement phase. We have also instituted the use of inflationary factors to give the citizens of Virginia more realistic cost estimates.

On December 13, Governor Gilmore unveiled a bold and innovative transportation reform initiative, designed to save time and money in the project development process. This initiative along with many of the other changes in our policies and procedures mark the new way of thinking in transportation in Virginia that is carried forward in our new Virginia Transportation Development Plan (VTDP). Therefore, we believe the concerns raised in this report have already been addressed.

Again, as mentioned earlier, the VTDP incorporates a new format as recommended by the Governor's Commission on Transportation Policy, along with new funding sources and new priorities from the Virginia Transportation Act of 2000(VTA). Incorporating the VTA into the plan was a long and complex process. To ensure that we could properly merge the two following the strict guidelines set forward by the General Assembly, it was necessary to change the old way of building the plan and create a new approach.

Attachment 2 provides detailed comments on our concerns detailing the background of the project development and delivery process, JLARC staff's growth factors, the Virginia Transportation Development Plan, various issues presented in the exposure draft, and recommendation-by-recommendation responses. The most significant concerns with the analysis can be summarized as follows:

- JLARC does not recognize the significant changes to both the project development and programming processes that have occurred in recent months.

- JLARC does not factor the impact of project delays due to no fault of VDOT, nor does the report recognize the potential loss of federal funds if we fail to plan for a certain amount of unexpected project development delay. If the Department did not maximize the number of projects in the VTDP, the Department would not be able accelerate additional projects. Attachment 1 provides examples of projects that have been delayed due to environmental permitting, litigation, utility relocation issues, and responses to requests for local government changes.

- It is critical to note that not all projects will go forward on schedule as a result environmental permitting, litigation, utility relocation issues, and responses to requests for local government changes. Therefore, it is important to maximize projects in the plan to fully utilize our federal assistance dollars.

- The application of your growth rates, both average and median growth, grossly overestimates project costs. JLARC staff's use of median and average growth rates results in a wide range of "overstatement" from $1.7 billion to $3.6 billion, underscoring the unpredictability and complexity of project estimation.

- The analysis performed by JLARC was based on "old" plans, not our revised plan development process, thus overstating the cost estimating impact. For example, using your analysis, we can provide a case study of the Route 288 project (see chart below), which highlights significant flaws in your methodology and resulting assumptions. The PPTA agreement between VDOT and the Koch Materials/APAC team is a fixed price (no workorders), fixed date ($25,000 per day late penalty) contract. The JLARC staff estimating formula predicts that Route 288 will actually cost taxpayers $395.5 million, approximately $108.1 million (+38%) more than appears in the Virginia Transportation Development Plan. Considering the final negotiated amount, the project would have been overstated by $169.5 million (+59%).

Route 288 Project Estimation

VTDP Estimate 9/00	Estimate Using JLARC Growth Factors 11/00-12/00	Diff. Between JLARC Estimate & VTDP	Actual Negotiated amount through PPTA 12/00	Diff. Between JLARC Estimate & Actual Negotiated Contract compared to VDTP Estimate
$287.4 million	$395.5 million	+38% ($108.1 mil.)	$226 million*	+59% ($169.5 mil.)

*Figure does not include $10 million for warranty and maintenance agreement

Thank you for the opportunity to respond to the report. If you have any questions regarding our response, please call me.

Sincerely,

Charles D. Nottingham

Attachments

Attachment 1

JLARC staff's analysis mistakenly assumes that all VDOT projects will trigger full construction costs on schedule. This chart identifies a sampling of recent projects that have encountered delays due to no fault of VDOT. Failure to recognize this reality results in an extremely negative and inaccurate projection of VDOT's six year financial obligations.

