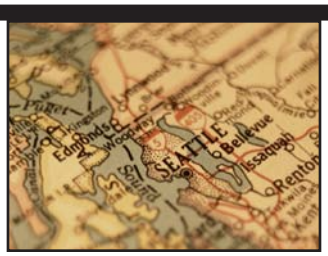
Performance Audit Report

Washington State Department of Transportation

Managing and Reducing Congestion in Puget Sound

Report No. 1000006



October 10, 2007

Washington State Auditor Brian Sonntag, CGFM

A letter from State Auditor Brian Sonntag

Brian Sonntag, CGFM
Washington State Auditor

The 2006 Legislature directed the State Auditor's Office to conduct comprehensive performance audits of transportation-related agencies in Washington during fiscal year 2007. This performance audit report is the second of four performance audits that, collectively, will give an overview of the state transportation system.

Washington citizens overwhelmingly told us in 2006 that transportation is one of their top three priorities, along with education, health and social services. Eighty percent of the citizens we surveyed in the Puget Sound region rated congestion as their top transportation priority.

Congestion incurs incredible costs in terms of time lost due to congestion, fuel consumption, environmental costs and freight costs, which drive up consumer prices.

This report, conducted on our behalf by Talbot, Korvola and Warwick, LLP, makes it clear that congestion in the Puget Sound is a solvable problem. Many of the solutions can be addressed in the next five years and within the Department's existing resources. Other solutions will take longer and will require more significant investments.

One of the most significant findings in this report is that the Department and the Legislature must make congestion a priority and tie budgetary and other decisions to projects that will improve congestion. Citizens have identified congestion as a priority and therefore, so must the Department and the Legislature.

The Legislature is key to instituting the recommendations. Some of the recommendations in this audit report cannot happen without legislative action.

I would like to thank the firm that conducted the audit; it brought years of experience and professionalism to this audit. Talbot, Warwick and Korvola, LLP hired subject-matter experts who have internationally recognized experience in traffic and congestion management. That expertise added invaluably to the quality of the work.

Improving congestion in the Puget Sound region is an achievable goal. To do so, the Department and the Legislature must heed the recommendations in the report. Instituting those recommendations will require ongoing work and different approaches, but the end result will improve the quality of life for millions of people.

About the audit

Why did we select this audit?

In 2006, the Legislature passed a bill directing the State Auditor's Office to conduct independent, comprehensive performance audits of transportation-related agencies. The legislation, ESSB 6839, appropriated $4 million to the Office to contract for this work between June 2006 and June 2007. The bill passed the Senate 44-2 and the House 92-6, and was signed into law by the Governor.

This audit is one of four the Office is conducting under the law. The others included in this comprehensive package are Washington State Ferries, which was released in September 2007, and the Department of Transportation's administrative operations and highway maintenance and construction management, both scheduled for release in Fall 2007.

These audits were chosen based in part on extensive outreach with citizens, including focus groups and town hall meetings, in which they identified traffic congestion and accountability for projects as their concern. During the course of these audits, our Office and the contractor met with Department of Transportation management and employees and with numerous groups and individuals wishing to share their perspective on the state's transportation system.

About the audit

This audit was conducted by Talbot, Korvola and Warwick, LLP and its subcontractors from April 2007 to October 2007 and was performed in accordance with generally accepted government performance auditing standards. The audit addressed the nine elements in Initiative 900 and the objectives outlined in the legislation to examine:

- The effectiveness of the Department of Transportation's current highway investments and infrastructure usage given current and projected highway user volume over the next five years.
- The financial and non-financial costs of any recommended improvements over the next five years.

Overall conclusion

The report states that over the next five years, taking the following actions could reduce hours of traffic delay by 15 percent to 20 percent — 12 million to 16 million hours — saving the average commuter some 10 hours of delay each year and the region some $300 million to $400 million in travel time and vehicle operating costs per year. In addition, the environmental and economic impacts of reduced vehicle emissions and improved access between employees and employers could potentially reach $300 million to $400 million, for a total economic impact to the Puget Sound region of $600 million to $800 million per year.

Those actions are:

- Investments to improve vehicle flow using existing infrastructure and resources.
- Increasing efforts to have people use carpools, transit and telecommuting.
- Coordinating traffic lights on major arterials.
- Continuing to improve operational efficiency.

The audit found that in the long term:

- The ability to manage congestion will require adding new lanes of highway.
- A commitment to reducing congestion is needed from the Department and the Legislature, with goals and milestones that can be tracked. This is similar to what other states have done.
- Transportation investments — highways and transit alike — should be measured, in part, based on how many hours of delay can be reduced for each million dollars of investment.
- The Department should make reducing congestion a primary goal. While the Department has been a national leader in many aspects of congestion management, it has not identified reducing congestion as a priority. Reducing congestion would complement the Department's current primary priorities, which are:
    - Safety
    - Maintenance
    - Preservation
    - Environment
    - Economic vitality

  A clear commitment to reducing congestion — after meeting safety requirements — would likely shift investment decisions.

About the auditors

Talbot, Korvola & Warwick, LLP and subcontractors Delcan Corporation and PlanB Consultancy, the firms that performed this audit, are internationally recognized for their audit and consultancy work in state, federal and international transportation. Members of the audit team have more than 200 years' cumulative experience auditing transportation systems.

Our audit authority

The complete text of Initiative 900 is available at www.sao.wa.gov/PerformanceAudit/PDFDocuments/i900.pdf.

The full text of ESSB 6839 is available at www.sao.wa.gov/PerformanceAudit/PDFDocuments/6839-S.SL.pdf.

Washington voters approved Initiative 900 in November 2005, giving the State Auditor's Office the authority to conduct independent performance audits of state and local government entities on behalf of citizens. The purpose of conducting these performance audits is to promote accountability and cost-effective uses of public resources.

Additionally, the Legislature passed Engrossed Substitute Senate Bill 6839 in 2006. The legislation required the Auditor's Office to hire contractors to conduct performance audits of transportation-related agencies.

The State Auditor's Office engaged Talbot, Korvola & Warwick, LLP to conduct this performance audit in accordance with Government Auditing Standards. Those standards require that the auditor plan and perform the audit to obtain sufficient, appropriate evidence that provides a reasonable basis for the findings and conclusions based on the audit objectives. The audit team believes that the evidence provides a reasonable basis for the findings and conclusions based on the audit objectives.

In planning the audit, the auditors gained an understanding of internal controls that relate to audit objectives. The results of the internal control work did not impact the nature, timing or extent of the audit procedures.

No privileged or confidential information was omitted in this report.

After the performance audit

Notices of public hearings are posted with the report at www.sao.wa.gov/PerformanceAudit/audit_reports.htm.

The release of this audit report triggers a series of actions by the Legislature in accordance with I-900. The appropriate committee or committees will take the following actions:

- Hold at least one public hearing within 30 days of this report's issuance to receive public testimony on the report.
- Consider the findings and recommendations contained in this report during the state budgeting process.
- Issue an annual report by July 1 detailing the Legislature's progress in responding to the State Auditor's recommendations. The report must justify any recommendations the Legislature did not respond to and detail additional corrective measures taken.

Follow-up performance audits of any state or local government entity or program may be conducted when determined necessary by the State Auditor.

Objectives and Scope

Objectives

The audit was designed to determine:

1. The effectiveness of WSDOT's current highway investments and infrastructure utilizations given current and projected highway user volume over the next five years; and
2. The financial and non-financial costs of any recommended improvements over the next five years.

In particular, this audit seeks to evaluate how current highway investments and infrastructure and possible highway investments and infrastructure can:

- Minimize congestion for the greatest possible majority of highway users.
- Maximize vehicle throughput.
- Maximize highway user throughput.

Additionally, Initiative 900 directs the State Auditor's Office to address the following elements:

1. Identification of cost savings.
2. Identification of services that can be reduced or eliminated.
3. Identification of programs or services that can be transferred to the private sector.
4. Analysis of gaps or overlaps in programs or services and recommendations to correct them.
5. Feasibility of pooling the entity's information technology systems.
6. Analysis of the roles and functions of the entity and recommendations to change or eliminate roles or functions.
7. Recommendations for statutory or regulatory changes that may be necessary for the entity to properly carry out its functions.
8. Analysis of the entity's performance data, performance measures and self-assessment systems.
9. Identification of best practices.

Scope

The performance audit was conducted from April 2007 to September 2007. The auditors reviewed information relevant to program operations; specific goals; objectives; expectations; organizational charts; job descriptions; regional information; project plans and specifications; national publications and other relevant documents.

Auditors examined data on speeds, travel times, and traffic volumes for 2001 through 2006 on Interstate 5, Interstate 90, Interstate 405, State Route 520 and State Route 167 in the Puget Sound region. This review included estimates of the speed at which maximum throughput occurred, identified changes in the intensity and nature of congestion over time and compared chokepoint locations with roadway characteristics.

Recommendations

Details of these recommendations may be found beginning on Page 64 of the full report.

To the Department

- Commit to congestion management and reduction as a primary goal.
- Use all tools at its disposal to mitigate the growth in traffic congestion, recognizing the relative contributions each tool can make, its benefits and associated costs with a focus on generating maximum congestion relief.
- Reduce weaving and other traffic conflicts across the Puget Sound freeway network.
- Accelerate design and construction of new lanes and additional capacity to address the previous 20-year deficit.
- Apply congestion-related goals, objectives and benchmarks to all highway and transit-related investments.
- Elevate congestion reduction benefits in all decision-making processes.
- Better link project planning, prioritization, and programming to reflect congestion reduction goals.
- The Department (or a new regional entity) should manage traffic congestion through a system of measurable performance objectives.
- The Department (or a new regional entity) should collaborate with the Puget Sound Regional Council and local jurisdictions to implement a traffic signal coordination program for major arterials in the region.
- Deploy future high-occupancy toll lane projects aggressively if the State Route 167 pilot is successful.
- Expand the Commute Trip Reduction Program to include increased financial incentives, additional financial disincentives and regional marketing.
- Implement a telecommute program focusing on telework incentives.
- Use available technology to expand coverage of real-time traffic information to all freeways and major arterials.
- Work to fully fund operations programs that emphasize congestion management.
- Continue to improve the ramp metering system.
- Automate all freeway management tools.
- Work with Washington State Patrol to improve its current incident response system through resolution of Patrol staffing issues and an all agency after-action review process for every closure over 90 minutes.
- Complete the core high-occupancy vehicle network, with an emphasis on the Interstate 5 corridor to Tacoma.
- Consider adjusting current high-occupancy vehicle lane policy where needed in order to meet existing performance standards.
- Critically examine expensive interchanges and direct ramp access before additional investments are made in high-occupancy vehicle lanes.

Recommendations

To the Legislature

- Empower a single body — either the Department of Transportation or a regional transportation entity for the Puget Sound Region — to allow for a more integrated approach to planning for congestion reduction.
- Choose/identify projects based on congestion reduction rather than other agendas.
- Implement new legislation to facilitate the expansion of road pricing should the Department's high-occupancy toll lane pilot be successful.
- Review whether new legislation is required for public-private partnerships for transportation infrastructure and implement any necessary changes.

To the Department and regional transportation-related agencies

- Pursue potential enhancements to Interstate 5 through downtown Seattle.

Congestion in the Puget Sound

What is congestion?

Congestion represents the difference between the highway system performance that motorists expect and how the system actually performs. Puget Sound commuters likely have a different view of congestion than the Federal Highway Administration.

The U.S. Department of Transportation Federal Highway Administration characterizes traffic congestion as an excess of vehicles on a portion of roadway at a particular time resulting in speeds that are slower — sometimes much slower — than normal or "free-flow" speeds. The Administration defines traffic congestion as travel slower than free-flow speeds and usually defines a safe free-flow speed as the speed limit.

The perception of highway congestion varies based on motorists' expectations. An intersection that may seem congested in a rural community may not register as an annoyance in a large metropolitan area. A level of congestion that motorists expect during peak commute periods may be unacceptable if experienced on Sunday morning.

The Washington State Department of Transportation describes congestion as based on speed that reflects the maximum flow of vehicles: "Highway is at less-than-maximum-productivity because drivers are jammed at less-than-optimal spacing." This condition occurs at 40 mph, or less than 70 percent of posted speeds.

The Department has another definition for severe congestion: "Highway is well below maximum productivity." According to this definition, severe congestion occurs at 35 mph or at 60 percent of the posted speed.

What long-term factors have contributed to the level of congestion in the Puget Sound?

Several factors have led to the congestion that exists in the Puget Sound corridor.

Population growth

Puget Sound's population has grown by 2 million people from 1960 to 2006. In 1960, there were 1.5 million residents in the region. In 2006, there were 3.5 million; 56 percent of that growth is from people relocating from other areas of the country.

Economy

King County has the majority of the jobs in the Puget Sound, as well as the highest home prices.

Freight movement

The Port of Seattle and the Port of Tacoma receive a great deal of freight, which must be moved via truck or train.

Drive-alone figures

Depending on the area of origin, 49 percent to 79 percent of commuters in the Puget Sound region drive alone.

As of 2007, the phenomenon of an all-day rush hour is beginning to happen across the Puget Sound region. During the morning peak period, 42 percent of traffic is below 45 miles per hour. During the afternoon peak period, that figure increases to

48 percent. Commute periods are lengthening, creating the all-day rush hour.

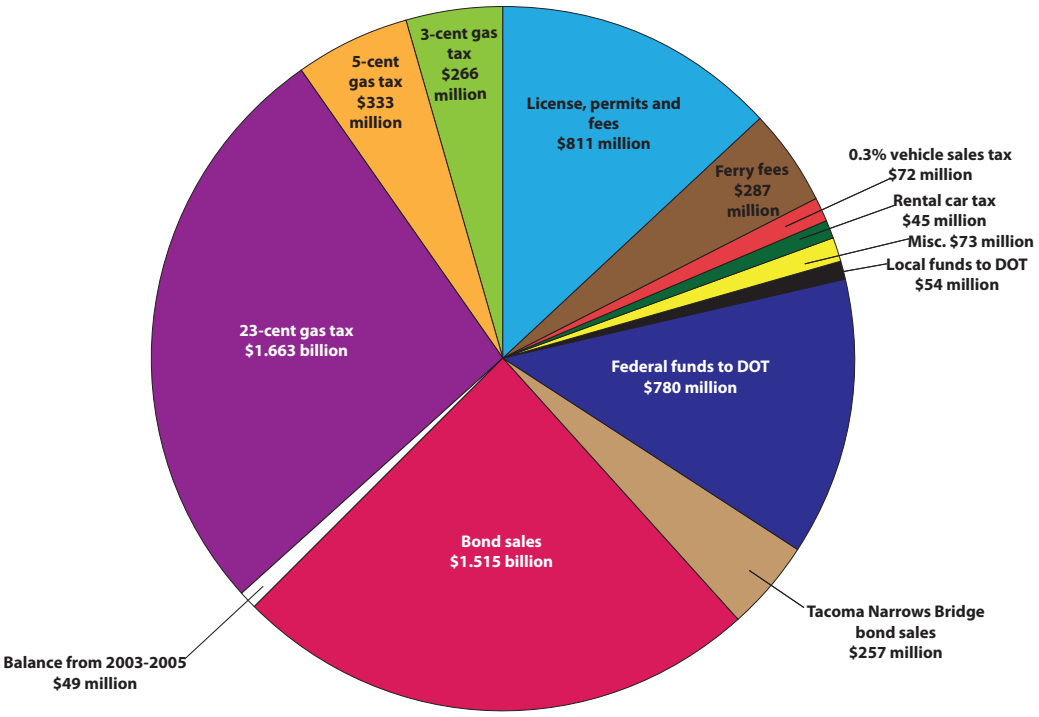
Who is responsible for Puget Sound's highway system?

More than 100 entities play a role in the governance of Puget Sound's highways. A partial list includes:

- Legislature
- Washington State Department of Transportation
- Washington Transportation Commission
- Washington State Patrol
- Puget Sound Regional Council
- Regional Transportation Investment District
- Sound Transit
- Local transits, such as King County Metro, Pierce and Kitsap counties transit agencies, Everett Transit, Community Transit (Snohomish County)
- Four county governments: Snohomish, King, Pierce, Kitsap
- 82 incorporated city governments

Funding for state highways comes from federal, state and local sources. Other funding comes from fees and taxes paid by consumers, including a statewide fuel tax; sales taxes that vary by county or city; vehicle sales tax; rental car tax; and Washington State Ferry fees. The Department of Transportation also funded highways through bond sales in excess of $1 billion for the 2005-2007 budget cycle.

2005-2007 Statewide Transportation Funds
$6.2 billion

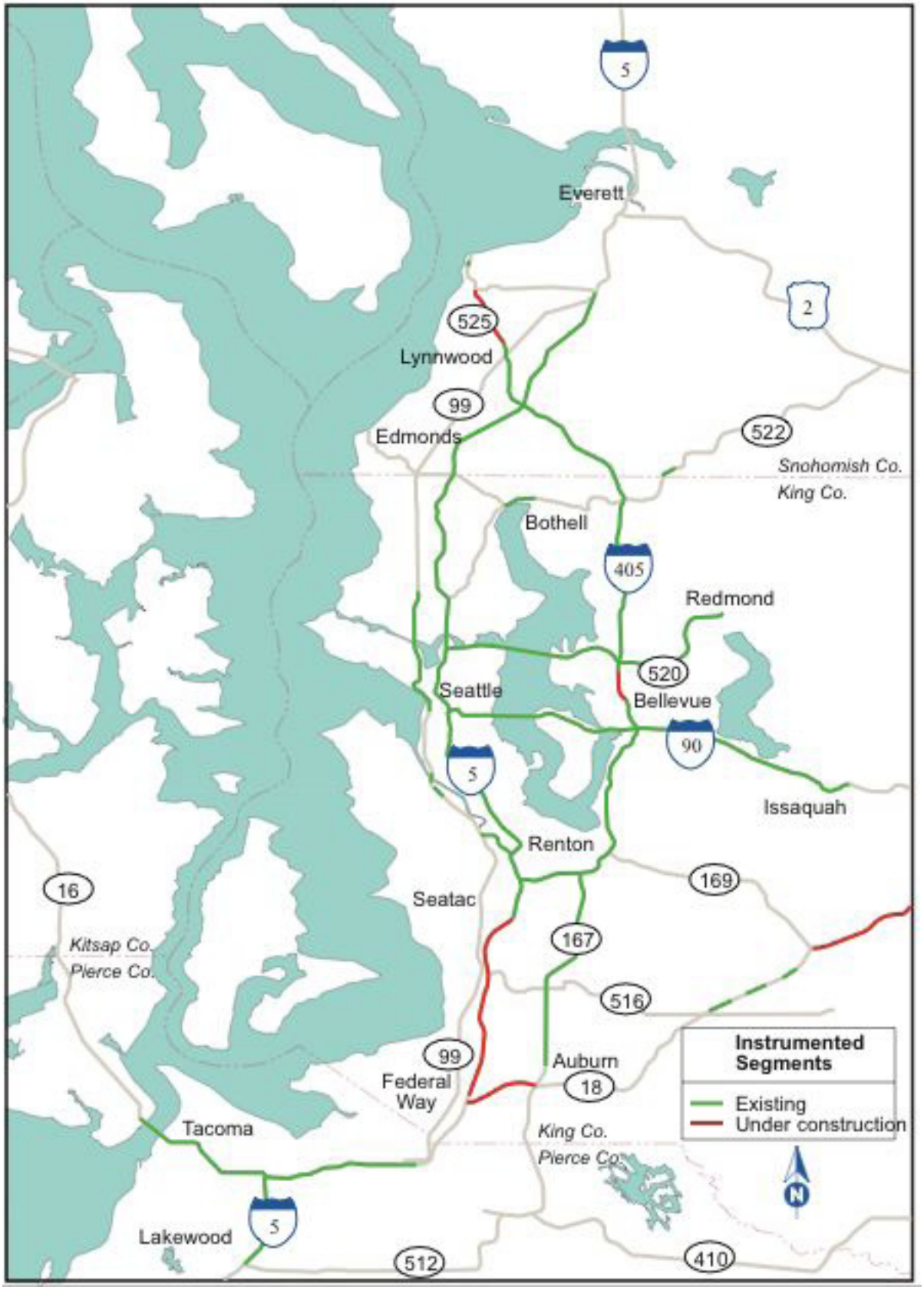


Cross-reference to I-900 elements

The chart below shows a cross-reference between the nine elements contained in Initiative 900 and where each is addressed in the recommendations.

Initiative 900 elements	Recommendation numbers
Identification of cost savings	Recommendations focus on opportunities to reduce the costs that result from congestion.
Identification of services that can be reduced or eliminated.	The audit's review of the Department's congestion management practices identified no opportunities related to this element.
Identification of programs or services that can be transferred to the private sector.	20
Analysis of gaps or overlaps in programs or services and recommendations to correct gaps or overlaps.	1, 3, 6, 7, 9, 13, 14, 15, 17, 19, 21, 22
Feasibility of pooling information technology systems	18
Analysis of the roles and functions and recommendations to change or eliminate roles or functions.	1, 2, 4, 9, 10
Recommendations for statutory or regulatory changes that may be necessary for the Department to properly carry out its functions.	1, 11, 12, 20
Analysis of performance data, performance measures and self-assessment systems.	3, 5, 6, 7, 8, 16
Identification of best practices	2, 3, 4, 5, 6, 7, 8, 9, 14, 15, 16, 17, 18, 19

Puget Sound Highways and HOV lanes



Map courtesy of University of Washington HOV project

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Mission Statement

The State Auditor's Office independently serves the citizens of Washington by promoting accountability, fiscal integrity and openness in state and local government. Working with these governments and with citizens, we strive to ensure the efficient and effective use of public resources.

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Washington State Department of Transportation
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Performance Audit

October 2007

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October 2007

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We have completed our performance audit of the Washington State Department of Transportation's (WSDOT) Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion. This report contains our detailed analysis and conclusions based on our review.

We wish to express our appreciation to WSDOT employees and managers and those persons from other organizations we spoke with for their cooperation and assistance during this analysis.

Talbot, Korvola & Warwick, LLP

Talbot, Korvola & Warwick, LLP

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Report Summary

WSDOT's Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion

REPORT SUMMARY

The Washington State Legislature directed the State Auditor's Office (SAO) to conduct an independent, comprehensive performance audit of all transportation-related agencies effective January 15, 2007, through June 30, 2007. The SAO retained the services of Talbot, Korvola & Warwick, LLP in conjunction with PlanB Consultancy and Delcan Corporation, to conduct a performance audit of the Washington State Department of Transportation's (WSDOT) process for the management and improvement to the state highway system for maximum throughput and minimal congestion.

AUDIT OBJECTIVES

The objectives of the performance audit are to determine:

1. The effectiveness of WSDOT's current highway investments and infrastructure utilizations given current and projected highway user volume over the next five years; and
2. The financial and non-financial costs of any recommended improvements over the next five years.

In particular, this audit seeks to evaluate how current highway investments and infrastructure and possible highway investments and infrastructure can:

- Minimize congestion for the greatest possible majority of highway users.
- Maximize vehicle throughput.
- Maximize highway user throughput.

This performance audit was conducted from April 2007 to October 2007 and was performed in accordance with generally accepted government performance auditing standards.

RESULTS

Traffic congestion in the Puget Sound Region is bad and becoming worse every year. During the typical afternoon peak period (4 p.m. to 7 p.m.) in 2006, 48 percent of travel on the major freeways was at less than 45 miles per hour. This level of congestion is one of the most severe among U.S. metropolitan areas. It has increased from 35 percent in just three years and 45 percent in 2005. During the morning peak period (6 a.m. to 9 a.m.) 42 percent of travel is at less

than 45 miles per hour, up from 32 percent in 2003. This level of delay and uncertainty harms daily commuters, commercial traffic, and the Region's businesses as well as adding to air pollution and disrupting non-work trips.

Without significant change, conditions will continue to worsen. Since 2003, the average speed during the morning and afternoon rush hours has dropped by more than one mile per hour per year. Congestion is not static in time or in location. The Puget Sound highway network is very fragile — small problems or small shifts in demand can trigger large delays. In some places, the effective capacity of the network has dropped extensively. Roads that currently experience little or no congestion will begin to incur deteriorating travel conditions. Roads that already experience congestion will experience it for longer durations and with increasing severity.

This problem has developed over many years. Causes reflect a long-term under-investment in roadway infrastructure that only now is beginning to change, a lack of focus on solving congestion by WSDOT, the Puget Sound Regional council (PSRC), the State Legislature, and others, a fractured decision making process for investments in Puget Sound, and lack of an agency with the authority to plan, coordinate, construct, and manage across all aspects of congestion including highways and transit. The nature of these problems goes beyond WSDOT or any single agency.

A number of the findings and recommendations indicate that reducing congestion should be WSDOT's top priority in determining how system performance is measured, how improvements are planned and programmed, and the overall culture of the agency. WSDOT has a long standing philosophy to focus first on the preservation, safety, and maintenance of the state's transportation system. This approach has been largely supported by the Governor, the Legislature, and the Transportation Commission. Improving mobility, which includes congestion reduction and capacity expansion, ranks fourth in priority of the five guidelines for future investment listed in the Washington Transportation Plan.