RECENT OR PENDING PROJECTS DELAYED DUE TO CIRCUMSTANCES BEYOND VDOT'S CONTROL*

Project Description	Prev. Adv.	New Adv.	Estimated Cost
Route 17 City of Chesapeake	7/01	9/02	$70,000,000
Pinner's Point Interchange City of Portsmouth	7/95	6/01	$172.000,000
Gilmerton Bridge City of Chesapeake	3/99	7/03	$65,000,000
Charlottesville Bypass	7/01	7/03	$115,000,000
Rte 95/Atlee-Elmont Intg.	5/90	7/00	$62,000,000
Chincoteague Bridge Accomac	3/99	3/03	$40,000,000
Armistead Ave. Connector City of Hampton	7/00	1/04	$48,000,000
Warwick Blvd. City of Newport News	1/01	1/04	$34,000,000
Main Street Bridge City of Danville	1994	9/00	$24,000,000
Rte 125 King's Hwy. Bridge City of Suffolk	10/99	3/03	$20,000,000

Other projects which have encountered substantial delays and no longer have an advertisement date include:

Southeastern Expressway Cities of Chesapeake & Virginia Beach	$400,000,000

Outer Connector (NW Quadrant) Stafford & Spotsylvania Counties	$112,000,000

***This is a representative sampling of projects-not a complete list.**

Attachment 2 – Additional Comments on JLARC Report

Background

To understand some of the driving forces behind the development of a six-year transportation plan, one must understand the project development and delivery process, and the forces that drive the project programming.

Beyond the requirements to provide for the public safety and to preserve our transportation infrastructure, the Virginia Department of Transportation has two primary functions relating to system improvement. These are to provide new transportation projects as quickly as possible and to maximize the resources available for the benefit of the people of the Commonwealth. In order to accomplish these two functions, any state transportation agency must include in its project plan the maximum number of projects, which would include allowances for project delays, that it is likely to achieve within the a financially constrained program. This is necessary because in any state transportation program, there will always be some projects that will not be ready as scheduled due to varying factors including environmental permitting, litigation, utility relocation issues, local government requests, and responses to requests for change as a result of public involvement. If this maximum transportation target were not included in the six-year plan of a state transportation agency, two extremely undesirable outcomes could occur:

1. The state would not be able to obligate all of the federal revenues available to it. This would mean that some revenue from the federal reimbursement program would be forfeited. VDOT has an outstanding record of utilizing all the available federal funds and has never allowed any obligated funds to lapse. Because VDOT maintains an effective strategy in programming projects, the Commonwealth has benefited from receiving federal funds redirected from other states which were not in a position to fully obligate their federal apportionments. For example, in September 2000, VDOT received an additional $4.3 million of funds previously obligated to other states. We are proud of this record because it allows us to deliver more transportation products to the citizens of Virginia.

2. VDOT would not be able to deliver the maximum amount of transportation program to the people of Virginia. If a program were to be developed without this maximum target level, then when projects are delayed, there would not be other projects ready to fill the gaps. This would reduce the product put in place in each year and would have an incremental inflation impact upon the projects delayed unnecessarily.

Initiating the maximum number of projects in a federally constrained program is a necessity to keep from losing federal funds. We neither condone nor practice

underestimating to achieve this objective; rather, critical stages of a project should be properly estimated and funded so that it could be activated, if needed. This could lead someone unfamiliar with our estimating process to conclude that we cannot fund the projects in the program. VDOT's experience, as with other state highway agencies, suggests that a significant number of federal fund eligible projects will not be allowed to proceed on schedule due to environmental permitting, litigation, utility relocation issues, local government change requests, or other unanticipated delays.

The second significant JLARC staff assumption that would indicate that VDOT has grossly underestimated future cost is to assume that the way VDOT worked in the past is the same as it works today. That assumption is also not valid as VDOT has made significant changes in how it estimates initial project costs so that most of the problems described in this report are no longer evident.

The third significant JLARC staff assumption that is no longer valid is that the six-year program is static and does not change. The fact is that the program is an ever-changing document as new information about project development and cost surfaces. The estimated project cost of every project is reviewed and adjusted annually.

Growth Factors

The exposure draft indicates that JLARC's estimated project cost, depending on the statistical measure used median growth rates versus average growth rates ranges from $1.7 billion to $3.6 billion more than the estimates included in the VTDP. The wide range reported by JLARC staff underscores the unpredictability and complexity of project estimation. While we understand the methodology of using growth factors to inflate the project estimates included in the VTDP, it is important to understand that the estimating process is complex and JLARC's methodology is probably not an accurate predictor of the true project estimates. For example, VDOT changed its own estimating process approximately two years ago to more accurately reflect the estimated project cost in the VTDP. If JLARC's growth factors were applied against VDOT's revised estimates the results would be misstated. However, the Department recognizes the intent of your report is to demonstrate that underestimating project cost could have an impact on the VTDP; but, as our revised estimating process is matured, our estimates better reflect the ultimate project costs.