Our recommendations focus on a philosophical shift in WSDOT's priorities. However, an approach focusing on congestion is not mutually exclusive from its other goals. In fact, this approach will actually enhance the ability to improve air quality, safety, economic vitality, and system preservation.

Several of our key recommendations cannot be implemented unilaterally by WSDOT and may require legislative changes. The governance structure within which WSDOT currently functions reflects an era when its focus was on the design, construction, and maintenance of freeways and the state highway system. Congestion, while not a new problem, is a more recent phenomenon for which this governance structure is less well suited. WSDOT, in partnership with various state, regional, and local agencies in the Puget Sound Region, is approaching congestion in a similar manner as other major metropolitan areas across the nation. In almost every case however, congestion continues to worsen.

Our recommendations reflect an approach that is currently being used in only a few locations. While it is too soon to definitively identify the success of these alternative approaches, there appears little chance that the traditional approach used by WSDOT and others can achieve much more than to slow the rate at which congestion worsens.

In the near term, WSDOT and the Region can take several practical actions. These include investments to improve vehicle flow within the existing system, increasing efforts to have people switch to carpools or transit and to telecommute, coordinating traffic lights on major arterials, and continuing to improve operational efficiency. Completion of these actions requires a focus on solving congestion by WSDOT and other agencies and a reprogramming of some near-term priorities. Over the next five years, these actions could reduce hours of traffic delay by 15 percent to 20 percent (12 million to 16 million hours), saving the average commuter about 10hours of delay each year and the Region approximately $300 to $400 million in travel time and vehicle operating costs annually. Benefits from reduced emissions and improved access to jobs and labor could add a similar level of benefits.

In the long run, the ability to manage congestion will require adding new lanes of highway capacity. Other actions include a clear mandate to reduce congestion with a target that can be tracked, similar to the actions undertaken by other states. Transportation investments (highways and transit alike) should be measured, in part, based on how many hours of delay can be reduced for each million dollars of investment. Although WSDOT is a recognized national leader in many aspects of congestion management, more can be done. In particular, no agency has yet to take ownership responsibility for solving the congestion problem in the Puget Sound Region.

Recommendations

This performance audit has identified specific recommendations for WSDOT, the Washington State Legislature, and other entities. Each recommendation focuses on the objective of helping to manage congestion by:

- Decreasing travel times
- Increasing speeds
- Increasing throughput
- Improving travel time reliability
- Reducing costs for travelers, including lower fuel costs and lower vehicle operating costs
- Improving air quality, due to reduced vehicle emissions
- Improving safety

Each of these objectives is common to our recommendations. For some objectives, potential outcomes can be direct and immediate. Others will have interim outcomes that will ultimately result in these desired outcomes. For example, implementing the recommendation that "a single body, either WSDOT or a new regional transportation entity, should be empowered with the authority to plan and manage multi-modal transportation solutions in the Puget Sound Region," would provide important support for many of the other recommendations.

Many recommendations also focus on developing a planning and programming process that includes an emphasis on reducing congestion. Many changes will help improve accountability making it easier for taxpayers and their representatives to track the effectiveness of dollars spent on their behalf in managing congestion.

The following table lists specific recommendations and initial outcomes. For simplicity, it lists only interim outcomes, with the ultimate outcomes listed above being implicit, but not stated.

#	Page	Recommendation	Initial Outcomes
1	66	The Washington State Legislature should choose/identify projects based on congestion reduction rather than other agendas. WSDOT should commit to congestion management and reduction as a primary goal.	• Accelerates the completion of highway improvements in the most congested areas • Elevates importance of operations and demand management programs
2	72	WSDOT should use all tools at its disposal to mitigate the growth in traffic congestion recognizing the relative contributions each tool can make, its benefits, and associated costs with a focus on generating maximum congestion relief.	• Encourages expansion and continuation of current congestion management practices • Elevates the importance of adding capacity
3	77	WSDOT should reduce weaving and other traffic conflicts across the Puget Sound freeway network focusing on: • improving interchange design, • eliminating some left-hand exits, • reconfiguring key interchanges/ freeway segments that experience significant weaving, merging, and safety hazards, • adding reversible lanes where practical, and • using collector/distributor configurations wherever practical.	• Adds capacity • Reduces congestion
4	81	WSDOT should accelerate design and construction of new roadway lanes to address the previous 20-year deficit.	• Adds capacity to the existing system
5	85	WSDOT should apply congestion-related goals, objectives, and benchmarks to all highway and transit related investments.	• Identifies projects with the most congestion benefits per dollar • Places highways and transit on a common basis for evaluation
6	88	WSDOT should elevate congestion reduction benefits in all decision-making processes.	• Encourages projects with the most congestion-reduction benefits
7	92	WSDOT should better link project planning, prioritization, and programming to reflect congestion reduction goals.	• Provides the ability to track the success of legislative programming in meeting planning goals
8	96	WSDOT (or a new regional entity) should manage traffic congestion through a system of measurable performance objectives.	• Provides benchmark for citizens and their representatives to track progress • Supports results-driven management of congestion

#	Page	Recommendation	Initial Outcomes
9	101	WSDOT (or a new regional entity) should collaborate with the PSRC and other local jurisdictions to implement a traffic signal coordination program for major arterials in the Region.	• Reduces congestion
10	108	WSDOT should deploy future HOT lane projects aggressively if the SR 167 pilot is successful.	• Adds capacity to the existing system • Supports demand management
11	110	The Washington State Legislature should implement new legislation to facilitate the expansion of road pricing should WSDOT's HOT lane pilot be successful.	• Accelerates the expansion of HOT lanes and pricing in general • Supports demand management
12	112	The Washington State Legislature should empower a single body – either WSDOT or a new regional transportation entity for the Puget Sound Region — to allow for a more integrated approach to planning for congestion reduction.	• Creates a single focus to plan, prioritize, and fund multi-modal transportation projects that address congestion in the Puget Sound Region
13	117	WSDOT should expand its Commute Trip Reduction Program to include increased financial incentives, additional financial disincentives, and regional marketing.	• Reduces congestion
14	123	WSDOT should implement a telecommute program focusing on telework incentives.	• Reduces congestion
15	126	WSDOT should use available technology to expand coverage of real-time traffic information to all freeways and major arterials.	• Reduces congestion • Supports Transportation Demand Management opportunities with accurate and timely traveler information
16	128	WSDOT should work to fully fund operations programs that emphasize congestion management.	• Ensures existing system is operated and maintained at optimal levels
17	130	WSDOT should: • continue to improve its ramp metering system. • expand it to other locations. • assess its ramp control algorithms.	• Reduces congestion • Improves reliability
18	133	WSDOT should automate all freeway management tools.	• Increases timeliness and accuracy of response
19	137	WSDOT, in conjunction with the Washington State Patrol, should improve its current incident response system through resolution of WSP staffing issues and an all agency after-action review process for every closure over 90 minutes.	• Increases timeliness and accuracy of response to incidents • Reduces congestion

#	Page	Recommendation	Initial Outcomes
20	139	The Washington State Legislature should review whether new legislation is required for public private partnerships for transportation infrastructure and implement any necessary changes.	• Provides ability to accelerate the construction of transportation infrastructure using private sector funds
21	142	WSDOT and the Region should pursue potential enhancements to I-5 in downtown Seattle.	• Adds capacity in the I-5 corridor
22	148	WSDOT should: • complete the core HOV network, with an emphasis on the I-5 corridor to Tacoma. • consider adjusting current policy where needed in order to meet existing performance standards. • critically examine expensive interchanges and direct ramp access before additional investments.	• Improve throughput • Reduce congestion

Introduction

WSDOT's Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion

INTRODUCTION

On behalf of the Washington State Auditor's Office (SAO), Talbot, Korvola & Warwick, LLP in conjunction with PlanB Consultancy and Delcan Corporation, conducted a performance audit of the Washington State Department of Transportation's process for the management and improvement to the state highway system for maximum throughput and minimal congestion in the Puget Sound Region.

AUDIT PURPOSE AND OBJECTIVES

Project Purpose

In November 2005, voters approved Initiative 900, giving the State Auditor's Office the authority to conduct independent, comprehensive performance audits of state and local government agencies. The intent of performance audits is *"to ensure accountability and guarantee that tax dollars are spent as cost effectively as possible."*

As required by Initiative 900, each performance audit shall examine the economy, efficiency and effectiveness of the policies, management, fiscal affairs and operations of state and local governments, and shall include nine specific elements:

1. Identification of cost savings
2. Identification of services that can be reduced or eliminated
3. Identification of programs or services that can be transferred to the private sector
4. Analysis of gaps or overlaps in programs or services and recommendations to correct gaps or overlaps
5. Feasibility of pooling information technology systems within the department
6. Analysis of the roles and functions within the department and recommendations to change or eliminate departmental roles or functions
7. Analysis of departmental performance data, performance measures, and self-assessment systems
8. Recommendations for statutory or regulatory changes that may be necessary
9. Identification of best practices

Also in 2005, the Washington Legislature granted the Washington State Auditor's Office with the authority to audit transportation-related agencies through the passage of ESSB 6839. The legislation states: "Citizens demand and deserve accountability of transportation-related programs and expenditures. Transportation-related programs must continuously improve in quality, efficiency, and effectiveness in order to increase public trust."

In response to its new authority, the Auditor's Office commissioned a series of citizen forums to shape the direction of performance audits. The Office contracted with FLT Consulting and Elway Research, Inc., to hold town hall meetings and focus groups with Washington voters across the state. The public surveys identified the Washington State Department of Transportation's efforts to minimize congestion as areas of interest for performance audits.

Both ESSB 6839 and I-900 require performance audits conducted on behalf of the Washington State Auditor's Office to meet generally accepted Government Auditing Standards. The performance audit of Washington State Department of Transportation was completed in accordance with generally accepted Government Auditing Standards.

Objectives

The objectives of this performance audit are to determine:

1. The effectiveness of WSDOT's current highway investments and infrastructure utilization given current and projected highway user volume over the next five years; and,
2. The financial and non-financial costs of any recommended improvements over the next five years.

In particular, this audit seeks to evaluate how current highway investments and infrastructure and possible highway investments and infrastructure can:

- Minimize congestion for the greatest possible majority of highway users,
- Maximize vehicle throughput, and
- Maximize highway user throughput.

The performance audit was conducted from April 2007 to October 2007 and was performed in accordance with generally accepted Government Performance Auditing Standards.

PROJECT APPROACH AND METHODOLOGY

Evaluation Criteria and Standards

In order to determine the efficiency and effectiveness of WSDOT practices, the Performance Audit Team compared actual WSDOT practices and results against generally agreed-upon standards and specific custom-tailored criteria. Where possible, the Team compiled existing evaluation criteria and standards from WSDOT policies and procedures, the Revised Code of Washington (RCW), and/or Code of Federal Regulations (CFR).

In the absence of existing evaluation criteria, the Performance Audit Team formulated its own specific, measurable, and realistic criteria based on team members' extensive experience working with governmental and private sector organizations and professional literature.

Public Accountability Criteria

Public accountability is defined as the obligations of persons/authorities entrusted with public resources to report on the management of such resources and be answerable for the fiscal, managerial and program responsibilities that they confer.

Efficiency, Effectiveness, and Economy Criteria

The efficiency, effectiveness, and economy of a governmental operation are inherent responsibilities of those charged with its management. The overall "effectiveness" of an organization is the determination of how well predetermined goals and objectives for a particular activity or program are achieved. Effectiveness signifies the result of effort rather than the effort itself. It is sometimes characterized as impact, results, or outcome. Efficiency focuses on the maximization of output at minimal costs or the use of minimal input of resources for the achievable output. Economy signifies the acquisition of resources of appropriate quality and quantity at the lowest reasonable cost.

Legal Requirements

Legal requirements include any purpose or goals prescribed by law or regulation such as statutes, rules, and ordinances.

Prior Years' Performance

Prior years' performance provides a historical baseline of accomplishments, services provided, timeframes, etc. against which to compare the results of a current program or activity.

Performance of Similar Organizations

Performance of similar organizations (e.g. operations, service delivery methods, results, etc.) can act as a proxy or a basis for comparison. Although organizational differences may prohibit direct comparisons, information obtained can assist an audit team with identifying other effective methods to provide services.

Methodology

Information provided during interviews became one source for observations found within this report. The information gained from these individuals and from other corroborative sources provided insight into the issues, needs, and expectations surrounding the study and was invaluable in reaching the conclusions and recommendations presented within this report. However, not all of the issues raised by WSDOT personnel fell within the scope of this project. Where possible, those issues have been addressed through means other than this report.

The audit team also evaluated numerous documents and files. Included in this review was information relevant to program operations, specific goals, objectives, and expectations, organizational charts, job descriptions, regional information, project plans and specifications, national publications, and other relevant documents. Quantitative and qualitative analyses were undertaken as appropriate to understand the particular issue being addressed.

This review included estimates of the speed at which maximum throughput occurred, identified changes in the intensity and nature of congestion over time, and compared chokepoint locations with roadway characteristics. Traffic data was obtained from the Washington State Transportation Center's (TRAC) web site. Data from 415 vehicle detector stations (VDS) covering most of the I-5, I-405, I-90, SR-520, and SR-167 freeways in the Seattle metropolitan area was examined. Additional detailed data sets for those same sensors were also obtained from WSDOT.

Industry information was also obtained from a variety of sources including the Federal Highway Administration, other states, the Texas Transportation Institute Urban Mobility Study, the National Cooperative Highway Research Program, and other applicable organizations. For the purposes of this performance audit, we did not audit or validate the data provided by these sources.

The specific scope and nature of this audit did not allow for detailed engineering studies to be conducted to determine financial costs of potential improvements.

AUDIT TEAM PERSPECTIVE

The audit team began this audit with an expectation of governmental excellence, a benchmark that all organizations should have as a primary objective. Holding governmental entities to the highest standards of efficiency and effectiveness serves the best interests of both the citizen and government. When those expectations are not met, the team attempted to identify opportunities to move toward an organization's own vision of excellence. However, this vision must be recognized, accepted, and internalized before significant organizational change can occur.

It is for this reason that many of the observations found within this report are *exception-based*. That is, they are oriented toward resolving problems or concerns. Although many aspects of operations are performed efficiently and effectively, the greatest benefits to an organization are typically derived from the identification of methods to achieve excellence.

STANDARDS

This audit was conducted from April 2007 through October 2007 and was conducted in accordance with generally accepted government performance auditing standards.

COMPLIANCE

As part of the audit, the audit team examined compliance with applicable state statutes and department rules and regulations as they pertained to the specific objectives of the performance audit.

For those items the audit team did not specifically test for compliance, nothing came to the team's attention that would indicate significant instances of non-compliance.

CONGESTION

WSDOT's Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion

CONGESTION

Congestion in the Puget Sound Region and in the City of Seattle in particular, is bad and getting worse. In 2006, 42 percent of the time in the morning peak period (6 a.m. to 9 a.m.) commuters travel at speeds less than 45 miles per hour on the Region's major freeways. Afternoon peak period speeds fall below 25 miles per hour 11 percent of the time and below 45 miles per hour 48 percent of the time. WSDOT estimates delays totaled more than 256,000 hours a day in 2005.

Traffic incidents and construction only add to rush hour problems. The Washington State Transportation Center (TRAC) concludes that non-recurring delays (including incidents, special events, and severe weather) generally range between 30 percent to 50 percent of all peak periods meaning that 1/3 to 1/2 of the time spent in peak hour congestion is related to such conditions. Between 2003 and 2005, travel times increased by 28 percent on major commuter routes. In addition, system reliability degraded. The 95 percent reliable travel time — the time it takes to arrive on time 19 out of 20 days — requires peak-hour travelers to leave a margin equal to almost three times the free flow travel time. Between 2004 and 2005, this safety margin increased by between 8 percent and 35 percent on most commuter routes. As a result, commuters must continue to leave home earlier in the morning in order to get to work on time. Some roadway segments show much worse conditions.

Seattle is not alone in its congestion battle. However, it does experience a more severe problem than similar cities in the nation. The Texas Transportation Institute's (TTI) 2007 Urban Mobility Report shows a total delay of 45 hours per traveler annually in the Puget Sound Region, placing the region among the top 20 most congested areas in the nation.

Without significant action, congestion will get much worse. The average number of vehicles that the system can handle is well below the number that is expected from modern roadways. The system appears very fragile with the effective capacity only slightly above demand for non-peak travel times at many locations. In areas where demand often exceeds capacity, the potential capacity of the system has at times dropped further. For example, on I-405 between I-90 and SR

167 the average throughput in the morning peak period dropped by 100 vehicles per lane per hour between 2001 and 2006.

The forecasts on which many future investment decisions are premised are not encouraging. With only modest changes to capacity, delays will increase from 258,500 hours per day today to 667,000 hours in 2028. Adding all planned new lanes, including the proposed RTID and ST2 packages, will reduce hours of delay by 155,000 hours. Although a significant contribution, it still leaves conditions 254,000 hours of delay per day worse than today. This growth is substantially more than the projected increase in jobs and population — almost 100 percent (98.5 percent) versus 34 percent for population growth. These forecasts assume passage of RTID and ST2 packages.

WHAT IS TRAFFIC CONGESTION?

The Federal Highway Administration (FHWA) characterizes traffic congestion as an excess of vehicles on a portion of roadway at a particular time resulting in speeds that are slower — sometimes much slower-than normal or "free-flow" speeds. Congestion often means stopped or stop-and-go traffic. For its own reporting purposes, FHWA defines traffic congestion as travel slower than free flow speeds and then usually defines a safe free flow speed as the speed limit.

The perception of highway congestion varies based on motorists' expectations. An intersection that may seem congested in a rural community may not register as an annoyance in a large metropolitan area. A level of congestion that motorists expect during peak commute periods may be unacceptable if experienced on Sunday morning.

Because of this, congestion is difficult to define. However, congestion does represent the difference between highway system performance that motorists expect and how the system actually performs. Individual transportation agencies across the nation sometimes develop their own definitions of congestion to suit their local circumstances.

In effect, while the state of congestion is often understood, it is not formally defined. Perceived congestion is an important factor alongside more objective definitions in driving the need for

policy measures. Definitions vary according to two major dimensions — the traffic engineering perspective and the economic cost driven perspective. These perspectives relate directly to the two major efficiency objectives — system efficiency and economic efficiency. Users' perceptions are generally consistent with one or the other of these dimensions.

The most common objective approach to measuring congestion is to compare actual travel times with travel times based on the posted speed limits as a practical measure of free flow conditions. The Texas Transportation Institute calls this comparison the travel time index — the ratio of travel time during congested periods to that during free flow. This method is used by the standard national analysis of traffic congestion by FHWA and by some WSDOT studies.

In addition, WSDOT uses a description of congestion based on speed that reflects the maximum flow of vehicles: *"Highway is at less than maximum productivity because drivers are jammed at less than optimal spacing."* This condition occurs at about 40 mph (less than 70 percent of posted speeds).

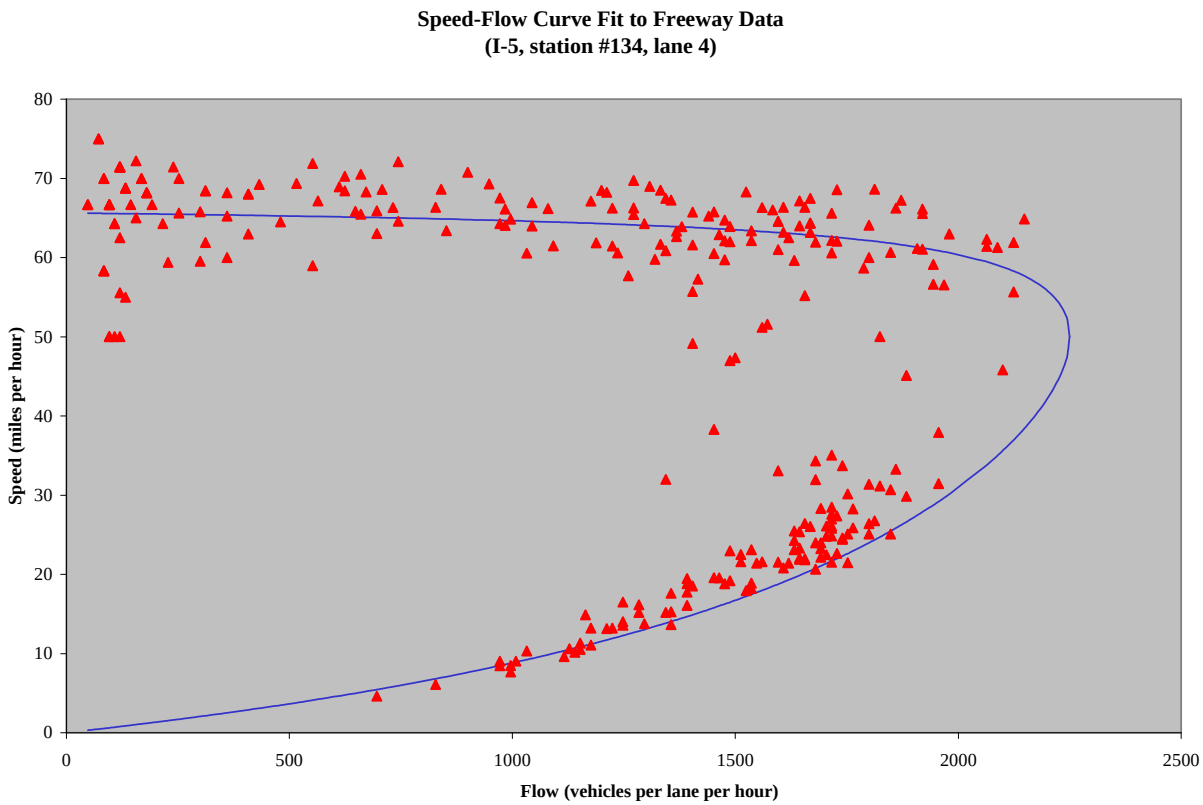
WSDOT has an additional definition for a severe congestion condition: *"Highway is well below maximum productivity*." The severe congestion condition occurs at 35 mph or below (about 60 percent of the posted speed.)

These measures are useful for managing highways in order to ensure the maximum throughput of vehicles, but differ from the definition recognized by most travelers.

FUNDAMENTAL CAUSES

Traffic congestion occurs when the number of vehicles attempting to use a section of a highway exceeds the capacity of the road. This is not a smooth process as roadways "break down" when traffic reaches a certain level. This breakdown is illustrated by a "speed-flow curve" with speed shown along the vertical axis and vehicle flow or throughput shown along the horizontal axis. The following example uses data from I-5 just north of SR 520 from April 2006. This example

is from the left hand lane (fast lane) and shows the road at its best possible conditions. Data for other lanes would shift to the left, showing lower maximum capacities.

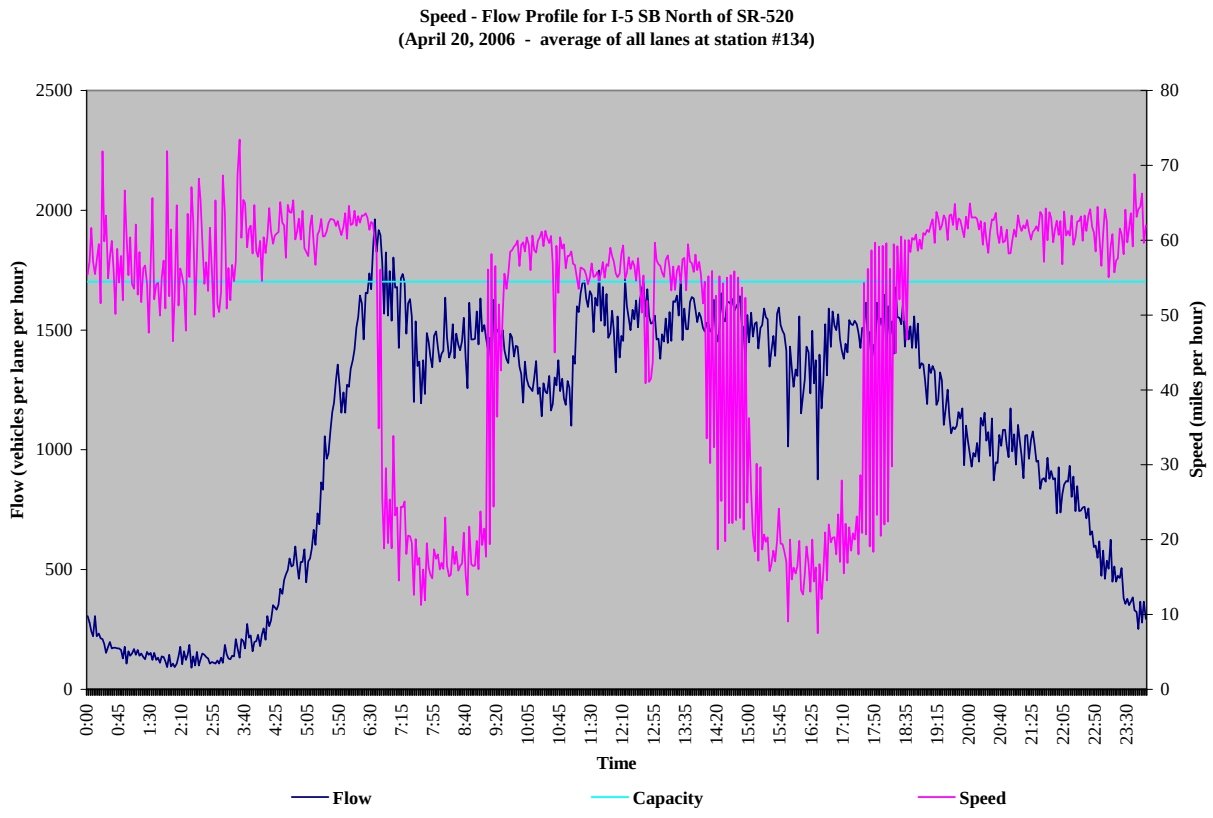


Source: Compiled by TKW

As shown by the above illustration, the roadway performs well when traffic is on the top half of the curve — speeds remain within 55 to 70 miles per hour even as traffic volume expands. But once this smooth flow is broken, speeds drop dramatically, often to 20-30 miles per hour. This breakpoint is often around 70 percent of free flow speed — or roughly 45-50 miles per hour. Once the flow of traffic "breaks" to the lower half of the curve, it usually takes time for the system to recover. This is one reason traffic congestion persists after an obvious cause has been corrected.