The application of growth factors is more dynamic than static, and utilizing straight-line historical trends to predict future costs can be misleading in light of the revised process and the most recent utilization of the Virginia Public-Private Transportation Act (PPTA). For example, the Department has just completed negotiation of a fixed price/fixed date contract for the completion of Route 288. The value of this contract as shown in the VTDP for the construction of this project is $249 million (not including at least $10 million in improvements subsequently necessitated by the Capitol One, Inc. headquarters location announcement). There is an additional amount of approximately $4.2 million in the VTDP for completion of the PE work that is currently

in progress. The Department has come to a negotiated total for the completion of this project, both construction and design, as well as a 20-year warranty with an estimated value of $10 million, for a total of $236 million. If JLARC staff's growth factors were applied to the Route 288 project, the estimates contained in the VTDP would be greatly overstated based on recent experience.

Virginia Transportation Development Plan

The Virginia Transportation Development Plan (VTDP) represents the Commonwealth Transportation Board's construction-allocation plan for a six-year period. JLARC staff's evaluation took a snap shot of VDOT's project history and projected future project cost. While historical trends are often used by analysts as an indicator of the future, there are many other factors affecting the estimating process. As a result, we should be very cautious in assuming that the project estimates in the VTDP are grossly understated. Our goal is to have a balanced program that takes advantage of every state and federal dollar available to build construction projects. In fact, VDOT annually reviews every component of the VTDP and adjusts it based on the most current available information. Therefore, if project costs were greater than originally estimated, the plan would be adjusted to accommodate the cost and delay projects, if needed. This is a self-balancing function that takes into account the most recent revenue estimate, project cost adjustments, and physical developments. We recognize that in the past our estimating process needed improvement and we have made substantial adjustments. We have addressed this more fully in the response to JLARC's recommendations.

The current approved plan is for the fiscal years beginning FY 2001 and ending FY 2006. We believe the current controls and changes to the estimating process, implemented approximately two years ago, will prevent grossly underestimated project costs. There are three basic steps involved in updating the plan:

- Revenue is re-estimated using the state revenue estimate provided by the Department of Motor Vehicles (DMV) and others. This independent review of VDOT's revenue estimate assures that we are conservative and incorporating the most current changes in state and federal legislation. This allows for VDOT to accommodate revenue adjustments such as the future open container penalty during the year it becomes a legislative mandate.

- Project estimates are updated to reflect changes in quantities and scope. Throughout the project development life cycle, engineering and changes as a result of environmental permitting, litigation, utility relocation issues, local government change requests, and responses to requests for change as a result of public involvement can cause adjustments in the final design of a facility. For instance, a locality may request a redesign of an interchange to include additional ramps, which were not in the original estimate. However, estimates could change as a result of public input. These changes are usually financed by VDOT.

However, in some cases the locality will finance the changes. Developing growth factors to predict these types of human behaviors will be difficult to accomplish.

- Start and completion dates of projects are re-examined and adjusted for the preliminary engineering, right of way, and construction phase. This process accounts for physical development delays that have occurred over the last year on specific projects. New, unforeseen developments such as lawsuits and regulatory delays are also factored into the update.

Once we have adjusted the program for new revenue, revised cost estimates and project development problems, we are at the point where, in JLARC's assessment, difficult choices must be made on which projects receive the available resources because of increased cost projections. While this is not an easy task, the Commonwealth Transportation Board with input from the public, elected officials and VDOT staff make these decisions.

Various Report Issues

Issue 1: On page 49 of the exposure draft, JLARC states, " Underestimation of costs and questionable assumptions underlying the plan means that there will be inadequate funds for the projects in the six year plan. The plan appears to underestimate maintenance costs over six years..."

Response to issue 1: VDOT builds its maintenance budget "from the ground up" each biennium. Maintenance appropriations for the 2000-2002 biennium grew 11% over the previous biennium, and maintenance appropriations are at the highest levels ever. We are not using old models and assumptions in the face of rapidly changing materials and maintenance management technologies, not to mention the revised funding sources contained in the Virginia Transportation Act of 2000.