The figure below identifies how this affects traffic for the average traveler. This tracks speed and flow during a weekday in April on I-5 heading southbound near SR 520. The light line shows the maximum capacity of this section of roadway — about 1,700 vehicles per lane per

hour across all lanes. When capacity reaches this level (shortly after 6:00 a.m. on this day) speeds drop from 60 miles per hour to approximately 20 miles per hour and lasts for more than three hours on this day. During the mid day, the roadway operates quite well — speeds around 60 miles per hour and high throughputs. However, a small increase in vehicles on this roadway would trigger another drop in speeds — this time the problem occurs at less than the maximum possible capacity, a clear sign of how fragile the system is. In this example, this second "break" happens around 2:00 p.m. and lasts until after 6:00 p.m. Again, a slight increase in traffic in the middle of the day would mean that the recovery after the morning rush hour does not happen until the afternoon rush hour ends. This phenomenon of an "all day" rush hour is beginning to happen across the Puget Sound Region.



Source: Compiled by TKW

Traffic congestion is often divided into two categories:

Recurrent Congestion: Delays created by a general imbalance between the demand for travel and the physical capacity of the roadway to deliver — that is, demand is greater than supply.

Non-recurrent Congestion: Delays created by unplanned events or, perhaps, faulty design.

WSDOT supports research conducted by TRAC relating to recurring and non-recurring congestion. TRAC concludes that non-recurring delays generally range between 30 percent to 50 percent of all peak periods and peak direction delays.

The FHWA has identified seven problems that can serve as immediate causes for traffic congestion. The causes often interact with one another, exacerbating the level of congestion:

Physical Bottlenecks ("Capacity")

Capacity is the maximum amount of traffic which a given highway section can handle. Capacity is determined by a number of factors including the number and width of lanes and shoulders, merge areas at interchanges, and roadway alignment (grades and curves). Nationally, bottlenecks are the source of 40 percent of congestion.

Traffic Incidents

Traffic incidents are events that disrupt the normal flow of traffic, usually by physical impedance in the travel lanes. Events such as vehicular crashes, breakdowns, and debris in travel lanes are the most common form of incidents. Traffic incidents can also include natural and man-made disasters such as earthquakes, wildfires, and terrorist attacks. Nationally, incidents are the source of 25 percent of congestion.

Weather

Environmental conditions such as rain, snow, or bright sun can lead to changes in driver behavior that affect traffic flow. Nationally, bad weather is the source of 15 percent of congestion. In Puget Sound, weather is a much less important source of delay, accounting for less than 5 percent of congestion.

Work Zones

Work zones are construction activities on the roadway that result in physical changes to the highway environment. These changes may include a reduction in the number or width of travel lanes, lane "shifts," lane diversions, reduction, or elimination of shoulders, and even temporary roadway closures. Nationally, work zones are the source of 10 percent of congestion.

Traffic Control Devices

Intermittent disruption of traffic flow by control devices such as railroad grade crossings and poorly timed signals also contribute to congestion and travel time

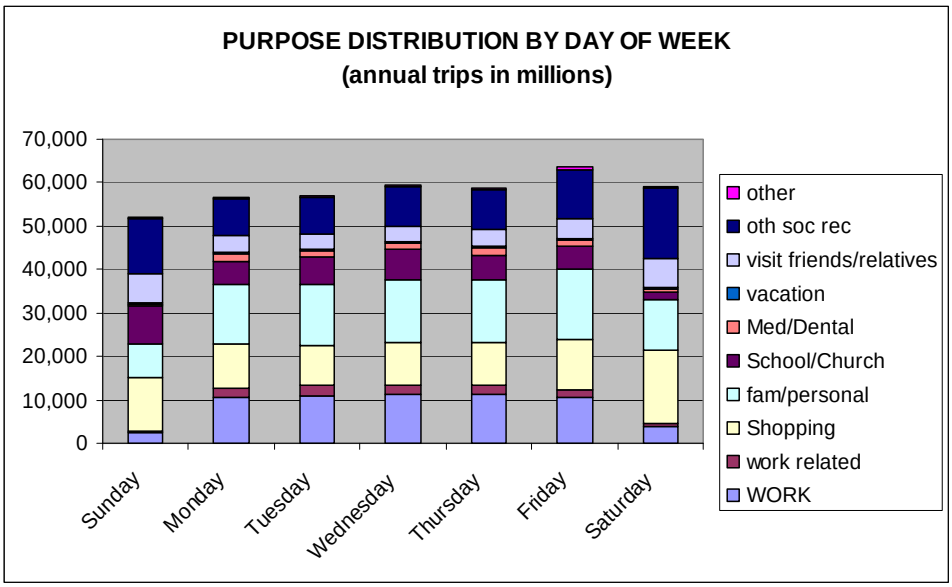
variability. Nationally, traffic control devices are the source of 5 percent of congestion.

Special Events

Special events can include sporting or entertainment events, fairs, conventions, etc. Unlike traffic incidents, special events are generally known about in advance. Despite advance planning, traffic flow in the vicinity of the event will differ radically from "typical" patterns. Special events occasionally cause "surges" in traffic demand that overwhelm the system, and may involve temporary restrictions and closures of the highway system. Nationally, special events are the source of 5 percent of congestion.

Fluctuations in Normal Traffic

Day-to-day and seasonal variability in demand leads to some days with higher traffic volumes than others. Varying demand volumes superimposed on a system with fixed capacity also results in variable or unreliable travel times.



Source: Commuting in America III, TRB NAS

The figure shows that the number of trips varies by day of the week and purposes shift as well. For example, Tuesdays tend to be the peak day for work trips dropping sharply on Friday with notable shifts away from work and to other purposes. Work trips account for a shrinking minority of all urban highway travel. Even in the Monday through Thursday morning peak, the average work share of travel nationally is about 35 percent (even less in the afternoon peak). Given the greater percentage of non-work commute purposes on Fridays, the work shares for Fridays are slightly less than the other days of the week.

LONG-TERM CAUSES

While the fundamental causes listed above represent possible "trigger" events for traffic congestion, a number of long-term causes contribute to the underlying circumstances that lead to congestion. These long term causes include economic activity, car ownership, environmental sensitivity, living standards, and investment in, and management of, the transportation system. These factors grow in significance as traffic volumes increase. In many areas today, system services are quite fragile meaning that small changes in volume or relatively minor events can create disproportionately larger delays. An accident at 3:00 a.m. is rarely a problem. However, an accident on a bridge at 7:00 a.m. can create major distress.

MEASURES OF CONGESTION

Measurement of congestion is an important step in managing and reducing congestion. Without quantitative measures, transportation agencies have no baseline against which to determine how well their transportation policies address congestion. Traditionally, level of service, speed, travel time, and delay, have been the commonly used measures of congestion.

The concept of "level of service" (LOS) provides a qualitative assessment of a road's operating condition and is a standard measurement that reflects the relative ease of traffic flow. Level of service is measured on a scale of A to F, with free-flow being rated at LOS-A, and severe congestion rated as at LOS-F. Freeways and arterial roads in urban and suburban settings are generally designed to provide LOS-C. This corresponds to stable flow, in which most drivers are able to drive at speeds close to free flow speeds. However, queues may be expected to form behind any significant blockage.

The Texas Transportation Institute's Urban Mobility Report ranks 85 metropolitan areas (including Seattle) according to several measurements, including:

- Annual delay per peak period traveler (the additional time spent traveling at congested speeds rather than free-flow speeds divided by the number of persons making a trip during the peak period)

- Travel Time Index (the ratio of travel time in the peak period to travel time at free-flow conditions)
- Total amount of delay
- Wasted fuel (additional fuel consumed during congested travel)
- Cost of congestion

Travelers indicate that reliability of the highway system is more important than the severity, magnitude, or level of congestion. Travelers in a large metropolitan area may accept that a 20 mile freeway trip takes 40 minutes during the peak period, so long as this predicted travel time is reliable and is not 25 minutes one day and two hours the next. This focus on reliability is particularly prevalent in the freight community where the value of time under certain just-in-time delivery circumstances may exceed $5.00 per minute. The importance of reliability is underscored by the Eddington Transport Study which estimated that for motorway widening schemes the total value of reliability benefits are in the order of an additional 50 percent above the value of total time savings benefits. Other studies use even higher estimates.

FHWA sponsors a Mobility Monitoring Program that is managed by Texas Transportation Institute and two other firms. However, FHWA uses different data sources to those used in the Urban Mobility Report. The Mobility Monitoring Program started in 2001, with the objective of tracking and reporting traffic congestion and travel reliability on a national scale. Its 2004 report includes 29 cities (including Seattle) and approximately 3,000 miles of freeway and tracks congestion and reliability measures:

Percent of Congested Travel: The ratio of congested travel to total travel, using vehicle-miles of travel (VMT).

Delay: The additional travel time that is incurred when actual travel times are greater than free-flow travel times. Delay is expressed in several different ways, including total delay in vehicle-hours, total delay per 1,000 VMT, and share of delay by time period, day of week, or speed range.

Buffer Index: The extra time most travelers add to their average travel time to ensure on-time arrival 95 percent of the time.

Planning Time Index: The extra time travelers must add to a free-flow travel time to ensure on-time arrival 95 percent of the time.

HOW BAD IS TRAFFIC CONGESTION IN THE PUGET SOUND REGION?

Traffic congestion is a problem around the world, across the nation, and in the Puget Sound Region.

Traffic Congestion Around the Nation and the World

Traffic congestion is a global phenomenon. However, given the lack of a single definition of congestion, global comparisons are not possible. In the United Kingdom, the Eddington Transport Study reported that almost 30 percent of travel time in major urban areas during peak periods in 2004 was spent at speeds below five mph and over 50 percent at speeds less than 20 mph. In the inter-peak period, when much of business and freight travel occurs, conditions were only slightly better with approximately 20 percent of time spent at speeds below five mph and over 40 percent at speeds less than 20 mph.

Although conditions are not yet this bad in the Puget Sound Region, traffic has worsened since the end of the recession in 2001/2002 and some portions of the Region already approach the worst examples in the nation. For example, traffic during the morning peak period on I-405 between SR 167 and I-90 is less than 45 miles per hour virtually all the time (89 percent) and drops below 25 MPH 43 percent of the time. During the peak hour conditions are worse.

In the United States, traffic congestion is described by the U.S. DOT in its 2006 Performance and Accountability Report to Congress. The percent of average daily travel nationwide (in approximately 400 urbanized areas) that is under congested conditions (moving at less than free flow speeds) is estimated to be 32.1 percent in 2006, up from 31 percent in 2003. Based on the current state of the highway system, it is expected that congestion levels will continue to rise if there is no significant improvement in transportation system capacity or existing operating practices.

Texas Transportation Institute's (TTI) 2005 Urban Mobility Report estimates that congestion caused 3.7 billion hours of travel delay in 2003 or 47 hours of annual delay for each peak traveler. In 1993, the corresponding delay was 2.4 billion total hours or 40 hours of annual delay

per traveler. Over the same period of time, the travel time index has risen from 1.28 to 1.37. This means a journey that takes 30 minutes under free flow conditions took 38.4 minutes under peak conditions in 1993 and 41.1 minutes under peak conditions in 2003.

Urban Mobility Report

The 2005 Urban Mobility Report (using data from 2003) ranks Seattle 20th for annual delay for each peak traveler and shows a total delay of 46 hours per driver annually in the Puget Sound Region, almost 25 percent higher than the national average of 37 hours for cities with population between one million and three million and compared with urban areas with populations above three million. Additionally, regional traffic congestion, measured by the regional travel time index, is significantly worse than comparable national cities; the 2003 travel time index in Seattle was 1.38 compared to a national average of 1.28 for cities of comparable sizes to Seattle. This means that a trip during peak periods takes almost 40 percent longer than the same trip off-peak; this is almost 10 percent more than the national average.

The recently released 2007 Urban Mobility Report makes substantial methodological changes; therefore, its reported values are not always comparable to values in past reports. The Report identifies Seattle as 16th nationally in terms of hours of delay per peak traveler with 46 hours of delay per peak traveler (using the revised procedures, the 2003 data has been downgraded to 43 hours of delay). The Report estimates that the total annual cost of that delay in the Seattle area is $1.43 billion ($877 per peak traveler, including 33 gallons of wasted fuel per year for the estimated 1.6 million peak period travelers in the region).

Although these estimates provide a basis for comparison, care should be taken when interpreting each. TTI cautions users of its report to avoid placing too much value on the rankings for all 85 urban areas. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. In addition, TTI continually updates its methodology, making it difficult to compare results across years. The most recent set of changes recognized the importance of operations — an area of strength for

WSDOT — but these changes mean that changes over time are misleading — at least for the Puget Sound Region.

The Gray Notebook

Measures, Markers and Mileposts, — the *Gray Notebook* — is a quarterly WSDOT publication that provides in-depth reviews of agency and transportation system performance. Section "What Gets Measured Gets Managed," of the Gray Notebook provides useful insights to the performance of the agency and the transportation system.

The report is organized into two main sections. 1) The *Beige Pages* report on the delivery of the projects funded in the 2003 Transportation Funding Package, 2005 Transportation Funding Package, and Pre-Existing Funds and 2) The *White Pages* describe key agency functions and provide regularly updated system and program performance information.

Of the 23 subjects addressed in the Gray Notebook, the following are the most relevant to this performance audit:

- Commute Options
- Congestion on State Highways
- Traffic Operations on State Highways
- Travel Information
- Truck Freight

The *White Pages* section includes system performance updates that are rotated over four quarters based on data availability and relevant data cycles. Annual updates provide in-depth analysis of topics and associated issues. Examples include Bridge Condition, Pavement Condition, and Congestion. The most recent annual update for congestion[1] provides extensive details on:

- Peak travel times
- Lost throughput productivity
- Percent of days when speeds were less than 35 mph
- Travel delay
- HOV lane performance
- Case study projects

[1] September 30, 2006 edition of the *Gray Notebook*

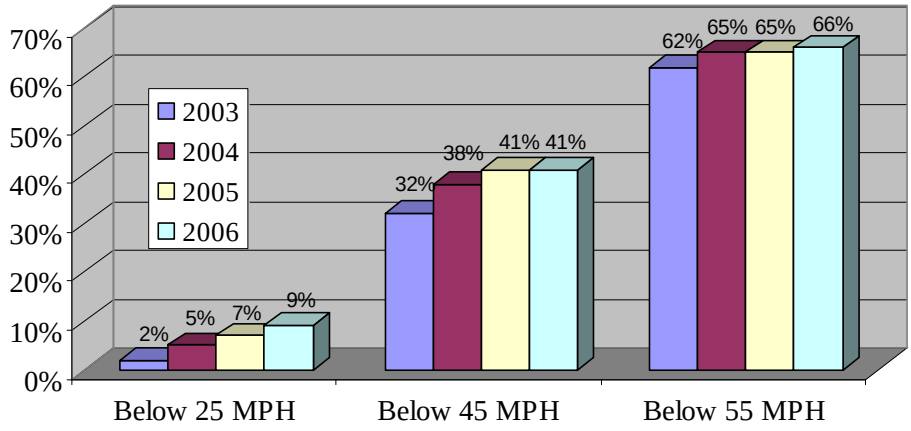
- Safety and congestion
- Arterial highways

Trends in Traffic Congestion

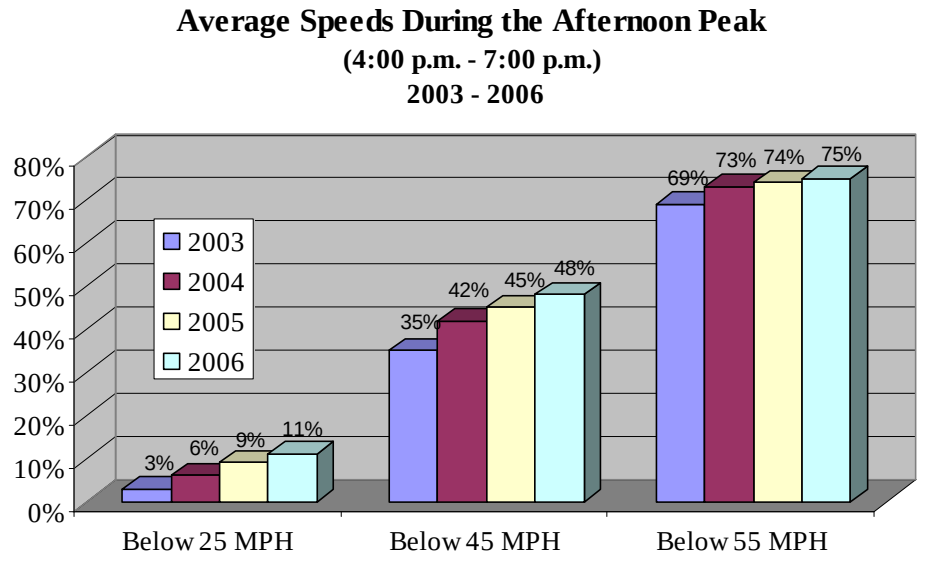
Traffic congestion in the Puget Sound Region is poor and is worsening at a rapid rate. This audit analyzed detailed data from fixed sensors that cover most of the Puget Sound freeway network. The southern portion of I-5 and SR 99 are the two most important segments with no sensor coverage for 2001 to 2006. Appendix A-2 provides a summary of the analysis.

The Region's highway system is not performing well in terms of traffic congestion. An increasing amount of each day is spent on the low side of the speed-flow curve — 42 percent of the morning peak period is below 45 miles per hour and 48 percent of the afternoon peak period is in these conditions. Just as the severity of the daily commute has increased, so has the length of time — commutes begin earlier and last longer.

Average Speeds During the Morning Peak
(6:00 a.m. - 9:00 a.m.)
2003 - 2006



Source: Compiled by TKW



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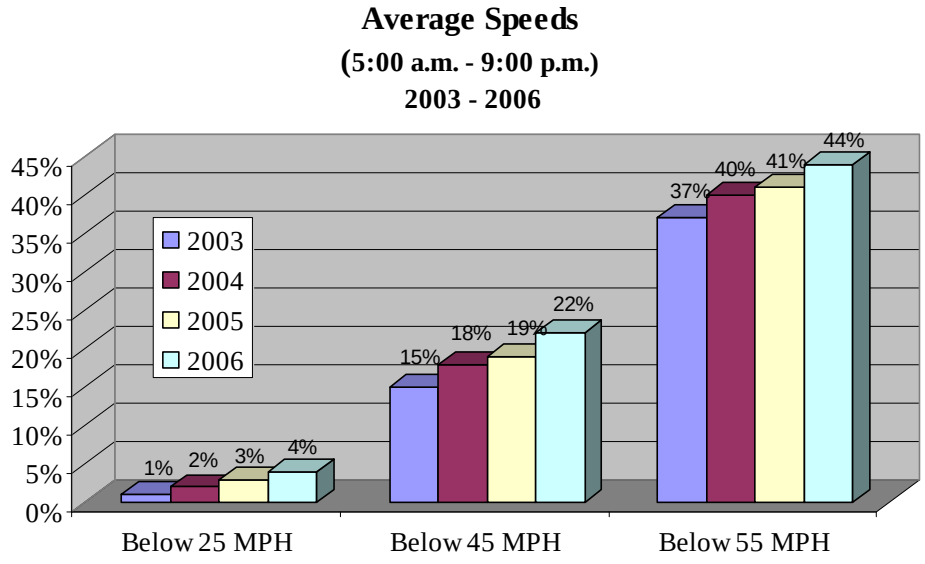
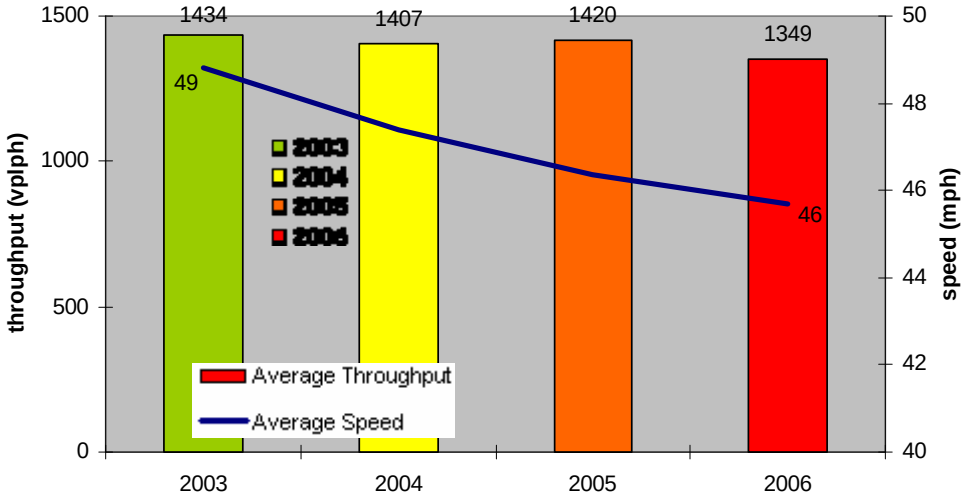


Source: Compiled by TKW

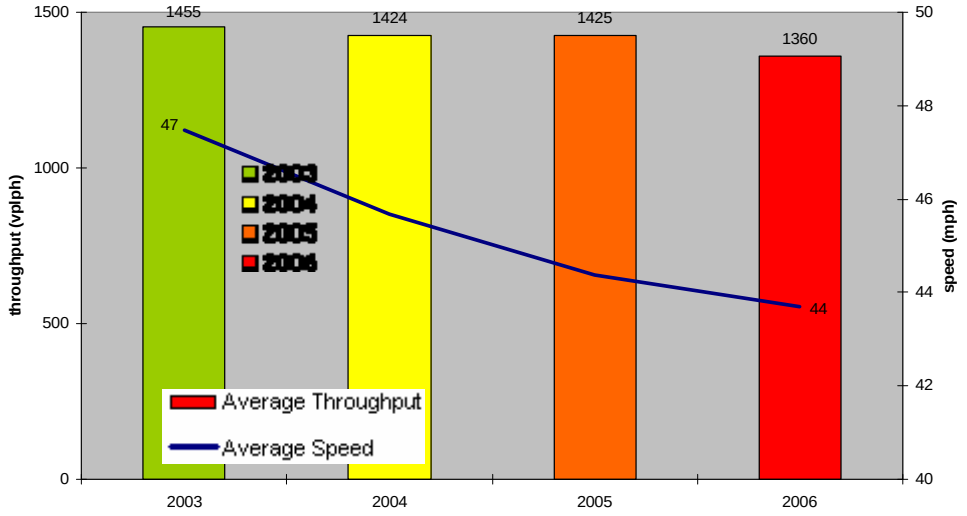
Average throughput as well as average speeds across the entire freeway network have been in a steady decline since 2003. Average throughput during both the morning and afternoon peaks has decreased by about 100 vehicles per lane per hour (vplph) since 2003 and average speeds are dropping by about a mile per hour every year as shown in the following exhibits.