The common name for the question the staff analysis raises is "crossover", or the point where maintenance funding will take dollars out of construction. VDOT's models have predicted this for years and years, yet it has never occurred. The reason it has never occurred is that normal annual revenue growth has always more than covered any projected shortfalls. To simply assume that maintenance funding will grow annually at a rate of 1-2%, totaling $158.9 million over six years in the staff analysis, does not reflect the changing economic conditions.

Instead of assuming that maintenance costs will grow each year, we are looking for ways to reduce these costs while still providing the highest-possible level of service. Our experience with privatized interstate maintenance provided by VMS, Inc. has already taught us that by applying innovative management and cutting-edge technology using state-of-the-art materials, it is possible to provide better quality at a lower cost. We have a five year, fixed price contract with VMS. The cost of this contract does not blindly grow year after year.

Implementation of new and innovative ways to maintain VDOT's infrastructure has resulted in substantial savings to the Maintenance Program. For example, savings generated by changing from the conventional methods of patching potholes to the new mobile pothole patching are as follows:

	Conventional	Mobile	% Reduction
Cost per patch	$120	$22	82%
Cost per lane mile	$900	$38	96%
Cost per ton	$5,900	$880	85%

This mobile patching is currently being used and we will be expanding to the entire state.

Issue 2: On page 60 of the exposure draft, JLARC states that VDOT has assumed that dedication of revenue for mass transit from the federal Surface Transportation program will cease after the current biennium.

Response to issue (2): Language contained in Item 506 of Chapter 1073 of the 2000 Virginia Acts of Assembly (the 2000-2002 Appropriation Act) directs that 6% of federal Surface Transportation Program funds and 10% of federal Minimum Guarantee funds be set aside for transit purposes. The same or similar language is not, however, contained in the Virginia Transportation Act of 2000. We follow this 6%/10% set-aside in the Plan for fiscal years 2001 and 2002 per the Appropriation Act language. However, we have no basis for continuing this set-aside beyond FY 2002, as there is no statutory language so stating. Should the General Assembly take action to permanently codify this language, we will adjust the Plan accordingly. In either case, the $61.9 million associated with this provision will remain in the plan, with the only difference being whether it will be spent on highway or transit projects.

Issue 3: On page 61 of the exposure draft, JLARC states that VDOT makes no allowance in its plan for the penalty of not having adopted open container law.

Response to issue (3): Our Plan assumes that the impact of Virginia's not adopting federally-mandated "open container" legislation will not continue beyond FY 2002. It is equally important to note that even now, these funds are not lost to Virginia; they must simply be used for safety purposes. These purposes may include hazard elimination on roadways such as straightening dangerous curves. You will find in the VTDP several million dollars worth of these hazard elimination projects. We are comfortable with this assumption because we believe that either Virginia will adopt an open container statute in the next two years, or that when the federal highway and transit funding program comes up for reauthorization in Congress in 2003, this provision will be eliminated. Virginia is among a majority of states that have not adopted open container legislation, and based on our success in building a coalition of states to address issues when TEA-21 was adopted in 1998 (the current federal authorization bill), we believe that we will prevail in eliminating this onerous provision. In any event, using the $60.3 million in question for

hazard elimination projects retains the funds in the program and can substantially offset any impact from the open container provision.

Issue 4: On page 62 of the exposure draft, JLARC states that it appears VDOT has not properly allocated FRAN funds to projects that do not qualify under law to receive FRAN funding.

Response to issue (4): There is approximately $850 million shown in the legislation in general funds but there is only approximately $550 million currently appropriated or planned. To make up the difference and keep the program in the plan, it became necessary to substitute FRANs for general funds in the amount of approximately $300 million. Since there has never been an intention to utilize FRANs on projects not in the Priority Trust Fund, the VTDP will have to be adjusted by this amount if the General Assembly does not make some changes in the VTA during the next session. Since this funding in the plan was used as a placeholder with no intention to utilize FRANs on these projects, but was rather intended to give the assembly the opportunity to advise the Department as to how to handle the perceived imbalance in the VTA, there was never a plan to issue these bonds and, therefore, no need for a planned reimbursement.