Average Throughput and Speed During Morning Peak
(6 a.m. – 9 a.m.)
2003-2006



Source: Compiled by TKW

Average Throughput and Speed During Afternoon Peak
(4:00 p.m. – 7:00 p.m.)
2003-2006

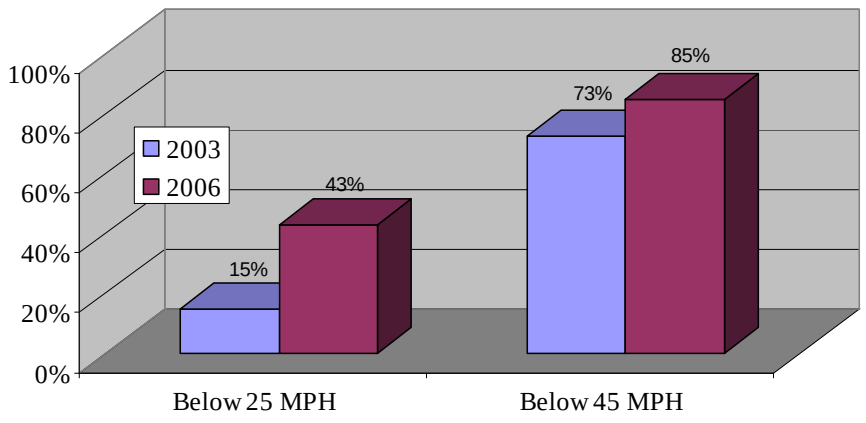


Source: Compiled by TKW

Congestion is not uniform across the Region. Conditions on I-405 northbound between SR-167 and I-90 for the morning peak period (6 a.m. to 9 a.m.) are worse than conditions for the region as a whole — with 43 percent of the period spent in speeds below 25 miles per hour versus 9 percent for all freeways in the Region and 85 percent of the time below 45 miles per hour versus

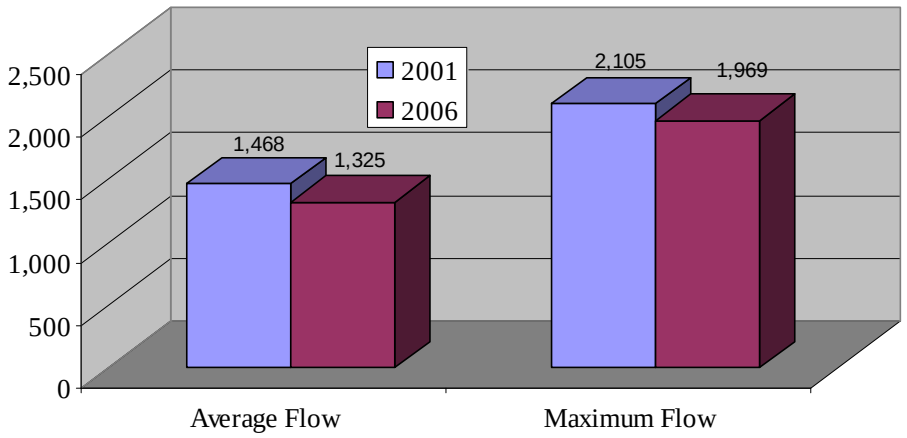
41.5 percent for the Region. Traffic congestion now occurs 100 percent of the time during the morning commute.

Performance of I-405 NB (SR-167 to I-90)
2003 and 2006 a.m. Peak Period



Source: Compiled by TKW

Average and Maximum Flow
(Vehicles per Lane per Hour)



Source: Compiled by TKW

The last figure shows that the effective capacity of this stretch of roadway has dropped significantly between 2001 and 2006. The average throughput in the morning peak period dropped by more than 100 vehicles per lane per hour from 2001 to 2006. This decline reflects the rapid growth in congestion since 2001.

CONGESTION MEASURES

Total Delays

WSDOT's Gray Notebook lists various congestion measures for 35 commute routes in 2003 and 2005. In practice these 35 commute routes comprise morning and afternoon peak information for 17 routes plus one additional route for the afternoon peak only. Some routes overlap, for example, Seattle to Federal Way and Seattle to SeaTac, both via I-5. The information covers sections of I-5, I-90, I-405, SR-167, and SR-520, between Everett, Federal Way, Auburn, Issaquah, and Redmond.

Recent Trends

Morning Peak

Between 2003 and 2005 in the morning peak, key measures on the 17 routes in the Seattle area changed as follows:

AVERAGE TRAVEL TIMES	
15 routes	Increased between 2% and 28%
Redmond to Bellevue	Decreased 10%

95% RELIABLE TRAVEL TIME (the time budgeted to be "on time" 19 out of 20 days)	
14 routes	Increased between 8% and 35%
Redmond to Bellevue	No change
Everett to Seattle	Decreased 3%

MAXIMUM THROUGHPUT TRAVEL TIME INDEX (ratio of peak travel time to maximum throughput travel time)	
13 routes	Increased on 13 routes
2 routes	No change
Redmond to Bellevue	Reduced

DURATION OF PEAK PERIOD	
13 routes	Increased between 5 and 85 minutes

Afternoon Peak

Between 2003 and 2005 in the afternoon peak, key measures on the 17 routes in the Seattle area changed as follows:

AVERAGE PEAK TRAVEL TIMES	
16 routes	Increased between 6% and 28%

95% RELIABLE TRAVEL TIME (the time budgeted to be "on time" 19 out of 20 days)	
16 routes	Increased between 8% and 49%
MAXIMUM THROUGHPUT TRAVEL TIME INDEX (ratio of peak travel time to maximum throughput travel time)	
15 routes	Increased
Seattle to Bellevue	No change

DURATION OF PEAK PERIOD	
13 routes	Increased between 15 and 140 minutes

Forecasts

Traffic forecasts for the Puget Sound Region are not encouraging. Even with projects currently in the pipeline from the Nickel and TPA programs and including funding (if approved) from the upcoming RTID and ST2 ballot measures, total hours of delay would drop by 155,000 hours each day. A significant impact but still leaving conditions almost 100 percent worse than today (254,000 hours of delay). Without voter approval of RTID and ST2, delay would be 353,000 hours worse — far more than double the current level of congestion. Although there will be a larger population and work force in 2028 to absorb these hours, delay will increase much more rapidly — 100 percent versus a 34 percent increase in workers and jobs. The ST2 proposal is estimated to have a limited effect on automobile delay, although it will provide an option for many along the major commuter routes once these segments have been completed.

Scenario	Average Speed	Vehicle Hours of Delay	Minutes Per Vehicle Trip	Miles Per Vehicle Trip
2006 Baseline	30.1	106,582	19.3	9.7
2028 Local Projects	25.3	255,441	21.7	9.1
2028 Local + Nickel + TPA	26.1	231,960	21.2	9.2
2028 Local + Nickel + TPA + RTID + ST2	27.8	191,290	20.2	9.4

Source: WSDOT

Factors That Influence Traffic Congestion in the Puget Sound Region

The Region

The Puget Sound Region had an estimated population of 3.5 million residents in 2006, an increase of 2 million since 1960. Fifty-six percent of this expansion is attributed to people moving to the region. Net migration has been volatile, however, rising and falling in response to economic factors, particularly employment. This is attributed to the economic slowdown and recession of the early 2000s.

Net migration has rebounded since the economic slowdown and recession of the early 2000s. The Region gained 40,200 persons during 2005 and 2006, compared to the historical annual average of 24,700. While positive for the region's economic well being, such increases have obvious negative consequences for traffic congestion.

Washington employment continued to grow in 2006 and 2007 with healthy gains in construction, manufacturing and professional and business services. The unemployment rate has declined in the central Puget Sound Region in each of the last three years following a slow recovery from the 2001 recession. The employment outlook is reported to favor professional business services and information services, with the largest relative gain in employment share and growth in the aerospace industry, which means the manufacturing employment share is expected to drop less in the state of Washington than nationally.

Labor Force and Unemployment, Washington State Metro Areas 2006

Metro Area	Labor Force	Employment	Unemployment Rate
Seattle- Bellevue -Everett	1,409,400	1,351,200	4.1%
Tacoma	376,200	356,700	5.25%
Washington State	3,339,700	3,171,300	5%

Statewide wages, per capita personal income, and household income have all followed the same growth trend over the past decade; that is, growth during the last half of the 1990s and stagnation or decline with the onset of the 2001 recession and growth since 2003. The average annual wage in the Seattle metropolitan area is $7,000 higher than the national average.

As in other metro areas, the location of jobs and homes has not been evenly matched. For example, the Regional Transportation Commission Final Report notes that between 1995 and 2003, King County added 69 percent of the Region's new jobs but only represented 42 percent of the population growth. One factor leading to the mismatch between job and residential location is the rapid increase in housing costs in Seattle and in King County compared to average annual wage. This increase in housing costs encourages workers to purchase homes in more affordable outlying counties which in turn increases demand on key travel corridors.

Freight movement is important, both for the Region and the nation. The combined Ports of Seattle and Tacoma are third only to the ports of New York and Los Angeles/Long Beach in terms of container traffic. $14 billion in state-originated exports pass through these Puget Sound Ports equating to 63 million metric tons of cargo. Freight volumes in Washington have been growing twice as fast as the state's population. Further, the Puget Sound Regional Council's (PSRC) modeling data for 2000 shows more than 45,000 hours of truck delay in the four-county region on an average weekday.

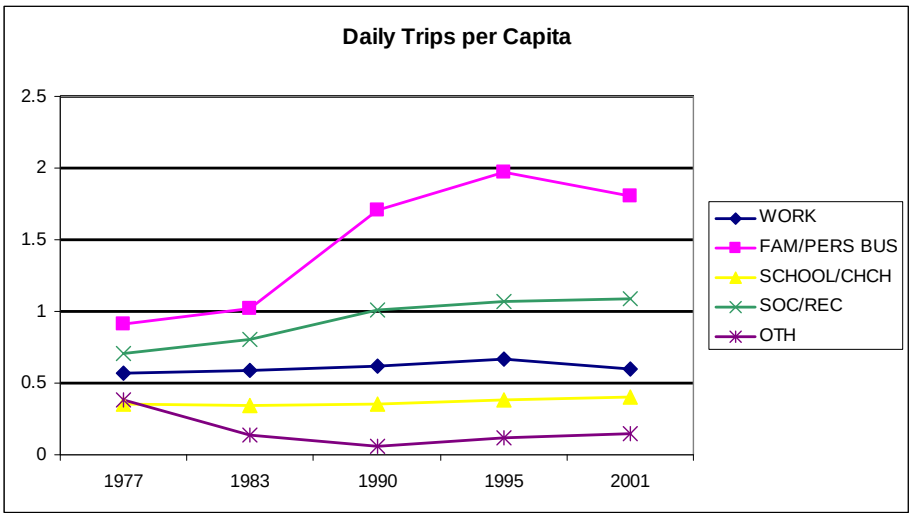
Continued growth in the Region implies a continued expansion in demand for commute, recreational, and freight movements.

Travel Patterns in the Puget Sound Region

Suburban growth throughout the Puget Sound region has changed the traditional commute to and from Seattle to a region-wide commute with multiple origins and destinations.

Travelers (*Who*)

We are all travelers and, for the most part, our regular patterns of economic and social activities require us to travel on an almost daily basis. We go to work, to school or college, to shop, to go out to eat, to visit medical facilities, to visit friends, and to take part in sporting or recreational events of all kinds. The following exhibit identifies key changes in trip purpose since 1977 and illustrates how important trip purposes other than commuting have become. Commuting is a small and declining share of total travel accounting for less than 20 percent of local travel. Tourism (local travel performed by visitors whose residence is outside the region) can be a very important segment of total travel in both an economic and a congestion sense. Beyond passenger travel we almost always forget the myriad activities of service, government and freight oriented vehicles in the traffic stream which are the economic lifeblood of any region. Focusing solely on work purposes in congestion approaches would dramatically narrow the span and scope of the elements involved and the potential solutions as well. Daily trips for other purposes such as personal business and social and recreational activities have been the predominant source of growth while work trips per capita have remained fundamentally constant for the past thirty years.

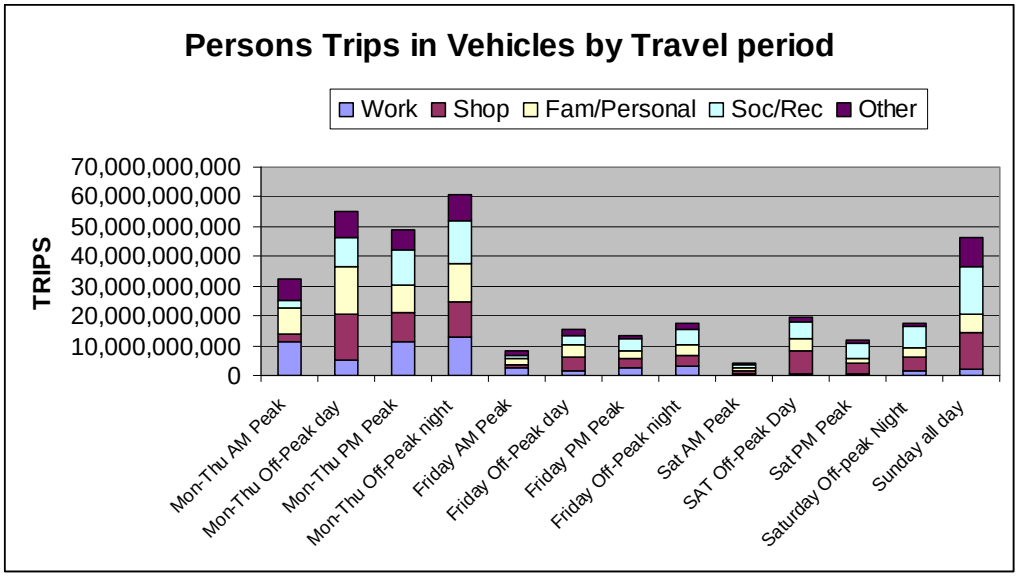


Source: Commuting in America III, TRB, NAS

However, the regularity of work travel and its tendency to be concentrated into two peak periods does support that it deserves greater recognition than other trip purposes. Work travel is where the public most often interacts with the freeway system on a recurring basis, where the public is

most affected by traffic congestion. The home and the workplace are often the anchors around which other trip chains evolve.

The next exhibit shows the distribution of travel by purpose for the major travel periods of the week. On the average Monday through Thursday, work purposes account for only a limited share of the vehicular travel even in peak periods.

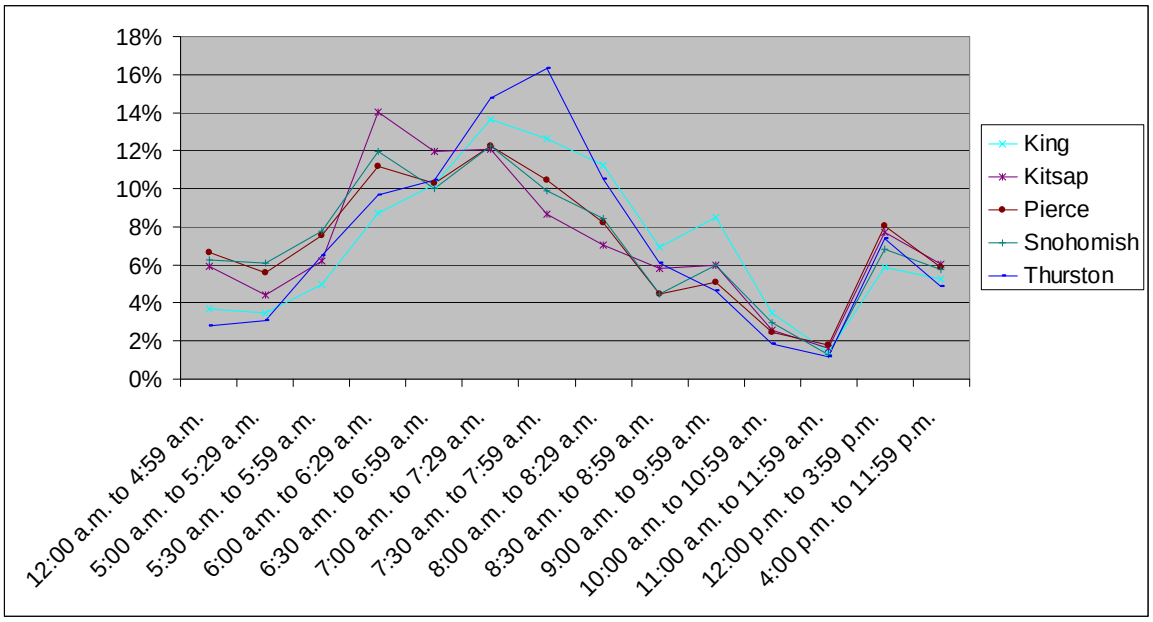


Source: National Household Travel Survey 2001

Time of Day (*When*)

The peak period travel periods are 6:00 a.m. to 9:00 a.m. in the morning and 3:00 p.m. to 7:00 p.m. in the afternoon. The following exhibit illustrates the variation in patterns for work travel in the Region. Peak periods have been getting longer and afternoon periods are the worst. An example of one of the Region's worst commutes is the afternoon journey from Bellevue to Tukwila on I-405. The route was congested in the afternoon for 5 hours and 35 minutes and for 4 hours and 10 minutes of that period, traffic speeds fell below 35 mph (severe congestion). Since 2003 the travel time has increased by seven minutes and the 95 percent reliable travel time by 13 minutes which indicates that not only have travel conditions deteriorated, but also become less predictable. Overall, approximately 20 percent of the Region's commuters now begin their

commute before 6:00 a.m. One example of this shift has been a shift in start times by fast food chains, some of which now open at 5:00 a.m.



Start time for daily commute
Source: 2005 American Community Survey, US Bureau of the Census

Origins and Destinations (*where*)

Where one lives is an important factor in choosing travel options for the journey to and from work. A PSRC analysis examined commute choices to the Region's five major downtown areas. Commuters who began trips in the Seattle/Shoreline Region demonstrated the greatest variety of choices. Those traveling to Bellevue, Everett, and Tacoma were most likely to drive alone. However, less than 40 percent drove alone if they were traveling to downtown Seattle. Commuters used the bus almost as often as driving alone for trips to downtown. This emphasis on bus trips for journeys to Seattle is repeated in King, Pierce, and Snohomish counties. Sixty-seven percent of residents within Kitsap County relied on the ferry as their major mode of transportation. When Seattle is not the major destination, driving alone becomes the major mode of travel.

An important feature of Seattle work trips is that while inter-county work flows are substantial, the Region does not exhibit the extensive inter-county flows for work trips found elsewhere in

the country. At least in percentage terms, it is significantly lower than the national average. A proportion of this may be attributable to the size and configuration of the counties in the Region. The metro area, and the state as a whole, have on average, 20 percent of workers leaving their home county to work in contrast to almost 28 percent nationally. The accompanying table shows that, as expected, King County is the lowest with only 8 percent leaving the county. Pierce, Snohomish, and Thurston Counties all exhibit levels either similar to the national average or higher. Focusing specifically on Seattle, approximately 75,000 workers (roughly 25 percent) residing within city limits commute beyond city borders. However, only approximately 15,000 leave the county.

	% Work In Home County	% Work Outside Home County
State	81 %	19 %
Metro Area	81 %	19 %
CSA	80 %	20 %
King	92 %	8 %
Kitsap	80 %	20 %
Pierce	71 %	29 %
Snohomish	61 %	39 %
Thurston	73 %	27 %
Skagit	77 %	23 %

Note: CSA = Combined Statistical Area; including Olympia
Source: prepared by Alan E. Pisarski from the 2005 American Community Survey Fact Finder, US Bureau of the Census.

Journey Purpose (*Why*)

Why do people travel? Travel survey categories invariably provide the following choices:

- Home, i.e. to go home
- Work
- School
- Accompaniment — drive or take others to an activity
- Errands — banking, picking up the dry cleaning, etc.
- Medical (may or may not be part of the above)
- Shopping
- Meals
- Social
- Recreational (may or may not be part of the above)

As daily lives get busier, people attempt to be more efficient with the way they organize their trips. Purposes are linked, making stops along the way. These trips are referred to as "tours" or "trip chains." For example, of the trips that make up work tours, 40 percent travel to work, 33 percent travel home, and 27 percent make intermediate stops at other types of destinations. Similar percentages hold for the other major trip purpose categories. If destinations are closely spaced as in dense urban areas, transit, walking, and cycling may be sensible solutions for linked trips. However, as the destinations become more widely spaced, automobile use becomes a more satisfactory alternative. Where a person lives, works, or goes to school are likely to be important contributors to the choice of travel mode. The nature of these trip chains will affect mode choice as well. When they involve dropping off people or goods they may almost mandate a private vehicle. The existence of complex combinations of trip purposes also makes it harder for people to switch modes (e.g. to carpools or transit).

Modal Choice (*How*)

PSRC's 2006 Household Activity Survey shows that 8 percent of the Region's residents report that they had used either bus or train in a 48-hour weekday period and 27 percent report having used transit in the previous 30 days. The results vary by home location and indicate almost one half of Seattle residents who traveled had used bus or train in the previous 30 days while only 23 percent of King County residents had done so with lower percentages for the other counties.

These findings are similar to those from *Census Data 2000* for the journey to work. It should be noted that between 2.6 percent and 7.6 percent work at home. The following illustration indicates the practicalities of commuting. In central Seattle it is possible for 15.6 percent of employees to walk or bike to work. However, in a suburban location such as Federal Way, only 1.4 percent of employees have that option. PSRC 2006 Household Activity Survey also concluded that location characteristics are important in explaining transit usage. Transit usage is significantly higher for:

- City of Seattle residents, relative to other area residents,
- Urban area residents,
- Residents with higher household densities, and,
- Residents of areas with more multi-family dwelling units.

Journey to Work Data for the Twenty Largest Places in Puget Sound

Place	Workers	Drive Alone	Carpool	Transit	Walk/ Bike	Av. Time in Minutes
North Seattle	135,420	59.2%	11.9%	16.9%	7.3%	24.6
South Seattle	87,025	62.4%	15.3%	15.6%	3.1%	26.9
Central Seattle	86,434	49.6%	9.6%	20.0%	15.6%	23.1
Tacoma	85,355	73.3%	15.15	5.1%	2.8%	25.4
Bellevue	56,445	74.05	11.3%	6.6%	3.0%	21.6
Everett	41,800	71.5%	17.8%	4.05	3.4%	27.2
Federal Way	41,240	73.8%	16.1%	5.8%	1.4%	30.2
Kent	39,565	73.5%	15.5%	5.6%	2.25	28.7
Kirkland	26,820	76.3%	10.6%	5.4%	2.3%	21.9
Renton	26,695	72.95	15.8%	6.1%	2.6%	27.7
Shoreline	26,215	70.2%	13.6%	10.1%	2.1%	26.9
Redmond	25,640	76.15	11.8%	4.2%	3.6%	20.7
Lakewood	24,480	75.3%	15.8%	3.9%	2.5%	25.2
Olympia	21,610	71.25%	12.85%	5.1%	7.5%	19.9
Edmonds	19,710	76.6%	10.5%	6.4%	1.6%	27.6
Auburn	18,920	72.9%	15.8%	4.9%	3.5%	27.8
Seattle Hill/Silver Firs CDP	18,075	78.5%	14.2%	4.05	0.3%	29.5
Cascade/Fairwood CDP	18,040	76.9%	13.9%	5.4%	0.7%	30.3
Sammamish	17,145	79.7%	9.6%	2.1%	1.1%	30.3
Lynnwood	16,615	70.3%	15.4%	7.5%	2.8%	27.6%

Source: PSRC Puget Sound Trends T21, November 2003

A key measure of mode choice is the sum of carpooling and transit, given that carpooling often competes with transit for riders and both modes reduce the number of single occupant vehicles. When that share is above 20 percent a metropolitan region is doing well in converting single occupant vehicle use to other modes of transport. While just below this level, the Seattle metro area is among only eight areas in the country above or close to that mark.

Another useful measure is the non-motorized (those who walk, bike, or work at home) share of all work travel. At 7.7 percent, the Puget Sound Region is one of the highest in the country, where the national metropolitan average is 6.3 percent. The typical central city share is around 8 percent.

The 2005 ACS data points out those overall trends seem to have reversed slightly from 2000. In 2000, the Puget Sound Region led the nation in shifts away from driving alone into carpools and transit with only 71.7 percent of travel in single occupant vehicles. In 2005 however, the share

of travel in single occupant vehicles had increased to approximately 72.7 percent — better than the 73.1 percent reported in 1990. Carpooling, after reaching 10.3 percent in 2000 has now returned to approximately 9.6 percent. These are small changes but are closely watched for trends.

Future Trends

If housing prices continue to cause people to live farther from job locations, the ability to cost effectively serve those locations with transit alternatives will diminish.

Based on recent patterns, it can be expected that miles individuals drive in the Region will continue to grow at approximately the same rate as population and employment. Average growth rates in the last 10 years indicate vehicle miles of travel grew an average of 1.2 percent annually while employment and population each grew 1.4 percent. This is an important shift since historically vehicle miles of travel have grown more rapidly than the general economy or the growth in population. One explanation is that many factors that contribute to travel growth such as driver's licensing and household vehicle ownership have reached saturation. In addition, large segments of the population are now beyond peak driving years.

The changing age structure of the population will also affect trip-making and mode choice. In general, an aging population tends to travel less but tends to be more oriented to personal vehicles. The average age in the region and the state is now 41.

Mobility

Personal mobility can be defined as the ability to move at will. When many individuals desire to move at the same time, in the same direction, using constrained infrastructure (roads or transit), they are frequently frustrated by delays, queues and crowding. One of the transportation policies intended to improve personal mobility has been the development of high-occupancy vehicle (HOV) lanes. In Washington, those who drive with others in the same car have the right to use HOV lanes that offer higher speeds, less crowding, and the promise of greater reliability.

Mobility is affected extensively by increases in congestion, especially as travel times increase and reliability — the need to arrive at a destination on-time either for an appointment, a meeting, to catch a plane, etc. — decreases. While reliability is a key part of freight movements where "just-in-time delivery" prevails, it is also part of the service economy and our daily lives.

Regional residents spend a substantial share of their income on transportation. In 2005, households across the nation spent almost $9,500 on transportation or approximately 17.6 percent of their total expenditures. However, annual wages on average were lower than Seattle's resulting in a greater share of income to transportation. San Francisco had similar spending patterns in dollar terms, but at much higher income levels. Although its vehicle ownership levels were among the highest in the west, Seattle's spending on vehicles was among the lowest.