Responses To Recommendations

Recommendation (1): The Virginia Department of Transportation should review the cost estimation process to determine if additional measures can be taken to improve the accuracy of the process. This should include the development of clear standards regarding the incorporation of incidental items and contingencies in cost estimates in order to improve the consistency of the estimation process.

Response to Recommendation (1): We have made numerous changes that address the issues associated with estimates. To provide background for those changes, we instituted a study of the scoping process in spring of 1996. This study was an effort to improve and enhance the scoping process and identify methods that would eliminate "scope creep" on projects. This report was completed in May of 1997 and was a first step in the evolution of purpose, need and estimate changes for projects.

The new process was discussed at statewide meetings along with the recommendations of the consultant conducting the business process reengineering of the plan development process. October 1998, a new instructional memorandum on the Initial Field Review/Project Scoping was executed. Consequently the projects, which have received their scoping prior to that date, would not have had estimates addressed as they are today.

As a result of using projects advertised within the last two years, a large number of projects scoped well in advance of the changes made in the plan development process would be reviewed. Consequently, this can and will skew the results. This will also

cause large fluctuation in the data, which is exacerbated by using the average growth factors in view of the median growth factors.

The difference between these factors changes the analysis regarding the understating of the Virginia Transportation Development Plan from $3.6 billion to $1.7 billion. For those projects in the VTA it would change the analysis from $2.1 billion to $1.2 billion. Although this exceeds our expectations for the appropriations of our estimates, it may more closely represent the program.

Consequently, we agree with recommendation number one and will continue to monitor and track the estimation of projects at various stages, making adjustments in the process to address the issues.

Recommendation (2): The Virginia Department of Transportation should review the preliminary engineering process to assess whether there is adequate management of project design contracts and whether there are adequate procedures in place to minimize errors made in the design of road construction projects. In addition, the department should review whether the preliminary engineering performed for highway construction projects includes an adequate examination of subsurface as well as other field conditions to ensure that all detectable conditions that may impact construction are discovered during the design phase.

Response to Recommendation (2): With regard to design errors and omissions, VDOT has a design plan quality evaluation as a part of its strategic outcome area. This evaluation addresses eight items and is completed on all construction projects. We recognize that there are projects which have errors, and that must be addressed during

construction and work diligently to use these projects as becoming tools to improve our design. For projects designed "in-house" the project designer performance evaluation is used to address this errors on process. On consultant projects, the consultant firm is placed on notice of liability for design errors. At the present time and in addition to other firms on notice there are two firms representative of projects in the report on notice of liability for design errors. For two of the firms on notice the potential liability is $1.5 million.

Recommendation (3): The Virginia Department of Transportation should examine why project construction and construction engineering costs exceed the budgeted contingencies and what measures can be taken to reduce the amount by which contingency amounts are exceeded. Additionally, the department should review whether it adequately budgets for construction contingencies, construction engineering, and other miscellaneous construction expenditures.

Response to Recommendation (3): The Department is by the BPR process making an improved effort to identify what the proper budget should be for a construction project.

Additional means are being taken to identify areas that typically have shortfall in our assessment of quantities and to identify design techniques that would help to close the gap on these shortfalls. Through early involvement, we can ensure that we have the proper estimate, including the contingency costs for all projects. There needs to be ways of identifying additional items that are done for municipalities and other outsource billed items so that they are not charged against the contingency costs of the project in our accounting process. Construction Engineering should always manage to stay within the budgeted amount. There are controls to ensure each year that we review the construction engineering costs related to jobs and that cost containment methods should be applied to ensure that these costs are not exceeded.

Recommendation (4): The General Assembly may wish to consider directing the Virginia Department of Transportation to submit the most recent cash flow forecast, along with assumptions on which the forecast is based, to the Senate Finance and House appropriations committees on a quarterly basis. The General Assembly may also wish to require the department to regularly report to the committees any projects for which advertisement has been delayed because of cash flow shortages.

Response to Recommendation (4): The Department is currently in the process of refining the cash-flow forecast process. Once completed, the Department would be willing to share information in a more timely manner.

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