Travel Times

WSDOT is consistently monitoring changes in travel times and these changes are reported in the Gray Notebook. For the period 2003 to 2005, Average Peak Travel Time for trips to Seattle worsened by 2 percent to 13 percent. For trips to Bellevue, travel time worsened in all but one instance with the deterioration registering between 6 percent and 28 percent depending on the route. For other locations, average travel times increased from 6 percent to 21 percent.

The key distributional measures of travel time include both 1) a positive measure — the percentage of workers getting to work in less than 20 minutes; and 2) a negative measure — the percentage of workers getting to work in over 60 minutes or 90 minutes (the extreme commute).

A "successful" commute can result when approximately 50 percent of workers make it to work in less than 20 minutes. The Washington statewide average is 45 percent (along with Skagit, Thurston, and Kitsap counties). The Seattle metropolitan region average is poor at 36 percent.

When more than 10 percent of workers take more than an hour, the area has serious problems. In the Puget Sound Region, this number is 8.4 percent.

Reliability

WSDOT uses a performance measure for reliability referred to as the 95 percent Reliable Travel Time. This equates to an estimated travel time with 95 percent certainty that you will arrive on time. This index is important for travelers who cannot afford to be late without important consequences. Adding time buffers to one's commute, however, restricts mobility and adds to wasted time. For the period 2003 to 2005, there is only one instance of an apparent improvement in 95 percent Travel Time Reliability. For the other monitored locations, deterioration in reliability ranged from no change to 35 percent degradation in performance.

HOV Performance

In terms of mobility, this leads to the question: "How much better have the 200 miles of HOV lanes performed? WSDOT and PSRC have an adopted performance standard for freeway HOV lanes that states that 90 percent of the time, the HOV lane should maintain an average speed of 45 mph or greater during the peak period. Six of the HOV lanes are now so congested that they fail the standard in the afternoon peak period and four fail the standard in the morning period. The reliability performance of several sections is also deteriorating under increasing vehicle usage. The crush of congestion has had a negative impact on the ability of HOV lanes to encourage more people to shift from single occupancy vehicles.

Commerce

Congestion has an extensive impact on the freight industry. Longer travel times, increased costs, and less reliable pick-up and delivery times for truck operators result. To compensate for these consequences, some motor carriers add vehicles and drivers and extend hours of operation. These compensations not only result in cost increases that ultimately are passed on to consumers but they also add to roadway congestion. In time, these problems can encourage firms to move part of their business to other, less congested, regions.

Growth in freight transportation is not expected to slow. Nationally, between 1998 and 2020, total Vehicle Miles of Travel (VMT) is expected to increase on average by more than 2.5 percent annually. Truck VMT however is expected to grow by more than 3 percent annually.

An example of the impact of congestion on freight is the regular route from Everett to Tacoma. Two round trips take nine hours during the day but night drivers complete three round trips in eight hours. FHWA has estimated that increases in travel time cost shippers and carriers an additional $25 to $200 per hour depending on the product carried. The cost of unexpected truck delays can add another 50 percent to 250 percent. Some delivery trucks in the Region now add an extra rider to their vehicle in order to qualify for the HOV lane.

The impact of congestion on freight movement has not gone unrecognized. The Freight Action Strategy for the Everett-Seattle-Tacoma Corridor (FAST Corridor) is a partnership of 26 cities, counties, ports, federal, state and regional transportation agencies, railroads and trucking interests, intent on solving freight mobility problems with coordinated solutions. The partnership targets projects of benefit to the movement of freight through the ports, on the roads and rails. Typical projects involve lane widening and grade separation of arterials from rail corridors. Among other things, these projects help reduce both car and truck delay. A number of successful projects have been promoted; however, the partnership has also identified a long list of as yet, unfunded projects.

Some companies have elected to schedule deliveries in off-peak periods. One company has implemented an incentive program that offers lower freight costs for customers accepting deliveries in non-peak hours. Savings can be 25 percent to 30 percent. Approximately 10 percent of all deliveries fall within this program. However, there are limitations to the effectiveness of the policy since smaller customers frequently find it is not cost-effective to have their facilities open after hours to receive deliveries.

Environment

Traffic congestion contributes to smog and pollutants. Under federal and state regulations, the Puget Sound Regional Council is required to demonstrate that the long-range metropolitan transportation plan, *Destination 2030* and the Transportation Improvement Program (TIP) conform to the State Implementation Plan (SIP) for Air Quality. PSRC is responsible for

modeling and evaluating air quality in the Puget Sound area in relation to growth and development plans and ensuring that air quality meets federal standards.

Areas are tested based on National Ambient Air Quality Standard (NAAQS) for a given pollutant. Six pollutants have been established:

- Ozone (1-hour and 8-hour standards),
- Carbon monoxide,
- Nitrogen dioxide,
- Sulfur dioxide,
- Particulate matter (less than 10 microns in diameter and less than 2.5 microns in diameter), and
- Lead.

Results fall into two designations:

Non-Attainment: An area that does not meet the standards;

Maintenance: An area that was previously non-attainment but which has since achieved the standard as demonstrated through continued air quality monitoring.

The Central Puget Sound Region is currently designated a maintenance area for carbon monoxide and particulate matter and is in attainment for all other standards. Generally, reduced congestion has positive air quality effects since vehicle engines are more efficient when they can avoid stop-and-go traffic and arrive at their destination sooner.

Safety

Experts believe that while congested traffic conditions may increase the number of vehicle crashes and interactions, their severity is normally lower than crashes under non-congested free flowing conditions. This is primarily due to the slower speeds of vehicles when congestion is present. One study using London data concluded that "results lead us to suspect that congestion as a mitigator of crash severity is less likely to occur in urban conditions, but may still be a factor on higher speed roads and motorways."

In the September 2006 Gray Book, a separate study reported equally inconclusive findings based on the analysis of State of Washington data in regard to severity of incidents in relation to congestion. However, it is reported that there is conclusive evidence that rear end collisions are highly correlated with congestion.

Construction zones frequently are responsible for both congestion and incidents and they must be carefully managed with a high priority given to safety concerns. WSDOT utilizes detailed guidelines and best practices to manage work zones to minimize impacts on road safety.

Energy

Congestion adds to energy usage with every hour of unnecessary delay on the roads. In addition, stop and go traffic is less energy efficient than traffic that flows smoothly at more continuous speeds. For this same reason, coordinating traffic signals for smoother continuous flow is a policy promoted by regional Air Quality Management Districts because the relative energy efficiency affects pollution.

HOW IS THE PUGET SOUND REGION'S TRANSPORTATION SYSTEM MANAGED?

Governance

Governance of the Puget Sound Region Transportation System is a complex process involving many parties. The problems that multiple parties create have been recognized by the Legislature and, in 2006, led to the creation of the Regional Transportation Commission, a citizen advisory group, to examine means of improving both the governance and the financing strategies for central Puget Sound's transportation needs. A final report was issued to the State Legislature in December 2006. The following is an abbreviated summary of the roles of the various regional partners in decisions regarding the management of Puget Sound's Transportation System:

Washington State Legislature

The House and Senate Transportation Committees are actively involved in managing State transportation expenditures. In 2003, the Nickel funding package was enacted which identified 158 projects to be funded over a ten-year period. Funding came from $0.05 per gallon increase

in the state tax on motor fuel, a 15 percent increase in gross weight fees on heavy trucks, and a 0.3 percent increase in sales tax on motor vehicles. In 2005, the Transportation Partnership Account (TPA) was adopted which increased the motor fuel tax by $0.095 per gallon over several years. Program and construction sequences were determined by the legislature.

Washington State Department of Transportation (WSDOT)

WSDOT is the primary transportation agency for the state with responsibilities that include: planning and construction, operations, and maintenance of all state roads and bridges. WSDOT does not maintain and operate state highways in cities with more than 22,500 people. As a result, the Department is responsible for very few roadways beyond the freeways in the Puget Sound Region.

Department responsibilities are administered through six regions. The portion of the Puget Sound Region with heavy traffic congestion is included in WSDOT's Olympic and Northwest WSDOT regions. There is also an Urban Corridors office responsible for the Alaskan Way Viaduct and other proposed large projects within Puget Sound. Washington State Ferries is a component of WSDOT. Transit operations are handled by local or regional bodies (including Sound Transit).

WSDOT operating and capital budgets have two-year cycles and the transportation commission helps direct the strategic development of the budget. The current 2005-2007 cycle provides a total budget of $3.5 billion.

On a regular basis, WSDOT collaborates with the WSTC to develop and update the twenty-year Washington Transportation Plan (WTP). The latest version is the 2007-2026 plan. The plan outlines goals and objectives for the entire state, not just for WSDOT.

Washington State Transportation Commission (WSTC)

The role of the Transportation Commission is largely advisory and, in cooperation with the Department, produced the 2007-2026 Washington Transportation Plan. It was also responsible

for oversight of a tolling plan. In the past, the Commission played a greater role in prioritizing state transportation projects.

Washington State Patrol (WSP)

The Patrol is responsible for enforcement and investigations on all state freeways and state highways outside of incorporated areas. A joint operations agreement with the Department and Washington Association of Fire Chiefs helps facilitate rapid response through training and agreed-upon procedures for on-scene traffic incident management. In partnership with the Department, the State Partrol has assigned trooper cadets to motorist assistance duties in King and Pierce Counties. Assistance patrol cadets work with the Department's incident response teams in Seattle on I-5 and in Tacoma on State Route 16. Cadets provide assistance to the motoring public when a trooper would otherwise be unavailable by aiding disabled motorists, removing roadway debris, assisting with collisions, and responding to a wide variety of other service calls.

Puget Sound Regional Council (PSRC)

The PSRC was established in the Puget Sound Region in 1991 to act as the Regional Transportation Planning Organization (RTPO) and the Metropolitan Planning Organization (MPO). Members include: King, Kitsap, Pierce, and Snohomish Counties, 71 cities within the region, four port districts, regional transit agencies, the Department of Transportation, the Washington Transportation Commission, the Muckleshoot Indian Tribe and the Suquamish Tribe. There are seven associate members: the Daniel J. Evans School of Public Affairs, Island County, the Port of Edmonds, the Puyallup Tribe of Indians, the Snoqualmie Tribe, the Thurston Regional Planning Council and the Tulalip Tribes. The governing body is a 32-member executive board that meets monthly. Most regional transportation planning is monitored by the transportation policy board, an advisory board that has 24 voting members and 19 non-voting members. Membership includes representatives of the jurisdictions, the state legislature, regional business, labor, civic, and environmental groups. By state law, all state legislators who represent districts within the PSRC's counties are also ex-officio, non-voting members of the Transportation Policy Board.

The PSRC develops three connected plans. *Vision 2020* is the Region's growth strategy, *Destination 2030 i*s the Region's long-range transportation plan, and a regional economic strategy is developed as part of the PSRC's role as the region's federally designated Economic Development District. *Destination 2030,* first adopted in 2001 and most recently updated in 2007, provides a 24-year regional investment strategy for roads, transit, freight and goods mobility, non-motorized transportation, and demand and system management.

The PSRC is a planning agency that distributes approximately $160 million in federal transportation funds each year. Seventy-four percent of the agency's operating revenues are from federal grants.

The RTC report stated: "PSRC is in an excellent position to accomplish the goals of regional transportation prioritization, but its current organizational charter and governance structure preclude it from carrying out that role. Today, the PSRC does not have the decision-making authority to oversee or prioritize specific projects for the four-county region's transportation plans. This authority would be essential if the PSRC is to prioritize the region-wide projects that most efficiently address congestion problems." Although PSRC is well positioned to identify and coordinate projects region-wide that could address congestion as a central goal, centralized prioritization of state funding is not within the statutory authority of the PSRC. This lack of authority results in problems in building consensus regarding regional priorities in support of congestion relief.

Regional Transportation Investment District (RTID)

RTID represents the counties of King, Pierce, and Snohomish counties. The Legislature authorized the creation of RTID in 2002 when the RTID planning Committee and Executive Board were charged with financing responsibilities to raise money to support transportation needs in the Region. The legislation was modified in 2003 to ensure that each county would receive a proportionate share of tax revenues generated within that county. The same legislation allowed the RTID investment plan to be modified by either a vote of the people in each county or

by Councils if the project costs exceed the original estimate by more than 20 percent. RTID was also given bonding authority and the right to use several funding sources, including a Local Options Gas Tax of up to 10 percent of the state gas tax. In 2006, additional financial modifications were made to the enabling legislation. An important addition was the requirement that the RTID planning committee submit its project and financing plan to voters along with the Sound Transit Phase 2 plan on the November 2007 ballot. This package deal is an all-or-nothing approach; both measures will either pass or fail.

The RTID Planning committee consists of 22 members. The Washington Secretary of Transportation serves as the non-voting chair. Voting power is weighted based on population. RTID has developed *A Blueprint for Progress* that identifies road and bridge projects along key corridors in the three counties to be funded over a 20-year period. The revenue sources identified are a proposed 0.1 percent sales tax and a 0.8 percent motor vehicle excise tax. RTID is heavily dependent on Department of Transportation staff support.

Central Puget Sound Regional Transit Authority: Sound Transit (ST)

In November 1996, voters in the urban areas of King, Pierce, and Snohomish Counties approved the local taxes to create Sound Transit. The agency's mission is to plan, build, and operate regional transit systems and services to improve mobility for Central Puget Sound. The system includes: high-occupancy vehicle (HOV) lane access improvements, ST Express bus routes, Sounder commuter rail, Link light rail, and new park-and-ride lots and transit centers. Sound Transit’s boundaries include the urban portions of the three-county area. Transit is governed by an 18-member Board of Directors; 17 members are local elected officials, and the 18th member is the Washington Department of Transportation Secretary.

The Sound Transit 2 package includes 50 new miles of light rail, improvements to commuter rail services, additional express bus services, and funding for operations and maintenance of the new facilities until 2028. This package, together with the RTID roads and bridges package, will be voted on in November 2007.

Other Transit Agencies

King County Metro was created by a merger of the Seattle Transit System with the Metropolitan Transit Corporation that had been serving suburban areas. Today, Metro serves a population of 1.8 million.

Pierce and Kitsap Counties each have transit agencies operating within their boundaries. In Snohomish County, Everett Transit serves the City of Everett while Community Transit is Snohomish County based. Both Everett Transit and King County Transit are part of their city/county governments. Pierce Transit, Kitsap Transit, and Community Transit are operated as independent public transportation entities governed by boards of elected local officials.

Counties of Central Puget Sound

The four counties of the central Puget Sound Region (Kitsap, Pierce, King, and Snohomish) are responsible for the unincorporated areas and extensive networks of streets and roads and bridges that form the complimentary transportation network to the State Highways. Each budgets, plans, manages, and maintains their networks.

Cities of Central Puget Sound

There are 82 incorporated cities and towns in central Puget Sound — the largest of which is Seattle followed in order of size by: Tacoma, Bellevue, and Everett. This is a further layer of ownership and governance in the regional transportation system.

The multiplicity of agencies in the Region, not unlike many other major metropolitan areas, is a constant factor in the complexity of addressing the kinds of problems like congestion that does not respect government boundaries. All regions today have coordinating councils or other similar means to communicate issues and plans.

The RTC focused a great deal of its attention on this problem in its recent report to the Governor. Its primary recommendation proposed a much stronger centralized agency with a purview encompassing highways and transit and other modal sectors for planning, prioritizing, and funding needed transportation. The Commission noted:

> *Formal and informal discussions with over 100 individuals and 50 agencies reveal the difficulties that these individuals and agencies face when attempting to prioritize regional interests in transportation infrastructure. These officials bring hard work, intelligence, and insight to their roles. However, they are charged with advancing the interests of an individual agency, district, city, county, or the state as a whole, or with protecting the interests of a particular mode of transportation, such as roads or transit.*

A key element in any coordinating body's role will be in assuring that transit investment decisions are integrated into the broad transportation planning process.

THE TRANSPORTATION PLANNING PROCESS

Transportation planning, prioritization, and programming defines the transportation decision making process by which transportation investments are conceived, evaluated, and matched with funds for construction. According to WSDOT, transportation planning is the first phase of this process that is developed in close coordination with Washington State's Metropolitan Planning Organization (MPO). In the case of the central Puget Sound Region, the Puget Sound Regional Council (PSRC) is designated by the Governor and local governments as the MPO. The process provides an opportunity to consider the effects of transportation enhancements for reducing congestion across the regional transportation system as well as an opportunity for goal-setting.

The state-of-the practice in long-range transportation planning focuses on meeting the goals and objectives of federal legislation. The Federal transportation statutes — amended by the Transportation Equity Act for the 21st Century (TEA-21) and the Safe, Accountable, Flexible, Transportation Equity Act, a Legacy for Users (SAFETEA-LU) define planning factors related to economic vitality, safety and security, accessibility and mobility, environment, integration and connectivity, system management and operations, and system preservation that must be considered by MPOs. These factors leave room for the integration of congestion objectives into the planning process through the long-range transportation plan; however, congestion mitigation

as a stand-alone goal is not required for states and metropolitan areas in order to satisfy federal planning certification reviews.

The joint regional and statewide planning process of WSDOT and PSRC has been certified by the U.S. DOT FHWA as meeting long-range transportation planning regulations under SAFETEA-LU. The spirit of the legislation provides "significant new authority" for MPOs, empowering them to play a lead role in choosing which transportation projects will receive federal funding. The PSRC, along with local agencies, WSDOT, and the regional transit organizations as partners, are responsible for determining long-range transportation needs and including them in a financially realistic long-range transportation plan. PSRC evaluates projects proposed for inclusion in the regional transportation plan through a process that seeks to ensure consistency with regional goals, completion of needed environmental review, and cost-benefit information where appropriate. A short-term strategy to implement or build these priorities would then be reflected in the regional Transportation Improvement Program (TIP).

In the Puget Sound Region, the process meets federal requirements and has even won planning awards. However, the federal process limits MPO's authority to select projects on the national highway system (primarily freeways in the Puget Sound Region). In addition, the MPO has no authority to select state-funded projects.

While requirements are being met, the spirit of these requirements — one of a "significant new authority" for the Region — is essentially overlooked due in part to the legislature's active role in project selection. A clear linkage between planning, project selection, and programming does not exist.

Because of a lack of funding prior to 2003, many transportation projects in Washington State that have been identified through the planning process have not been implemented. These unfunded projects form a backlog or "historic pipeline" of many needed enhancements which have been known and understood for 10years or more. The 2003 and 2005 state transportation budget packages have provided significant resources to start implementing some of this backlog.

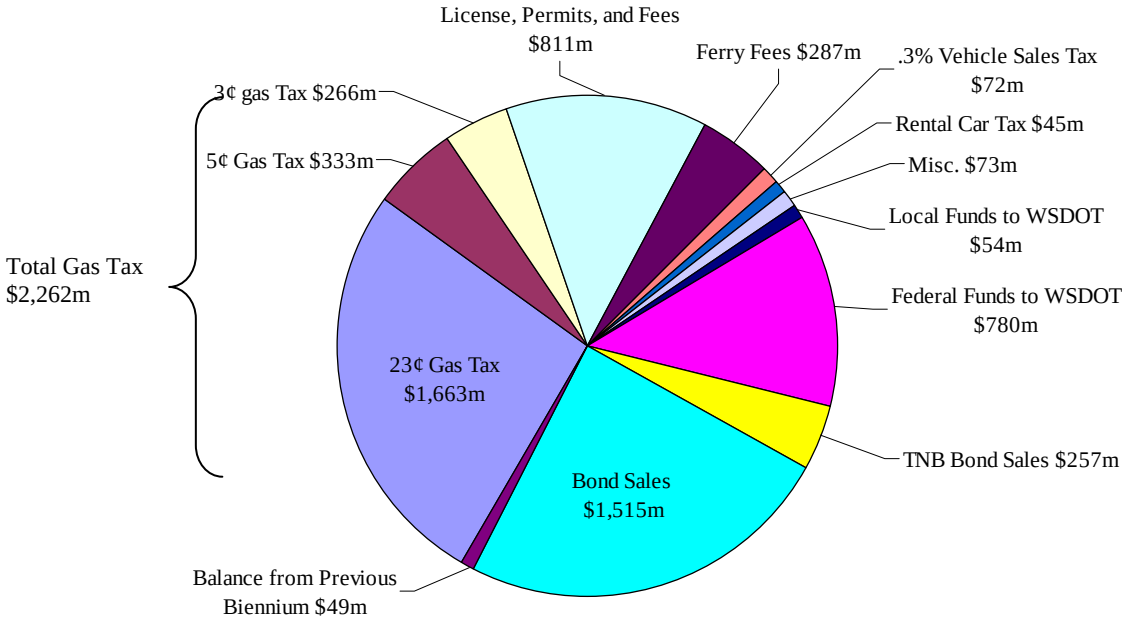
To select projects for funding, WSDOT ranks them on the "historic pipeline" list, and submits the ranked list to the Washington Legislature. The Legislature chooses the projects that will be funded with state and federal funds that they have project selection authority over.

PSRC is responsible for "programming" projects — including the projects in the TIP — that are chosen by the legislature, by PSRC, by local agencies, and by transit agencies. The PSRC TIP process attempts to ensure that projects proposed for funding are consistent with the region's transportation plan, conform with regional air quality requirements, have available funding, and are ready for implementation. The TIP has been described as a plan where most of the investment decisions are made by the Legislature after a review of planning data and then simply added to the plan. The regional TIP process also includes a public review process to enable citizens an opportunity to comment on projects proposed for funding.

FUNDING

The following figure identifies WSDOT's primary sources of funds for its 2005-2007 budget. Many of these sources were committed under the recent tax referenda (the Nickel and TPA packages) and have already been matched with projects. The 2007-2009 capital budget request prepared by WSDOT for the Legislature does not propose any new mobility projects — projects that are most likely to include congestion reduction benefits — and only proposes funding for the completion of projects previously approved by the Legislature.

2005-2007 Statewide Transportation Funds
$6.2 Billion



Source: WSDOT 2005-2007 Budget

This budget shows a combination of gasoline tax and federal funds. In addition to funds provided at the state level from fuel and excise taxes, counties, cities, and public transit authorities can levy taxes to be used for local transportation enhancements.

Motor Vehicle Fuel Tax:
A statute dating from 1944 limits these revenues only to highway uses and prohibits any funding for mass transit. The current rate when fully implemented in 2008 will be $.375 per gallon, less than the inflation-adjusted rates of the 1950s and 1960s.

Motor Vehicle Excise Tax (MVET):
From 1977 until December 1999, part of these revenues helped fund transportation systems. This tax was capped in 1999 and was eventually repealed altogether by the Legislature.

Sales Taxes:
Counties, cities, and public transit authorities can levy a general sales tax within their jurisdiction of up to 0.9 percent. Prior to 2000 they received matching money from MVET revenues. In addition Sound Transit was authorized to tax regional sales in its constituency at a 0.4 percent rate.

Funding transportation improvements of all kinds in the Puget Sound Region has been a struggle. In 2002, the Legislature approved a $0.095 increase in the gas tax to support an extensive package of improvements. This package was taken to the electorate as Referendum 51 which failed to find popular support. However, King County voters did approve a 0.2 percent transit sales tax to restore service cuts necessitated by the loss of MVET. In 2003, the Legislature approved a $0.05 per gallon gas tax increase to fund $4.2 billion in priority "Nickel projects." The package will fund 158 projects over a ten-year period. In addition to the gas tax, revenues were raised from a 15 percent increase in gross weight fees on heavy trucks and a 0.3 percent increase in sales tax on motor vehicles.

In 2005, the Legislature approved a 16-year expenditure plan that raised the gas tax over a period of four years by $0.095 per gallon. It also relied on a vehicle weight fee on passenger cars and light trucks and an annual motor home fee. This is referred to as the Transportation Partnership Act program. In 2005, there was an unsuccessful attempt to repeal this legislation by referendum.

WSDOT also uses federal funds to support the state's large investment. As noted on WSDOT's website, "Federal funding is an important supplement and complement to state transportation funding, providing about 15 percent of WSDOT's overall budget, and 20 percent of the WSDOT capital budget, for the 2007-2009 biennium." While federal funds are important, the bulk of WSDOT's program is driven by state resources.

Current federal funds have been committed to support projects under the TPA and Nickel programs. The state's contribution then makes up the difference between the required investment to complete chosen projects and the federal allocation. This approach will also be used for the RTID program, if approved.

While committing federal dollars under these packages provides revenues for needed projects, it also leaves limited funds available for regional projects beyond of these pre-set packages. PSRC notes that 70 percent of all regional investment decisions are pre-committed under these

programs. The remaining 30 percent of federal dollars are those from the Congestion Mitigation and Air Quality Improvement (CMAQ) Program and Federal Transit Administration (FTA). These funds cannot be used to fund general purpose capacity, are tailored to transit investment, and are outside of WSDOT's control.

INVESTMENT PRIORITIES

The planning, prioritization, and programming process in Washington State has been described as very complicated. While the planning processes at the statewide and metropolitan level should set the goals and objectives for prioritizing projects and then programming them in the regional transportation improvement program for the PSRC Region, investment prioritization appears to occur at the legislative level, where projects are essentially earmarked under the funding programs described above.

WSDOT takes responsibility however, for providing project prioritization information to the Washington Legislature. WSDOT, with support from PSRC, prioritizes the historic project pipeline by a number of methods, including:

- "Check-box evaluation," where congestion benefits are shown as equivalent to environmental, safety, and other benefits by simply checking a box if the benefit exists, and
- Cost-benefit analysis, in which benefits include delay savings through value-of-time calculations, is part of WSDOT's Mobility Prioritization Process (MP3). WSDOT estimates that congestion related benefits account for about 64 percent of the benefits included in this calculation.

Projects from the historic pipeline are ranked by WSDOT and submitted to the Washington Legislature for programming. The Legislature chooses projects that will be matched with funds and constructed. However, political realities typically require a financial balance in spending to areas based on revenues generated there. From a transportation systems perspective however, spreading investments evenly across jurisdictions rarely makes sense, as many of the most critical projects necessary to deal with congestion will likely be grouped in certain areas as is the case in the Seattle metropolitan region.

Results

WSDOT's Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion

Talbot, Korvola & Warwick, LLP

RESULTS

con · ges · tion [k*uh* n-**jes**-ch*uh* n]
–noun overcrowding; clogging: *severe traffic congestion.*

Traffic congestion is a condition characterized by slower speeds, longer trip times, increased queues, and reduced throughput of vehicles. When traffic demand exceeds the capacity of a road, congestion occurs. Congestion rarely involves a smooth set of changes, but rather a breakdown with an abrupt drop in speeds requiring a longer period of time to recover. Extreme traffic congestion, where vehicles are in stop-and-go conditions is commonly known as a traffic jam.

Traffic congestion is a national problem. It disrupts our daily lives and weakens our economy. In recent years congestion has begun to receive attention as a problem that should be a focus, if not *the* focus, of all transportation agencies. This call for a new emphasis in transportation comes from the U.S. Department of Transportation (U.S. DOT), individual state DOTs, as well as a diverse group of national organizations including the American Association of State Highway and Transportation Officials (AASHTO), the Government Accountability Office (GAO), and the Reason Foundation.

In May 2006, the U.S. Secretary of Transportation announced a major initiative to reduce transportation system congestion. This plan, the *National Strategy to Reduce Congestion on America's Transportation Network* (the "Congestion Initiative"), provides "a blueprint for federal, state, and local officials to consider as we work together to reverse the alarming trends of congestion." The former US Secretary of Transportation has stated: "Congestion is not a scientific mystery, nor is it an uncontrollable force. Congestion results from poor policy choices and a failure to separate solutions that are effective from those that are not."

WSDOT reports that if there were no traffic congestion, the average morning and afternoon commute in Puget Sound for 2005 would take fifteen minutes. "Normal" traffic congestion increases this time by 13 minutes or 87 percent (morning commute) to 14 minutes or 93 percent

(afternoon commute). In recent years, traffic conditions have progressively become worse even though the rate of growth in traffic has slowed. Between 2003 and 2005, hours of delay on major freeways in Puget Sound have increased by 23 percent. Preliminary results for 2006 show the problem continues to escalate with delays on major freeways higher in 2006 relative to 2005 and morning peak period speeds below 25 miles per hour 9 percent of the time (up from 2 percent in 2003). Afternoon peak period speeds fall below 25 miles per hour 11 percent of the time (up from 4 percent in 2003) and below 45 miles per hour 48 percent of the time (up from 35 percent in 2003). WSDOT estimates delays in 2005 totaled more than 256,000 hours per day. A recent Reason Foundation report forecasts that congestion in Seattle will rival conditions in the nation's largest metropolitan areas within 20 years — although already few metro areas can report worse statistics than these.

Traffic congestion, however, is not just about average delays, but also about not being able to predict when we will reach our destination — a lack of reliability. The average commuter in Puget Sound must provide a margin equal to almost three times the congestion-free travel time (2.7 times in the morning and 2.9 times in the afternoon) in order to be 95 percent certain to arrive on time. This extra time adds almost one hour for a morning commute from Everett to Bellevue and 37 minutes for the trip from Federal Way to Seattle.

These results suggest fragility in the Puget Sound highway network. This fragility has become much worse in the last few years. Further, in places where demand often exceeds capacity, the potential capacity of the system has sometimes dropped further. For example on I-405 between I-90 and SR 167 during the morning commute, average throughput dropped by more than 100 vehicles per lane per hour from 2003 to 2006. The average number of vehicles that the system handles is well below that expected from modern roadways. This situation reflects a network that has been modified and adjusted many times over the past thirty years with a loss in system-wide effectiveness — despite the well-intended nature of these individual changes.

While this performance audit examines WSDOT directly, the audit also focuses on traffic congestion in the Puget Sound Region. Congestion management is unique. It differs from most

government services in that it is not confined to jurisdictional boundaries, yet each agency can only address congestion on its own section of roads. WSDOT, for example, controls little more than the major freeways in the Puget Sound Region. Although an extremely important component of the transportation network, it is not the only part of the roadway system affected by congestion. Some 128 agencies manage aspects of transportation in the Puget Sound Region. In terms of spending, in 2003 WSDOT accounted for 40 percent of total highway expenditures in Puget Sound Region and about 20 percent of total spending by highway and transit agencies in the Region. WSDOT's share is likely to increase somewhat as the Nickel and TPA programs continue to come on line.

Many urban areas measure congestion and track historical trends. WSDOT is a national leader in this field. However, few regions or states use congestion as a focus to improve transportation investments and operations. Nationally, there are no agreed-upon standards to define an unacceptable level of congestion. Some states, however, have begun to set targets for their own departments of transportation. While it is still too soon to judge the success of these efforts, both Georgia and Texas have set targets for their own departments of transportation. Georgia has set a maximum travel time index of 1.35 for Atlanta (meaning that the typical trip would take no more than 35 percent longer than if there was no congestion), while Texas calls for reducing congestion by 50 percent over the next 25 years to a state-wide level of 1.20. Using 2003 data, the 2005 Texas Transportation Institute's Urban Mobility Study calculated Seattle's average travel time index as 1.38. These actions indicate that at least the potential for quantifiable success exists.

Congestion affects our lives in many ways. Individually, the most immediate impact is on our mobility meaning our ability to travel when, where, and how we choose. Time spent in traffic congestion means more than lost time and increased stress. Congestion wastes fuel, increases air pollution, and can lead to additional accidents.

Congestion has a direct impact on our economy. Business trips are less likely to be completed on time — either our ability to get to work on time or the ability to deliver freight when a

customer needs it. Some trucking companies in Puget Sound have decided to restructure their business to avoid travel at congested times or have added additional drivers and vehicles in order to maintain a reliable schedule. Congestion can also discourage some people or businesses from making trips.

Congestion limits a firm's access to labor just as it limits the number of potential jobs within a reasonable commute time of where a worker lives. Firms may need to increase their inventory of goods on hand to offset congestion risks. Congestion can affect business location decisions and some firms may look to less congested parts of the metropolitan region or to other cities entirely for future expansion. Dell Computer for example, located a new manufacturing facility outside the state of Texas as a result of traffic congestion in its home base of Austin, Texas. For the first time in more than two decades, the cost of transportation to the U.S. economy has increased. These costs are passed on to consumers and make it more difficult for United States' businesses to compete with firms in the global economy.

Most efforts to quantify the cost of congestion focus on direct losses such as delay in time and higher costs to operate vehicles. These numbers exceeded $63 billion nationwide in 2003. The addition of the economic costs described above (mostly related to productivity losses, reduced reliability, and increased pollution) could add another $100 billion — more than double the direct costs.

Congestion reflects an imbalance between supply and demand — an excess of highway travel demand relative to highway capacity. Since 1980, lane miles in Puget Sound have increased by approximately 2 percent compared to an 82 percent increase in vehicle miles traveled. This minimal increase in lane miles has almost no impact on improving congestion issues.

This imbalance is a national problem and not exclusive to the State of Washington or to the Puget Sound Region. Reasons for this inability to add new capacity in Puget Sound are complex and include:

A lack of adequate funds for highways

For almost two decades prior to the 21st Century, the State of Washington was unable or unwilling to increase motor fuel taxes — the primary source of funds for roadways. This has changed in recent years and some new roadway capacity has begun to be built around the state, including in the Puget Sound Region. However, current levels of funding and proposed investments (RTID, for example) will only serve to slow the rate of growth in congestion. Failing to invest in any additional capacity would more than double the level of congestion over the next 20 years.

Increased difficulty of adding lanes today versus 30-40 years ago

Stronger concerns over protecting the natural environment along with related laws and regulations have lessened the ability to add additional capacity through new lanes. Continued growth in urban areas also makes it more expensive to add new lanes as well as making it politically difficult to purchase existing homes and businesses. A recent rebirth of interest in light rail transit in the Region has led some to argue that transit can offer a practical solution to traffic congestion, making new highway capacity less relevant. Forecasts for Puget Sound and experience elsewhere, however, show that the likely congestion benefits from rail transit are limited. For example, forecasts for Sound Transit 2 call for 74,000 new transit trips a day in 2030 when PSRC forecasts more than 11 million daily trips in total for the Region.

A lack of focus on congestion as a solvable problem

This is a national concern. The phrase "we can't build our way out of congestion" is often said by planners and some transportation executives. While new construction is only one of the tools available to reduce congestion, the belief that congestion is simply something we have to live with tends to discourage action and limit innovation. Change, however, has started, as indicated by recent efforts by the U.S. Department of Transportation and the states of Texas and Georgia.

A fractured decision-making process for investments in Puget Sound

While congestion is one of the objectives used to evaluate transportation investments, its role in project selection is unclear and it represents one of many objectives used by WSDOT and the Legislature to select projects for funding. Transit and highway programs are planned and funded largely as independent efforts.

Competing decision making bodies in the Puget Sound Region

There are an estimated 128 public entities with a role in selecting transportation investments, carrying these out, and then operating the system. Although each of these entities has varying authorities and responsibilities, the very large number does make it difficult to select and implement actions that offer a comprehensive approach to traffic congestion. While WSDOT has an important role in the Region, its focus on the network of major freeways limits its ability to plan, construct, coordinate, and manage transportation in the Region.

These issues are not unique to the Puget Sound Region, WSDOT, or the State of Washington. However, while WSDOT has been revitalized in recent years, the lack of a focus on solving congestion problems has contributed to the imbalance between the demand for travel and the supply of capacity in Puget Sound.

The answer to the question: *How can metropolitan areas such as Puget Sound manage congestion?* has several parts. While congestion has grown rapidly, the tools available to deal with regional congestion problems also grows providing states and metropolitan areas with a range of solutions to manage and, in some cases, reduce, traffic congestion. The congestion tool box has three components:

1. Better manage the existing system (a comprehensive response to congestion)
2. Shift demand to other modes or times, eliminate trips, or provide priority for certain trips (managing demand), and
3. Add capacity, new lanes in particular (adding capacity).

A Comprehensive Response to Congestion

The Puget Sound Region stands as one of a few major urban areas that have increased the share of trips that use transit, carpools, and vanpools. While still small (19 percent in total), the Puget Sound Region ranks among the top eight metro areas in this measure. At the same time, the absolute number of people who use single occupancy cars continues to increase in Seattle and the Region. Although these programs have had an impact in the Region, barriers do exist limiting the ability to effectively manage the existing transportation system.

One of the challenges faced by transportation agencies when addressing traffic congestion is that they can only manage their respective "real estate." No single entity is responsible for all traffic congestion. The Puget Sound Region would benefit from a coordinated effort focusing on the congestion tool box. The establishment of a regional, responsible entity would direct its efforts on providing planning, design, funding, and operations responsibility for highways and transit. Its mandate would include clear targets to improve congestion. While several options exist for how such an entity might be organized, one option is covered in the report prepared for the Legislature last year by the Regional Transportation Commission.

An important part of one responsible entity, either an entirely new regional transportation entity or a division within the Department of Transportation, is to change the setting of spending priorities to reflect congestion relief as the primary goal (once safe roads and bridges have been assured). Today, the weighting system applied to support investment decisions is unclear, particularly in regards to congestion. Analysis of the impacts on congestion is usually performed after an investment package has been selected. A more transparent process would help improve public confidence as well as make it easier to track performance.

In collaboration with taxpayers and the State Legislature, WSDOT or a new regional transportation entity should determine the level of acceptable congestion as a policy objective. Setting such a target is partly a political decision and as such is likely to consider quality of life issues including the environment, available funding, and the shape of an economic environment

in which businesses and residents can thrive. The availability of funds will be key, since adding new lanes is not only the most effective way to reduce congestion, but is also the most costly.

Transportation is a means to an end. Transportation agencies are the instrument of carrying out policy, rather than the policy-setting body. The community and its representatives should decide the level of acceptable congestion. Transportation agencies such as WSDOT (or a new regional entity) should manage within these goals. Although a new concept for surface transportation, this is a common practice among private firms and some public agencies. U.S. DOT has set a congestion goal among its annual targets for itself as have Texas and Georgia DOTs.

Today, WSDOT considers congestion as one of many goals. However, a clear commitment to congestion reduction defined as the agency's primary goal (after meeting safety requirements) would likely shift investment decisions. Using congestion levels as a key decision factor will require changes in WSDOT's (and by extension, Puget Sound Regional Council's) planning and programming process. It will also change the culture within the Department.

In order to move toward committing to congestion as the primary goal, the Washington State Legislature would need to require WSDOT, PSRC, and Sound Transit to use a very different performance measure — hours of delay reduced per million dollars spent. Monitoring reports would display these rankings and performance based on this figure. For example, WSDOT has plans to improve the flow of traffic on I-5 through the center of Seattle; however, these plans will only be carried out as part of a planned pavement reconstruction program scheduled for the next decade. While WSDOT's plan will minimize the total costs of the project, it also will delay the benefits from reduced congestion for 10 years.

There is an interaction between congestion and other transportation objectives — particularly environmental and safety goals. When Metro Atlanta modeled congestion improvements, it was observed that a program focused on reducing congestion also improved safety and air quality. In Washington, the reconstruction of the SR-520 floating bridge was motivated in large part by safety concerns. However, it also created the opportunity to add capacity with either a six — or

eight-lane bridge and improved connections on both shores. In addition, minimizing stop-and-go traffic significantly reduces fuel consumption and air pollution.

With this in mind, objective-driven management, with associated rewards and penalties, is the ultimate goal. Consistent and regular reporting of transportation system performance should have positive impacts on not only what transportation agencies do, but also how well they do it. Useful feedback can be provided to voters and their representatives on the efficiency of their tax dollars spent.

Managing Demand

WSDOT is among the nation's leaders in implementing programs to reduce travel demand on the highway system during the most congested times. In particular, it has developed an effective Commute Trip Reduction program and extensive vanpool program.

In addition to being a leader in travel demand management, the Puget Sound Region already has one of the nation's largest high-occupancy vehicle (HOV) systems. In 2008, WSDOT will implement a pilot test of a high-occupancy toll (HOT) lane on SR-167. HOT lanes make spare capacity in the HOV lane available to single occupant vehicles that pay a toll — which varies according to level of congestion — in order to guarantee a more predictable travel time. This is part of a new trend across the country and could be expanded to other parts of the Puget Sound network.

WSDOT and the region should consider a regional HOT Lane network. This could be implemented for a relatively modest cost and would ensure full use of unused capacity on the region's network of existing and planned HOV lanes. More importantly, the use of variable prices would provide significant benefits to the region's economy by increasing the likelihood that more trips will be completed on time. WSDOT's plan to implement a pilot project on SR-167 in early 2008 offers an excellent opportunity to identify technical problems and to assess how well this approach would work in the Puget Sound Region.

Adding Capacity

The third tool in the congestion management tool box is adding lanes to increase capacity. For several decades, the addition of lane miles in the Puget Sound Region has not kept pace with growth in demand. The recent Nickel and Transportation Partnership Account (TPA) funding packages begin to address this backlog. The package proposed by the Regional Transportation Investment District (RTID) will help as well, in part due to its focus on the Puget Sound Region. While these programs will add capacity in certain places, they were not developed with congestion reduction as a primary objective. Rather RTID proposes projects that reflect past suggestions from WSDOT and local and regional entities. They provide a geographic balance across the region. While adding new capacity will help reduce congestion from what it would be without the investment, the RTID plans were not developed with congestion reduction as a primary goal, rather a focus was on providing a package that would be most likely to generate a broad base of political support across the region. At best, they will offset a portion of the expected long-term growth in congestion.

Notwithstanding all the initiatives currently being undertaken by WSDOT, a considerable imbalance remains between supply and demand in the Region. The I-5 corridor is the busiest and arguably, the most strategic corridor in the state. Yet efforts to add capacity over the last two decades have been limited. This corridor also has national importance given its role in serving international and interstate freight movements.

Adding light rail to the I-5 corridor will have a measurable but very limited effect on traffic congestion. Because of the physical constraints along I-5 in downtown Seattle, most of the currently available tools are unlikely to reduce traffic delays along the corridor compared to today's congestion levels. Non-traditional options should be examined such as a car-only tunnel which, though expensive, could be designed with a smaller profile than traditional full-service tunnels to help move commuter traffic.

New Technology

Transportation technology is changing, in terms of how vehicles operate, how highways are managed, and how the two communicate with each other. Because the pace and nature of these changes are beyond the control of any single state or metropolitan region, this report does not focus on technology. However, these changes offer long-term solutions for significant improvement in the effective capacity of the Region's highway system.

Many of these changes are grouped into a program called *VII* — Vehicle-Infrastructure Integration. This program is an effort led by the U.S. DOT that would coordinate actions by the automobile manufacturers and the state DOTs and other transportation entities. Automobile companies would agree to add certain communications and related technology to all new vehicles while the public sector would allow the deployment of communications technology that would make it possible to share real-time information among vehicles and to and from the DOT and other public entities. The implications of this technology are far reaching, including the ability to have real-time information on travel conditions and safety issues across the entire roadway network. At the same time, in-car improvements should make it possible to allow vehicles to travel closer together in safety. In time, this would make it possible to reduce spacing between vehicles, thus increasing the capacity of existing roadways. How soon this new technology might happen is not clear since it requires not only the development of technology (well on its way) but also the deployment of these systems across a large fraction of the fleet. Beyond technology, institutional issues concerning who would own, operate, and finance such a system remain unresolved.

Although not mentioned as a specific recommendation (since it will have no practical value for congestion within the next five years and since success requires actions by organizations well beyond the control of WSDOT or the State of Washington), WSDOT should continue to be actively involved in the discussions over VII and should seek to participate in early test bed activities.

What Can be Accomplished in the Next Five Years?

Opportunities currently exist based on each of the three types of tools available: 1) improving operations (including enhancing current capacity), 2) shifting demand, and 3) adding additional capacity. Although specific recommendations focus on long-term investments (most importantly, the addition of new lanes), most proposed actions can be implemented over the next five years.

Many actions can be accomplished within WSDOT's existing budget while some require major investments and thus depend on reprogramming some current investment plans. However, the potential gains derived from the recommended strategy will be significant, providing a broad base of benefits for the citizens of the Puget Sound Region. These changes will likely require a delay in some portions of the TPA and Nickel Programs or a shift in geographic focus. Making these changes calls for discussions with the Legislature.

At present, the average throughput of the Puget Sound roadway system is low, averaging less than 1,400 vehicles per lane per hour during peak traffic conditions. Recent history shows that the system is fragile — small negative changes can have large negative impacts on speed and travel times. A key focus of several recommendations is to work to reverse this decline in average throughput. These actions should make it possible to "buy" approximately five years of time. Thus, if changes could occur instantly, congestion levels might return to those experienced in 2001 or 2002.

In addition, actions designed to shift demand to other modes or to other times of the day should be able to offset the growth in peak-hour demand by another year or two of growth. A regional approach to coordinated traffic lights to improve throughput could reduce travel times on major arterials by up to 20 percent. Major arterials account for almost 40 percent of regional traffic delay and are an important part of traffic congestion. Allowing single occupant cars to use excess capacity in HOV lanes (at a price) would make it easier for high priority trips to be completed on time. Other recommendations cover improved operations as well as actions needed to support these larger changes.

The implementation of these tools will yield substantial improvements. However, after the initial yield, re-implementation will result in diminishing returns. In the long term, if the region wants to make progress on traffic congestion, it will need to focus on investments that add new lanes to the region's roadway capacity. New lanes are expensive and a regional transportation entity would help support cost-effective implementation. This would be encouraged by having clear and enforceable congestion performance targets. Such targets might include clear and specific goals regarding congestion reduction and summary measures such as hours of delay reduced for proposed investments in highways and transit. A vital underpinning of this effort is to develop a culture within WSDOT that brings a focus on reducing congestion with support from an improved planning and programming process. While WSDOT should have a major role in most recommendations, success requires actions by others, most importantly the State Legislature.

The near-term actions summarized above could reduce traffic delays in the region by 15 percent to 20 percent, with most gains focused on the region's network of freeways and major arterials. This could save 12 million to 16 million hours of delay each year, saving the average commuter approximately 10hours of travel time and the Region approximately $300 to $400 million in travel time and vehicle operating costs annually.

These estimated benefits will result from:

- Reduction of legacy design problems and related bottlenecks (making more effective use of existing infrastructure),
- Coordination of traffic signals on arterials, and
- Expansion of demand management (expanding an already successful WSDOT program that has a focus on peak-period travel).

The primary effect of infrastructure improvements will be an improvement in vehicle flow. One way to measure this is by an increase in effective capacity. An increase of 150 vehicles per lane per hour would offset the decline in capacity since 2001 and increase the effective flow to about 1,500 vehicles per lane per hour. Although still well below the flow achieved by new roadways, this improvement would reduce the hours of delay in 2010 by 6 percent to 8 percent.

Traffic signal coordination is a national problem that reflects the difficulty in coordinating changes across multiple jurisdictions. Experience in other regions shows that appropriate traffic signal coordination can reduce delays on arterials between 13 percent and 30 percent. The Region could potentially reduce delays 13 percent to 18 percent. However, since arterials account for less than 40 percent of regional traffic delay, the region would most likely realize gains between 5 percent and 7 percent.

WSDOT estimates that its current traffic demand program has reduced congestion by more then 11 percent. Over the next five years, increasing resources and expanding to support telecommuting programs, could make it possible to double the current number of peak-period trips diverted from single occupancy vehicles. This could potentially reduce delays by an additional 4 percent to 5 percent.

These benefits correspond to a potential savings of $300 to $400 million in direct operating benefits (based on a $25 per hour estimate for travel time and operating costs). Not included in this calculation are environmental impacts from reduced emissions and economic gains by improved access to jobs (for workers) and to employees (for firms). Other estimates show these gains could be as much as 150 percent of direct savings. Because economic gains are likely to be more modest for a single region these additional gains are estimated at another $300 to $400 million annually. These total benefits (or "avoided costs") exceed $600 million per year. As actions are implemented, benefits will increase over time but could also be achieved within the next five years.

Improvements to one portion of the highway network create impacts on other parts. For example, improved capacity on the freeway system will attract some trips from the arterial network as well as generating a small increase in overall VMT. Similarly, improving traffic signal coordination along major arterials will divert some trips from the freeways, thus reducing congestion there as well.

These numbers understate the value of these changes since it is difficult to quantify the impact of reduced stress from missing meetings, personal appointments, or deliveries, and the economic gains from improved reliability. A regional commitment to reducing traffic congestion along with the ability to show tangible near-term progress toward this goal could have positive economic impacts on the Region. While difficult to estimate on a regional basis, this could more than double the benefits for the Region. WSDOT is among the nation's leaders in implementing programs to reduce travel demand on the highway system during the most congested times. In particular, it has developed an effective commute-trip reduction program and extensive vanpool program.

Introduction to Recommendations

A key focus of the following identified recommendations is to work towards reversing the decline in effective capacity. A critical first step however, calls for the State of Washington to adopt congestion reduction as its primary focus (once safety is assured). The Audit Team has identified this commitment as Recommendation #1. WSDOT, in conjunction with statewide leadership, should commit to reduce congestion in the Puget Sound Region as its primary goal. The goal of congestion reduction must be a top priority, along with safety, across all programs and agency objectives — starting with the planning process. The Transportation Commission along with WSDOT, the Governor, and the Legislature have made system preservation and maintenance the top priority — not uncommon among state DOTs. However, the goal of congestion reduction is currently a component of the Agency's goal of mobility (the third priority after maintenance and safety) where mobility has many other meanings in addition to congestion relief.

Closely linked to Recommendation #1 is the second recommendation which calls for WSDOT to continue to do what it does best in demand management and operations but with a greater emphasis on increasing capacity in the Region. A successful approach to congestion management requires all three parts of the tool box.

In the short term, capacity can be addressed by eliminating some of the "legacy design" components of the regional highway system (Recommendation #3). WSDOT is not alone in this problem where design standards appropriate for the old Interstate Highways system simply cannot meet the demands of the information technology age. By modifying the system to effectively add capacity, actions designed to shift demand to other modes of transportation or to other times of the day should be able to offset the growth in peak-hour demand by another year or two of growth. However, given the time required to plan and design new lanes, general capacity as a stand-alone issue should be addressed immediately. Allowing single occupant cars to use excess capacity in HOV lanes (at a price) would make it easier for high-priority trips to be completed on time.

With congestion reduction as the primary goal, the deficiencies in the regional planning process must be addressed, particularly the components in project selection. Recommendations #5 to #9 underscore the importance of focusing on congestion reduction from planning through prioritization to programming. Better linkages among these three components also will allow for more transparency with the public and elected officials and make it easier for WSDOT to answer the question: "What has been done to reduce congestion?" Using clearly defined performance measures will have important implications not only for choosing those investments that provide the most relief per dollar of investment, but also for garnering public support — a key barrier to capacity expansion in the Region.

Other demand management and operations enhancements are addressed in Recommendations #10 to #20. Of these, expansion of WSDOT's commuter trip reduction program, to include an aggressive telecommuting component, will likely have high payoffs at minimal cost. Additionally, automating ramp metering and other incident response functions will help reduce recurring congestion. Recommendations #21 and #22 complete the full set of congestion reduction strategies and include possible solutions that must be addressed over time such as the potential for an I-5 tunnel through downtown Seattle and completion of the HOV system (with or without some of the more expensive interchanges).

A Comprehensive Response to Congestion

Issue 1: WSDOT does not Focus on Congestion as a Primary Goal

Today, WSDOT regards congestion as one of many important "sub-goals." This may reflect an unclear direction provided by the State Legislature or an effort to meet a myriad of goals, each aimed to please a particular constituency. Congestion-related objectives are considered to be part of WSDOT's goal to increase mobility for people and goods. The Washington Transportation Plan provides the overarching goal of mobility as priority #4 in the "prioritized investment guidelines," among: 1) preservation, 2) safety, 3) economic vitality, and 5) environmental quality and health. Congestion is, in fact, an important part of mobility. However, mobility includes other objectives as well. WSDOT notes that 18 different Washington State laws address criteria for project prioritization; many of these criteria are in conflict. The resulting confusion provides ample opportunity for lack of accountability, certainly as it relates to performance in reducing congestion, but also as it relates to other objectives.

The correlation between congestion management and investment decisions is not well-defined. WSDOT has not elevated the goal of congestion reduction to priority level despite the degraded traffic conditions in the Puget Sound Region. Although WSDOT, consistent with other state DOTs, has focused on safety as its primary objective, congestion reduction and safety are not mutually exclusive. Safety always outweighs congestion reduction, particularly when overcoming structural deficiencies on regional bridges. However, approaching congestion reduction as a stand-alone goal (perhaps in line with or as a close second to safety) will help achieve other more "attitudinal" goals related to quality of life and economic vitality often used in transportation planning activities.

When Metro Atlanta modeled congestion improvements, it was observed that a program focused on reducing congestion also improved safety and air quality. In Washington, the reconstruction of the SR-520 floating bridge was motivated in large part by safety concerns; however, it also created the opportunity to add capacity with either a six- or eight-lane bridge and improved connections on both shores.

A clear commitment to congestion reduction as a primary goal would shift investment decisions. Congestion reduction as a key decision factor will require changes in WSDOT's prioritization process. More importantly, it will require the Legislature to choose/identify projects based on congestion reduction rather than other agendas. The Legislature currently chooses packages of projects but those projects not chosen generally are not evaluated based on their potential effects on regional congestion. This process makes it difficult, if not impossible, for WSDOT (and the public in general) to measure and track the ability of alternative investment packages to meet the commitment to reduce delay. No summary score-card exists that shows the benefits of projects chosen versus those not regarding congestion reduction on the Puget Sound regional transportation system.

A commitment to congestion reduction as a primary goal will require performance measures that can be used to evaluate investment decisions. The Legislature should require WSDOT, PSRC and Sound Transit to use a common measure of effectiveness such as hours of delay reduced per million dollars of investment for each project that they consider. Possible options should display these rankings and then the performance of actual investments implemented should be monitored on this basis.

The Legislature should also commit to following these priorities when it comes to identifying projects as part of any future tax package. For example, WSDOT has plans to improve the flow of traffic on I-5 through the center of Seattle. However, the current plan calls for completion of this improvement as part of a planned pavement re-construction program scheduled for 2017. While this approach will minimize the total costs of the project, it also will delay the benefits to the traveling public from reduced congestion for 10 years. If congestion reduction was a primary goal, these enhancements would likely occur much sooner.

Committing to congestion reduction starts with top-level leadership including the Washington State Legislature and WSDOT. Leadership within WSDOT is required to move towards a

congestion-based approach. WSDOT should consider organizational changes that would support a new emphasis on congestion.

Recommendation 1a: **We recommend the Washington State Legislature choose/identify projects based on congestion reduction rather than other agendas.**

Recommendation 1b: **We recommend WSDOT commit to congestion management and reduction as a primary goal.**

WSDOT Response: Congestion reduction is critical, and one of many important priorities that are WSDOT's responsibility. The Governor and WSDOT, with the support of the Legislature and Transportation Commission, have chosen to focus first on the safety, preservation, and maintenance of the state's transportation system. This "fix it first" mandate is critical, as it ensures the continued and long-term use of the 7,000 centerline miles of state highways upon which we depend. These priorities are not unique to Washington they reflect the priorities of many states nationally and governments internationally.
The 16-year financial plan includes 388 projects specifically related to the revenue packages passed by the 2003 and 2005 Legislatures. These legislatively mandated projects, worth more than $14.9 billion, are targeted to safety, preservation and congestion relief.

OFM Response: Addressing congestion is of great importance to the Governor, the Legislature, WSDOT, and the citizens of our state. Yet safety, preservation, and maintenance must remain our highest priorities. We must continue to protect travelers and the investments we have made. Economic vitality and environmental protection also must remain high priorities.

We need to improve how we communicate about what is being done to address congestion in each of the following categories: 1) adding system capacity, 2) managing demand, and 3) improving operating efficiencies. Unfortunately, we currently do not have the budgeting or reporting systems in place to organize data in this manner.

For example, the following are programs that address congestion, yet are not formally categorized as "congestion relief."

- **Capacity Improvements –** The 2003 and 2005 Legislatures respectively passed nickel and nine-and-one-half cent revenue increases to support the largest capacity improvement program in Washington State history.
- **HOVs** – As of 2006, 205 miles of the more than 300-mile central Puget Sound HOV system have already been opened to traffic, 44 miles are currently being designed, and 58 miles are under construction. Over $1.1 billion has been spent on the core HOV system to date.
- **Incident Response** – There are 55 incident response vehicles on the freeways to assist drivers promptly and keep traffic flowing when there is an incident. The number of incidents

to which WSDOT has responded increased from 17,479 in 2002 to 59,276 in 2006. In the 2007-09 biennium, $9.5 million is committed to this program.

- **Park and Ride Lots** – There are 294 park-and-ride lots statewide with more than 35,000 parking stalls.
- **Traffic Management Centers** – WSDOT maintains seven Traffic Management Centers throughout the state. The cost to operate these centers in 2007-09 is about $5.5 million. These systems provide real-time travel information to the media and keep the variable message signs updated with current traffic conditions and incidents.
- **Real-Time Traffic Information** – The real-time commute trip information provided by more than 475 traffic cameras and other equipment has become an expected part of every daily newscast to help travelers determine their commute time. Based on a survey cited in the audit, 11 percent of commuters change or postpone their trips based on real-time traffic information.
- **Variable Message Boards** – Of the 169 variable message boards statewide, 80 are permanently located in the Puget Sound area. These boards have become an important tool for managing traveler expectations and for providing sufficient notice to drivers to use alternative routes. They are estimated to have a current value of $25 million.
- **Ramp Metering** – Ramp meters are a proven means of smoothing and increasing traffic throughput. Since 1981, the department has increased its use of ramp meters in the Puget Sound area from 22 to 135. The long-range estimated need for King, Snohomish and Pierce Counties is approximately 140 additional ramp meters at a cost of $180 million.
- **Commute Trip Reduction** – More than 1,100 worksites participate in the CTR program. CTR has reduced 14,200 vehicle trips each weekday morning and has reduced travel delay by an estimated 11.6 percent. The audit recommends doubling this program annually. The appropriation for the current biennium is $5.6 million.
- **Van Pools** – Every work day, approximately 1,389 vans operate in the Puget Sound area, with more than 1,650 vans statewide. Washington has the largest van pool program in the nation.
- **Urban Partnership Agreement –** The U.S. Department of Transportation recently awarded $138 million to WSDOT, King County, and the Puget Sound Regional Council in an Urban Partnership Agreement to reduce congestion in the SR-520 corridor with an innovative combination of transit, technology, telecommuting, and variable tolling. WSDOT will continue to work with the Governor's Office and the Legislature on implementing the Urban Partnership proposals in the 2008 and 2009 legislative sessions.

These are just a few examples of the size and type of investments made to address congestion relief, yet budget and reporting systems are not in place to easily summarize and communicate this kind of information.

<u>Action Steps and Timeframe</u>

- OFM will convene a budget instructions workgroup in the fall of 2007 to evaluate, among other things, how we budget and report on congestion relief. This effort will be completed by June 2008.

- The 2007 Legislature mandated OFM to report on the progress being made on five policy goals in a newly required attainment report. Congestion will be addressed under the mobility policy goal. OFM will convene an attainment report workgroup in the fall of 2007 to address which congestion measures should be included in this report. The first report will be submitted to the Legislature in December 2007.

Auditors' Comment: Although safety, preservation, and maintenance of the State's transportation system is appropriate, congestion relief is not an independent action and does not imply that any of these components should be sacrificed. In fact, congestion relief supports other objectives, including safety, air pollution, economic growth, and rehabilitation.

Issue 2: WSDOT must Use a Combination of All Available Tools to Effectively Mitigate Congestion

While congestion has grown rapidly, the tools available to deal with regional congestion problems also continue to grow, providing states and metropolitan areas with a range of solutions to manage, and in some cases, reduce traffic congestion. WSDOT currently uses a variety of these tools to manage congestion with varying degrees of success. These tools can be combined into three distinct categories: 1) managing demand, 2) operating the system more effectively, and 3) adding capacity.

Managing Demand

One measure of a Region's ability to handle work trips efficiently is the number of workers per vehicle. On this basis, Seattle ranks as one of the top urban areas in the country with 1.28 workers per vehicle in 2005 (1.28 = total persons going to work divided by total vehicles carrying workers to work; in this case 1.83 million workers in 1.43 million vehicles). As the following illustration indicates, this level of efficiency places Seattle in select company along with Boston and Philadelphia, traditional eastern transit-oriented cities and behind only four areas in the country.

Area	Ratio of Workers to Vehicles in the Commute
New York	1.65
San Francisco	1.35
Chicago	1.33
Wash D.C.	1.31
Seattle	1.28
Philadelphia, Boston	1.28

Source: Commuting in America III, TRB, NAS

Seattle was among the few areas that saw that ratio rise between 1990 and 2005. Most metropolitan regions saw sharp declines. Despite this impressive effort, the number of vehicles in use in the commute rose to 1,430,000 in 2005 increasing by 240,000 vehicles since 1990, including 225,000 as single occupant vehicles.

The Puget Sound Region has one of the nation's largest HOV systems and in 2008, WSDOT will implement a pilot test of a High Occupancy Toll (HOT) lane on SR-167. HOT lanes make spare capacity in the HOV lane available to single occupant vehicles that pay a variable toll — which varies according to level of congestion — in order to guarantee a more predictable travel time. This new approach is being used across the country and could be expanded to other parts of the Puget Sound network.

Operating the System More Effectively

WSDOT is currently recognized among its peers as a leader in transportation operations. WSDOT's Assistant Secretary chairs the AASHTO technical subcommittee on operations and systems. WSDOT is a leader in applying active traffic management principles to improve operations. However, opportunities exist to do more. For example, many freeway management systems rely on manual operation rather than automated systems. For these manually-operated systems, expanded and modernized ramp metering has proven to be a successful option. This is also true for other entities in the Region. Traffic signal coordination, for example, has proven to be an effective, low-cost way to improve travel times on major arterials.

Adding Capacity

The third tool in the congestion management tool box is adding capacity. For several decades, the addition of lane miles in the Puget Sound Region has fallen well behind growth in demand. The recent Nickel and TPA funding packages begin to address this backlog with a statewide program. Additional dollars are included in the RTID package that will go before voters in November 2007. While these programs will add capacity in certain places, they were not developed with congestion reduction as a primary objective. Rather, RTID proposes projects that reflect past suggestions from WSDOT and local and regional entities. They provide a geographic balance across the region. While adding new capacity will help reduce congestion from what it would be without the investment, the RTID plans were not developed with congestion reduction as a primary goal, rather a focus was on providing a package that would be most likely to generate a broad base of political support across the region. At best, they will offset a portion of the expected growth in congestion.

The need to focus on operations improvements is self-evident where such modifications can make significant contributions. They tend to be lower in cost and faster to implement than most other approaches resulting in high pay-offs — pay-offs in the range of 17 to 1 are possible. WSDOT's strategy has emphasized effective operation of expensive facilities. This is a logical first step towards using other parts of the congestion tool box.

WSDOT should take full advantage of effective operations before moving to other more expensive options. The public expects high pay-off approaches to be implemented before transportation leaders seek expensive new facilities or propose policies that may affect other choices.

Operational approaches have a primary weakness — options are limited as are the number of places to do them. Although new approaches are being developed, certain opportunities may have been exhausted. Recent research conducted as part of an assessment of the future of the Interstate System discovered that many options were not advisable until volumes grew sufficiently in the future. This research indicates that limitations exist regarding what can be

done cost-effectively at any given point of time. Even with the high volumes in the Puget Sound Region, only so many additional ramp meters can be added.

The demand management philosophy also has weaknesses. Limits exist in regard to how far governments can convince travelers to change their behavior. As the population and economy grow and facilities become more congested, individuals may be forced to shift where and how they live and travel. These actions can cause people and companies to find more congenial and productive life styles in other metropolitan areas. Continued growth in the Puget Sound Region area will result in an increase in the value of time lost due to congestion and will lead to an enhanced willingness of citizens and freight companies to pay for faster, more reliable service.

The growing wealth of our society and of the Puget Sound Region area, will lead citizens and freight companies to require, and be willing to pay for, faster, more reliable service. As wealth grows, the value of time increases. The system in use today will be less acceptable in future years to people whose value of time has risen. Time lost will be judged more severely against new standards. The history of household expenditures indicates that individuals increase their spending on transportation in both absolute and percentage terms as their incomes rise (except for individuals with very high incomes). The number of trips, the length of those trips and the modes chosen all increase with income. This trend makes congestion reduction an even more important policy and planning objective.

The economic and social costs of congestion will grow — even if the Puget Sound Region is able to keep congestion from getting worse. WSDOT (and PSRC among others) would benefit from tracking the effect of congestion on individuals and firms.

WSDOT should continue to seek every opportunity to improve operations in order to gain additional capacity from the current system. However, WSDOT also needs to recognize that pay-offs in the future will be limited and more difficult. Inevitably, there will be a need for new lanes for general purpose capacity. The Region has added almost a 250,000 vehicles to its commuter pool over the past 15 years. WSDOT has been immensely and successfully diligent in

that period at improving operations and demand management but additional lanes are still needed. WSDOT is correctly perceived by its peers in the transportation business as a leader in operations. WSDOT should continue to build on this leadership position to develop demand and supply-based solutions.

Recommendation 2: **We recommend WSDOT use all tools at its disposal to mitigate the growth in traffic congestion recognizing the relative contributions each tool can make, its benefits, and associated costs with a focus on generating maximum congestion relief.**

WSDOT Response: We appreciate the audit's acknowledgment that WSDOT has been diligent and successful in using demand management and other tools to improve traffic conditions. We agree that numerous tools are required. WSDOT's use of such tools are documented in the response to Recommendation #1. The recently-released 2007 Urban Mobility Report by the Texas Transportation Institute suggests a series of congestion relief strategies and tools, all of which are closely aligned with WSDOT's current initiatives, strategies and projects.

OFM Response: We agree that WSDOT must continue to use all available tools to effectively mitigate congestion. To remain a national leader in this area, WSDOT will need to continue bringing creative approaches to the Governor and Legislature for their consideration. One example being explored by DOT is Active Traffic Management which may improve throughput and reduce incidents through innovative concepts, such as "speed harmonization." This includes such things as installing overhead gantries across the highway at close intervals to allow drivers in each lane to be warned of upcoming roadway conditions and speed changes. It also includes consideration of variable speed limits, lane closures, and the use of shoulders if feasible.

Action Steps and Timeframe

- WSDOT will evaluate the costs and benefits of active traffic management including "speed harmonization" and report to the Governor and the Legislature during the 2008 legislative session.
- The SR-167 HOT lane pilot will open in the spring of 2008. WSDOT will report on the effectiveness of the HOT lane pilot project on a semi-annual basis beginning in the fall of 2008.
- WSDOT will continue to convene local and state entities regularly to exchange information and share ideas about tolling policies, practices, and strategic initiatives. These ideas will be presented to the Governor and the Legislature by June 2008.
- As part of the Urban Partnership project, various tolling options will be evaluated and submitted to the Governor and Legislature for consideration in the 2008 legislative session.

Existing lane capacity is not being used to its full potential — primarily due to a legacy of older designs and to a series of individual additions and changes over the past thirty years or more that often do not appear to have considered system-wide effects. This combination degrades the effective capacity of portions of the freeway network to levels significantly below those that can be achieved using new construction techniques. While a modern freeway can handle 2,000 or more vehicles per lane per hour, the Puget Sound Region performs in the 1,300 to 1,800 vehicles per lane per hour range. Reduced productivity is partially due to demand exceeding capacity. Roadways in the low end of this range (such as I-405 between I-90 and SR167 and the central part of I-5) have frequent stop-and-go traffic. Almost half (48 percent) of the afternoon peak period is spent at 45 miles per hour or less versus 35 percent in 2003. Examples of deficient design practices observed in the Puget Sound Region include:

- Interchanges with cloverleaf design configurations which include short (300-foot) merge/diverge weave segments. Short sections of weaving results in congestion and bottlenecks.
- Left lane on/off-ramps (for example at I-5 and Corson, I-5 and Seneca, I-5 and SR 520, SR520 and I-5, SR 518 and I-5, Mercer St. and I-5 north bound): Friction in the outer lanes caused by merging, diverging, and weaving segments has a negative impact on performance of the freeway as a whole and compromises safety. These configurations go against driver intuition. Additional signs are required, adding to driver confusion.

Issue 3: A legacy of Outdated Design Practices from Previous Eras Degrade the Effective Capacity of the Freeway Network

- Closely spaced interchanges (I-5 between Spokane St. and the Convention Center for example). The weaving caused by closely spaced interchanges can decrease effective lane capacity. For example, existing data shows a 20 percent to 25 percent decrease in potential lane capacity on I-5 in the downtown area where interchanges are most closely spaced. In this area, the effective throughput on I-5 is 1,500-1,600 vehicles per hour per lane where approximately 2,000 vehicles per hour per lane is possible on roads with current standards.

WSDOT has begun to address existing configuration problems as part of major improvement and resurfacing projects. The Broadway left lane off ramp in Everett was removed and replaced with a right lane off-ramp as part of the recently completed I-5 upgrades. However, WSDOT usually addresses these as part of larger freeway improvements and has not tried to implement other options such as the actual elimination of some left hand exits or some closely spaced exits. WSDOT has also started to use a collector-distributor configuration freeway construction with

closely spaced interchanges such as I-405 at NE 4th and NE 8th interchanges. These configurations are reflected in WSDOT current design standards.

Of the six worst bottlenecks in Washington State, five are located in Seattle. The worst in the state, with delays almost 10 times more than the second most congested bottleneck, is located on I-5 at the I-90 interchange. This bottleneck affects more than 300,000 vehicles per day and results in more than 14 million hours of delay per year. This I-5 bottleneck is caused by a number of factors including:

- High vehicle demand. The demand and projected growth on the I-5 at the time it was originally designed has since been exceeded many times.
- Left lane off ramps (for example, I-5 and Corson).
- Old design standards (these have since been significantly improved and enhanced but existing configurations are rarely retrofitted).
- Close spacing of interchanges.

As a result of these design issues, the segment of the I-5 in the I-5/I-90 vicinity is currently operating at an effective throughput of approximately 1,600 vehicles per hour per lane. This throughput is significantly less than the theoretical capacity of freeways which is 2,000-2,200 vehicles per hour per lane. This 25 percent shortfall in lane capacity indicates that significant potential exists to make physical or operational improvements to increase capacity.

WSDOT should emphasize re-designing the freeway configurations that result in bottlenecks and chokepoints as a result of compromised designs. National best practices and guidelines for freeway interchange designs are reflected in the FHWA Freeway Management and Operations Handbook and the Highway Capacity Manual (HCM). These manuals also provide guidance for the use of auxiliary lanes and/or collector/distributor lanes in areas with closely spaced interchanges.

An effective way of increasing throughput capacity is to focus on system-wide lane continuity and lane balance on the Puget Sound freeway network. WSDOT considered such an approach in their traffic operations study for I-5 through Seattle. This study was completed in 2003 and identified a series of improvements, including:

- Providing three mainline lanes in each direction through the Central Business District,
- Extending the termination of express lanes south to Spokane Street and north to SR-104,
- Revising the collector-distributor system in the vicinity of 4th Avenue, and
- Improving numerous other ramp and weave section improvements (such as the connection from westbound I-90 to northbound I-5).

Full implementation of these improvements is not expected before 2017 — the current schedule for reconstructing the pavement on I-5 through Seattle. The approach — minimize current overall costs to WSDOT rather than spending more now in order to reduce congestion in the near future — will ultimately cause further system problems and cost far more to correct. WSDOT conducts an ongoing traffic operations review to estimate the likely full impact of these changes.

Other innovative approaches and best practices which address congestion by maximizing existing capacity should also be considered. Best practice approaches to maximizing capacity include use of medians, shoulders, reversible lanes, etc. The use of shoulders to increase capacity for the mainline freeway is used as part of WSDOT's active traffic management approach — in response to incidents, construction, and other capacity-limiting events. Also, in the past, WSDOT has converted numerous shoulder sections into permanent lanes. However, more can be done in some areas (although not necessarily in the downtown portions of I-5) including:

- Allowing buses to use shoulders
- Using the right shoulder lane as travel lane during peak periods
- Providing a shoulder evacuation lane in response to natural disasters

The use of reversible lanes makes it possible to use "unused capacity" in one direction to carry traffic on congested lanes in the other direction. Reversible traffic operations are usually motivated by one of five general categories:

- Mitigation of routine peak-period congestion,
- Enhancement of transit and high-occupancy vehicle (HOV) operations,
- Traffic management during special events,
- Maintenance of capacity through construction work zones, and
- Emergency movement of people during natural disasters.

WSDOT should place a higher priority on utilizing existing capacity to reduce congestion. Strategies such as use of shoulders and reversible lane operations (using existing lanes) can be put in place in the near term at relatively low costs (i.e. costs associated with these strategies would include signage, barriers, enforcement, and strengthening some shoulders to handle increased vehicle loadings). Another option that would provide immediate improvements is to lengthen merge and deceleration lanes at older interchanges where bottlenecks currently occur due to "old design standards and practices" that would provide immediate improvements.

Reconfiguration of interchanges with left hand off or on ramps, to provide right lane on and off ramps although relatively costly, would provide significant improvements to traffic conditions and safety as a result of the elimination of weaving. WSDOT should also consider the use of collector distributor configurations in areas that currently experience significant weaving (I-5/Mercer segment, for example).

Recommendation 3: **We recommend WSDOT reduce weaving and other traffic conflicts across the Puget Sound freeway network focusing on:**

- **improving interchange design,**
- **eliminating some left-hand exits,**
- **reconfiguring key interchanges/freeway segments that experience significant weaving, merging, and safety hazards,**
- **adding reversible lanes where practical, and**
- **using collector/distributor configurations wherever practical.**

WSDOT Response: We agree that modern design standards more effectively accommodate safe and efficient traffic movement in congested areas. In today's highway projects, WSDOT uses design practices that offer more effective ramp and interchange configurations yielding greater throughput.

In the 1960s design of I-5 through downtown Seattle, many design deviations occurred largely because of the geological and physical constraints engineers encountered when constructing I-5. For example, the retaining walls on the east side of I-5 are literally holding up Capitol and Beacon Hills, and have tightly spaced 120-foot deep cylinder pilings below the walls. On the

west side of I-5, high density developments, including basements of high rise buildings, pose barriers. Please consider the following items pertaining to the recommendations.

- **Interchange Design** – Existing interchange designs, dating to the 1950s and 1960s, were developed to meet capacity and design expectations of the 1980s. Current use greatly exceeds what was anticipated. WSDOT has worked with the Legislature to discuss alternatives. Improvements to interchange design must consider local expectations, funding, and available land for construction. As the audit states, physical constraints significantly limit solutions.
- **Left-hand Exits** – For left-hand exits to be eliminated, directional ramps with right-hand exits would likely need to be constructed. The I-5 southbound exit to the SR-520 bridge is one of these left-hand ramps. The benefits/costs of these types of ramp relocations have to be evaluated to determine if there are any feasible alternatives.
- **Interchanges/Freeway Segments** – The Washington Transportation Plan, and the soon-to-be published Highway System Plan update, place great emphasis on addressing bottlenecks and chokepoints. A major traffic modeling effort was completed to identify these locations. Strategies have been developed to address these problems, but many remain unfunded.
- **Reversible Lanes** – It is not clear whether additional reversible lanes could be added north or south of downtown Seattle. Further assessment, including identifying benefits and costs, is needed.
- **Collector/Distributor Configurations** – The decision to add collector/distributor lanes must consider that high-rise buildings and other development are within feet of the freeway through much of downtown Seattle. It would carry substantial right-of-way costs to create room for a collector/distributor corridor.

OFM Response: WSDOT constructs to the design standards of the day. It would be cost-prohibitive to bring all outdated facilities up to current standards. The Central Puget Sound area is particularly problematic as noted in the WSDOT response, yet some opportunities for design and construction improvements may be available. Given the constraints on the current 16-year plan, additional funding would most likely be required.

Action Steps and Timeframe

- WSDOT will work with House and Senate Transportation Committee members during the 2008 legislative session to evaluate options that might be available to increase the effective capacity of the freeway network through downtown Seattle and the greater Puget Sound region.

Auditors' Comment: The need to replace left-hand exits with right-hand exits may not be necessary in all cases. Opportunities exist to use collector/distributors and reversible lanes beyond the central I-5 corridor.

Issue 4: WSDOT's Lack of Focus on General Purpose Capacity in the Last 20 Years has Resulted in a Shortfall in Lane Miles Relative to Population Growth and Traffic Demand

The addition of new roadway lane miles has fallen well short of growth in population and traffic demand in the Puget Sound Region over the past three decades. "*Since 1980, daily VMT [vehicle miles traveled] in the three-county region has increased by 82 percent, while roadway lane miles have increased by about 2 percent. By 2030, VMT is expected to increase by an additional 45 percent over current volumes. In the same period, lane miles will increase by only about 2 percent with currently planned improvements in the Region (PSRC 2001a*)"[2].

This shortfall creates a significant deficit in the lane miles needed on both freeways and arterials within the Puget Sound Region. This lack of capacity results in increased congestion, significant delays, and decreased reliability. Lack of sufficient funds is one reason for the lack of new capacity.

Capacity is the maximum amount of traffic capable of being handled by a given highway section. When certain physical aspects of the highway are at capacity, they create traffic "bottlenecks." These, in turn, restrict the flow of traffic, drop speeds below free flow, and increase travel times. Minimizing the impacts of or eliminating bottlenecks, by increasing capacity, is a direct and effective way to reduce congestion. In parts of the Region's freeway network, however, these bottlenecks require new lanes rather than local improvements.

Since 1980, the population in the Puget Sound Region has grown from two million people to approximately 3.2 million, an increase of almost 60 percent. The Region's population is projected to reach almost double the 1980 population by 2010. In this same period the demand for auto travel within the Region (as indicated by the total daily vehicle miles traveled) has more than doubled — an increase of 102 percent between 1980 and 2005. This population growth has been fueled largely by a robust regional economy supported by increased personal incomes.

[2] Sound Transit SEIS, P. 8 of chapter 4.9 http://www.soundtransit.org/x2399.xml

However, the number of lane miles of freeway capacity has not kept pace with the tremendous population and demand growth. In the early 1980s, FHWA stated that new construction should focus on HOV rather than general purpose lane construction. In addition, during the 1980s and 1990s the highway tax rates that funded the state portion of the highway program in Washington stagnated. While this has changed in recent years with passage of a $.05 per gallon increase and the TPA program, funds for the twenty years prior to this were restricted. In addition, available funds were often used to add capacity in other parts of the state with less congestion — Spokane and Vancouver. As a result, (from 1980 through 2000) construction has not been the first approach to congestion in the Puget Sound Region; instead operations and improvements to the HOV system were WSDOT's top priority.

WSDOT's plans for additional freeway miles do not come close to meeting the demand resulting from the Region's significant population increase and continued economic growth. Even with the additional capacity expected to be provided by the Nickel, TPA, and RTID projects, average speeds are expected to drop by approximately 8 percent and trip durations are expected to increase by almost 5 percent. In absence of RTID and ST2 improvements, analysis shows a 13 percent decrease in average speed and a 12 percent increase in trip duration.

State funds have been inadequate to address growing demand in the Region. Moreover state funds have not focused on the areas of most severe congestion (i.e. the Puget Sound Region). Notwithstanding all the initiatives that WSDOT has underway, a considerable imbalance remains between supply and demand in the Region. The I-5 corridor is the busiest and arguably the most strategic corridor in the state, yet efforts to add general purpose capacity over the last quarter of a century have been limited. This corridor also has national importance given its role in serving international and interstate freight movements.

Though construction of new capacity is the most expensive option available to WSDOT, it is likely to be the most cost-effective way to yield congestion reduction results. Even modest initiatives, such as the recent addition of an auxiliary lane on I-5 between University Street and Mercer Street that reduced travel times by 9 percent while total volume increased by 20 percent,

can have extensive localized effects. Larger-scale projects, which might include traditional surface widening, reversible lanes, and high-occupancy toll (HOT) lanes, will likely have even more dramatic results. If current population growth rates continue, WSDOT may also need to consider other options such as double-decking or tunneling to achieve the necessary system throughput.

A number of mitigating circumstances conspire to make the addition of lane miles very difficult. Aside from the cost of construction, which alone represents a significant barrier, geographic, commercial, regulatory, political, and environmental circumstances have and will likely continue to impede expansion. Among the most significant challenges is divided public sentiment regarding adding new lanes versus investing in more public transportation. This underscores the need for an aggressive public involvement program to accompany any project that seeks to add lane-miles.

As cited above, few capacity expansion projects could be classified as low-cost. A more appropriate measure would be cost-effectiveness, expressed in terms of reduction in delay per million dollars spent. Regardless of measure, a phased approach — one that combines modest short-term expansion and a more ambitious long-term capacity growth — is perhaps the most suitable.

Current land-use patterns coupled with geographically limiting factors such as large bodies of water leave limited right-of-way space for construction of new facilities in congested areas such as the I-5/I-90 interchange. Under such circumstances, adding the additional capacity necessary to offset long-term population growth may only be possible through the construction of grade-separated lane miles. In these cases, WSDOT is encouraged to examine non-traditional options. For example, while expensive, a car-only tunnel could be designed with a smaller profile than traditional full-service tunnels and could help move commuter traffic.

The need for additional capacity is region-wide as can be seen from the improvements proposed as part of the RTID Planning Committee Recommendation. The improvements selected cover a wide range of corridors in Snohomish, King, and Pierce counties.

In those instances where sufficient space does not exist along the center of the right of way, similar results may be obtained through modest outward expansion of the paved surface, the reversal of existing lanes, or both. Though it is unlikely that the net effect on throughput would be as great as that for newly constructed lane miles, it may still result in significant improvement.

Recommendation 4: **We recommend WSDOT accelerate design and construction of new lanes and additional capacity to address the previous 20-year deficit.**

WSDOT Response: The disparity between the growth rates of lane miles and the growth rates of population and economic growth has not been caused by a lack of focus on congestion, but a lack of funding. Like many other parts of the country, the primary cause for "not keeping up with growth" has been a lack of resources. Funding has not been identified to accelerate the design and construction of enough capacity to address the previous 20-year deficit.

As the audit acknowledges, the high cost of construction, geographic, commercial, regulatory, public sentiment, and environmental circumstances are all factors that have contributed to the shortfall of construction of new lane miles. In addition, state and regional policy makers have not indicated that solving congestion will be addressed only through freeway expansion.

WSDOT has focused its available funds on key capacity projects, such as adding HOV lanes (see OFM's response to #1). For example, I-5 has received significant investment during the last two decades. WSDOT has nearly completed the core HOV lanes on I-5 through King County, is in the process of completing the core HOV lanes in Snohomish County, and has been funded to complete the system in Pierce County to SR-16.

OFM Response: WSDOT cannot be held accountable for the under-funding of the transportation system. Thirteen years passed between the 1990 gas tax increase and the 2003 nickel gas tax increase. During that 13-year period, inflation increased by 31 percent, our population grew by 25 percent, and vehicle miles traveled (VMT) increased by 25 percent. The 5.0 cent gas tax in 2003 was bolstered by the subsequent legislative adoption of an additional 9.5 cent gas tax in 2005. These two legislative acts combined provided $ 14.9 billion in funding. In 2005, the voters rejected an initiative to repeal most of these increases.

Action Steps and Timeframe

This recommendation is beyond the control of WSDOT.

Auditors' Comment: While WSDOT does not control the level of highway taxes available for transportation, WSDOT does influence whether or not available funds are used to add additional capacity.

Issue 5: Multimodal Planning in the Puget Sound Region is not Focused on Cost-Effective Congestion Reduction

A 2005 article in the *Economist* noted that Seattle had the "worst transport planning in America." The article focused on multimodal transportation planning which includes all transportation modes (e.g.: highways, transit, and the once considered monorail initiative) and the "political culture" in the Region that has allowed for questionable multimodal proposals. Investments in transit, HOV, and general purpose infrastructure in the Puget Sound Region appear to be inconsistent with historic and forecast modal usage. They are disproportionate with the present shares of travel by mode and any reasonable forecast of future expected shares obtainable by these modes.

The State and Region may have other goals associated with the intent to shift modal usage (from single occupant vehicles (SOV) to non-SOV modes, including transit) outside of those related to congestion reduction. Such goals may be beneficial and may have merit unto themselves, but they can be very expensive, thereby placing heavy burdens on limited resources and providing limited prospects of congestion benefits.

Current proposals for transit improvements fail to show meaningful impacts on congestion. The Congestion Relief Analysis conducted for WSDOT in 2006 concludes: "[A] according to the computer modeling, transit expansion alone is not shown to be effective in reducing total delay at the system level." The "Transit Focus" scenario, which employs expenditures in the range of $25 billion to $33 billion with an annual operations and maintenance cost of almost $900 million, reduces expected delay in 2025 by only 6 percent (from 1,118,000 hours to 1,052,000 hours.) It further states: "A transit-oriented solution produces benefits for transit riders, but not much congestion relief for those traveling by auto."

A 2005 article in *The Seattle Post-Intelligencer* also cites the impact of the proposed Light Rail Transit (LRT) system on congestion — for every 100 people, only seven would ride LRT while the other 93 people would remain stuck in traffic. This is primarily because transit shares for LRT will primarily consist of current transit users and attract few highway commuters. In addition, LRT has a fixed capacity. When comparing the maximum ridership of LRT in the I-5 corridor in 2020 versus today's I-5 person-trips, LRT will carry only 14 percent of traffic. This statistic also may understate actual ridership as it compares 2020 ridership with 2005 highway volumes. 2005 highway volumes will likely increase greatly by 2025 further reducing the potential transit mode share.

NCHRP Report 08-36, Task 7(2) identifies the key requirements for multimodal tradeoff analysis, which include clearly defined performance objectives, evaluation criteria, and/or impact categories that define consequences of different levels of investment in each of the modal areas being explored. The framework suggests that multimodal tradeoff analysis is largely based on gathering and organizing data to present to decision makers.

In practice, multimodal tradeoffs are rarely explored beyond a conceptual planning approach because data are not readily available for comparison between modes. The NCHRP Report refers to the inability to compare multimodal tradeoffs in the Puget Sound Region for two separate case studies. The first case was originally constructed to demonstrate the application of the tradeoff approach at a programmatic level by investigating the benefits and costs associated with continued investment in ferry service across the Puget Sound versus continued investment in roadway improvement in the Puget Sound area. This case application was to evaluate the benefits from transferring these cost savings to improving roadways. The second case application was to demonstrate the application of the tradeoff approach at a corridor level by investigating the relative merits of several alternatives for improving transportation in the I-405 corridor. However, the NCHRP research team was unable to identify adequate data to fully test the framework on a program-level tradeoff analysis as was intended.

The report does provide a list of essential elements for tradeoff analysis that could be applied in Washington State. Defined congestion-based performance objectives are necessary along with a method to relate the level of investment in that area to the results in that area (e.g. delay reduced per unit cost). In addition, a method for comparing or "equating" the results generated by each program area (e.g. transit, general purpose, and HOV enhancements) as a result of a specific allocation of resources between the areas.

WSDOT's Multimodal Investment Choice Analysis (MICA) which is in development could potentially serve as a tool for comparing multimodal investments. MICA allows for multimodal projects to be ranked according to a user-specified prioritization scheme based on weights for various performance measures. If congestion is the key priority, weights should be reflected as such. MICA relies on a pre-determined set of performance measures however, which should be adjusted to reflect key delay measures such as delay reduced per unit costs. Additionally, applying MICA evaluations for programming and decision making is much more important than the rankings themselves. It is not enough to complete multimodal analysis as such analysis has to be applied to decision-making in the project programming process.

WSDOT actually has little or no influence over transit appropriations or project selection but can influence HOV expansion. The potential effects of consistent multimodal analysis for project selection would help focus Legislative and regional decisions on congestion impacts. Implementing this recommendation will likely have large congestion reduction payoffs, since they will force a focus on two key dimensions: cost and effectiveness in reducing congestion. At the same time, a regional entity would help influence these decisions since today no single organization has the necessary motivation to take the lead in providing, documenting, and implementing the effectiveness of more than one mode of transportation.

Recommendation 5: **We recommend WSDOT apply congestion-related goals, objectives, and benchmarks to all highway and transit-related investments.**

WSDOT Response: We agree that linkage between congestion-related goals, objectives, and benchmarks to all highway and transit-related investments is a desirable practice. Although WSDOT considers these linkages in the project selection process and collaborates with transit agencies, the Auditor correctly notes that WSDOT has little or no control over transit appropriations. It is not in our purview to comment on transit.

WSDOT agrees that having multimodal analysis for project selection would help focus legislative and regional decisions on congestion impacts. In corridor studies where congestion solutions are initially developed, WSDOT routinely evaluates multimodal improvement options. Only the most viable and cost-effective improvement options are recommended for implementation. For example, the I-405 corridor study in 2002 led to successful funding of several major mobility improvement projects in the corridor.

Through benefit-cost and environmental impact analysis and consensus building, the study proposed a comprehensive corridor improvement program that included freeway widening, new high-capacity transit, added arterial capacity, and other improvements that address multi-modal transportation needs throughout the length of the I-405 corridor. When completed, these projects are expected to significantly reduce congestion.

Corridor studies and environmental impact studies (EIS) commonly include consideration of multimodal options. A corridor route study or an EIS generally considers a range of alternatives from doing nothing to increasing investments in high-capacity transit and other transportation demand management strategies to adding capacity. Many of these studies take years to complete, involve extensive public involvement, and include multiple transportation interests.

In addition, WSDOT works with the major transit agencies in the region and PSRC to develop the highway system so that it is conducive to efficient transit operations. For example, HOV lanes increase travel time reliability for transit buses, vanpools, and carpools.

OFM Response: The U.S. Department of Transportation and other transportation experts recognize the complexity of this kind of analysis; however, it is worth pursuing.

Action Steps and Timeframe

- OFM will work with WSDOT to seek emerging and new multi-modal investment trade-off methodologies. The assessment will be completed for consideration in the next biennial budget.

Issue 6: WSDOT has not Emphasized Congestion Reduction in its Decision Making Process

Audit interviews confirm that transportation projects in Washington State come from a "historic pipeline," where needed enhancements have been known and understood for

two decades but have lacked appropriate funds to complete. This group of projects is then evaluated by a number of methods including:

- "Check-box evaluation," where congestion benefits are shown as equivalent to environmental, safety, and other benefits by method of simply checking a box if the benefit exists, and
- Cost-benefit analysis, in which benefits are measured by delay savings through value-of-time calculations and then compared to the costs for each project, is part of WSDOT's Mobility Prioritization Process (MP3).

Projects are ranked by WSDOT and submitted to the Washington Legislature for prioritization and approval. The Legislature chooses projects that will be matched with funds and constructed.

This approach results in:

- Lack of documentation on the importance of congestion reduction. When/if projects are prioritized solely by congestion benefits, it is not apparent and not consistent between programs developed using state funds.
- Uncertainty in decision-making. Even when/if the prioritization process is adjusted to reflect congestion as a priority, it is not clear that the Legislature will choose projects that have the best congestion-reduction payoff from a system (or multimodal) approach.
- Limited transparency. Citizens and professionals who wish to understand the process cannot readily comprehend the decision-making process. There is no "score-card" which indicates the projects implemented along with their associated costs and payoffs.
- Difficulty in tracking performance of investments over time.

WSDOT confirms that while congestion may be used as a priority in some cases, "18 different Washington State laws address and, in many cases, conflict in describing the criteria for prioritizing projects." WSDOT's cost-benefit analysis (C/B analysis), where potential project benefits are compared to project costs, does seem to focus on congestion reduction. WSDOT interviews and documentation provided suggest that congestion reduction as it relates to C/B analysis is weighted at 64 percent. The results of this analysis are then combined with four other non-monetized project benefits. However, the relationship of C/B to these non-monetized benefits is not clear nor is its role in project selection.

The actual application of the C/B analysis within legislative programming is not obvious which raises the question of whether the Legislature actually uses the analysis to choose projects. WSDOT provides ranked lists of projects to the Legislature along with some C/B information, including rankings of "A, B, and C grades" (although this method has not been identified as a unique method of prioritization during this audit). The Legislature then chooses packages of projects to be matched with funds or "programmed." Analysis for those projects not chosen and their potential effects on regional congestion are not evaluated.

From a regional congestion perspective, this approach ultimately eliminates from consideration many projects that could provide greater benefit. The political process can result in decisions being made based on voter mandates, not necessarily greatest need. From a transportation systems perspective, spreading investments across jurisdictions rarely makes sense as many of the most critical projects necessary to deal with congestion will likely be grouped as is the case in the Seattle Metropolitan Region.

Congestion, as part of WSDOT's project prioritization process, should be weighted to show its importance. A documented prioritization process should be used and available for public review. At the same time, it is critical to link planning, prioritization, and project programming/selection based on performance-based goals and objectives. Congestion is a transportation system problem that cannot be addressed in a piecemeal fashion or under political considerations driven by sub-area equity concerns. With much of WSDOT's budget committed by legislative programs under the TPA, Nickel, and potentially RTID programs, WSDOT in effect has no control over the outcomes of these projects if those decision-makers choosing the projects do not follow a performance-based approach to congestion reduction in the selection.

Statewide leadership is necessary to elevate the importance of congestion reduction. In Atlanta, the Governor's Congestion Mitigation Task Force recommended an aggressive congestion-reduction target for Atlanta by 2030. To facilitate this goal, it called for revamping the project-

selection criteria for the long-range plan to make congestion-reduction 70 percent of the project score (instead of about 10 percent as previously applied).

Implementing this recommendation will likely have large congestion reduction payoffs. If projects are chosen in packages that focus on relieving congestion in the Puget Sound Region, the most valuable projects will be constructed to reduce delay and increase throughput. However, with much of WSDOT's budget already committed and with the rest of potential state and Federal Highway Trust Fund dollars committed under RTID, this strategy must be applied immediately.

Even more importantly, any prioritization process that elevates congestion will have no value if it is not followed by the Legislature for project programming. Congestion reduction in the Puget Sound Region should also then be a primary goal of the State Legislature and/or the State Legislature should commit to following the goals and objectives of the transportation planning process. Elevating congestion reduction within the Legislative project selection process will enable the implementation of capacity, operations, and demand management strategies and will be critical to reducing congestion in the Puget Sound Region. This will also make it easier to track future performance of the selected investments.

Recommendation 6: **We recommend WSDOT elevate congestion reduction benefits in all decision-making processes.**

WSDOT Response: This recommendation closely aligns with Recommendations #1 and #5. As previously stated, WSDOT uses congestion as a major weighting factor in calculating project benefits. In prioritizing highway projects, WSDOT relies on cost-benefit analysis. In this analysis, delay and accident reduction accounts for about 64 percent of the benefits. The remaining 36 percent includes such factors as community support, environmental impacts, relationship to other travel modes, and land use impacts.

OFM Response: As noted in the audit, the department does a cost-benefit analysis on improvement projects that weigh congestion relief at 64 percent of the benefit calculation. However, current budget practice does not enable the department to submit its budget to the Governor or Legislature based on congestion relief as a stand-alone budget category.

Action Steps and Timeframe
Please see Action Steps under Recommendation #1.

Auditors' Comment: The cost-benefit analysis is only one of eight criteria used by WSDOT to assess projects. We commend the inclusion of congestion within the cost-benefit analysis but this is diluted by the other criteria and its overall weight in selection is not clear.

Issue 7: Project Programming does not Reflect Clear Linkages to Planning and Prioritization

The joint regional and statewide planning process of WSDOT and PSRC has been certified by the U.S. DOT's FHWA for meeting long-range transportation planning regulations under the Safe, Accountable, Flexible, Transportation Equity Act: A Legacy for Users (SAFETEA-LU). However, congestion reduction is not a stand-alone goal of WSDOT's *Washington Transportation Plan* or PSRC's *Destination 2030*. In addition to a limited performance-based focus on congestion, a clear linkage between planning, prioritization, and programming is not apparent. This does not allow for a transparent analysis of the importance of congestion or a measurement of the effects of projects — either programmed or not — on congestion goals.

The planning, prioritization, and programming process in Washington State has been described as very complicated. Additionally, congestion is currently considered a "symptom" by WSDOT's definition rather than a problem that should be directly approached. The U.S. DOT, however, has acknowledged that congestion results from poor policy choices and a failure to separate and embrace solutions that are effective from those that are not. This underscores the fact that congestion is not a symptom but a "choice."

This choice becomes very apparent in the transportation planning process where goals of congestion reduction are often overlooked as regulations that dictate planning activities do not mandate their inclusion. This is especially evident in the Puget Sound Region. Goals of federal legislation leave room for the integration of congestion objectives into the planning process through the long-range transportation plan (LRP). However, congestion mitigation as a stand

alone goal is not required for states and metropolitan areas to meet federal planning certification reviews.

The planning processes at statewide and metropolitan levels should set congestion-related goals and objectives for prioritizing projects and incorporate them in appropriate regional transportation improvement programs (TIP). However, there is no evidence in the Puget Sound Region that projects conceived in the transportation planning phase are evaluated and programmed according to their congestion benefits. In fact, the TIP has been described as a plan where most of the investment decisions are made by the Legislature after a review of planning data and then simply added to the plan.

For congestion-related objectives to be meaningful they must be developed in planning, used to prioritize projects, and followed for project selection. Performance-based measures such as hours of delay reduced per million dollars of investment and reductions in the regional travel time index, a ratio of peak hour travel times to free flow times (where a travel time index of 1.3 means that a trip takes 30 percent longer in the peak hour) should be considered as primary objectives in prioritizing projects. These measures should be used to model the packages of projects that are presented to the state legislature and should be objectively considered for project selection. For transparency, the public should have access to the results of these measures including the effects of chosen projects on congestion reduction as well as the potential effects of the projects that were not chosen. Only then can WSDOT, the Puget Sound Region, and the state legislature accurately measure how well they are doing to relieve regional congestion.

The Texas Metropolitan Mobility Plan (TMMP) provides an excellent example of what can be done to develop goals and objectives related to congestion reduction and match those goals to a total cost. Each local TMPP set performance goals using a regional travel time index. This metric is then used to show the effect of alternative spending packages to reduce congestion in Texas' largest metropolitan areas. The TMMPs helped each metropolitan area to focus on unfunded needs necessary to eliminate level-of-service F (the equivalent of stop-and-go traffic).

In fact, actions needed to eliminate level-of-service F also resulted in average congestion indices of approximately 1.2 or less (the travel time index is the ratio of travel time during peak travel to that in free flow conditions). This made it possible to set a congestion reduction goal of 1.15 to 1.2 in Texas' largest metropolitan areas. These goals were the product of a process developed by the Texas Governor's Business Council comprised of the top 100 businesses in the state under the direction of Texas's Governor. This process was the product of the Governor's intention to assure the future competitiveness of Texas. Much of this work was the reaction to the Dell Computers announcement that its next assembly plant would not be built in Texas because of the lack of a plan to manage congestion problems.

The Texas approach indicates that planning for the future using congestion-based goals can have extensive results when coupled with statewide leadership. When undertaken as part of the transportation planning process, this technique adds very little cost to the Region.

Benefits from implementation relate mostly to tracking the ability of investments to meet congestion goals over time. However, performance-based goals endorsed by high-level leadership could provide an incentive for the Puget Sound Region to focus aggressively on congestion reduction. Additionally, congestion reduction must be a primary goal of WSDOT, the State Legislature, and the Puget Sound Region to enable implementation of the capacity, operations, and demand management strategies recommended throughout this report.

Without congestion-based goals, congestion in the Region will continue to grow resulting in the Region rivaling other large metropolitan areas with a forecast travel time index of 1.79 by 2030 — meaning that the average 10 minute trip will take almost 18 minutes (and many will be much worse). Congestion this severe could have large negative economic impacts with key business potentially leaving the Region if no progress is made in meeting congestion in the state's economic center.

Recommendation 7: **We recommend WSDOT better link project planning, prioritization and programming to reflect congestion reduction goals.**

WSDOT Response: We agree and have been working on improving this connection between planning and implementation of congestion relief projects. Our soon-to-be released Highway System Plan demonstrates key improvements in strengthening these linkages.

Most projects in the 16-year plan are already committed to. Future projects will be selected using a new approach. In the 2007-2026 version of the Highway System Plan, WSDOT has revised its needs criteria for congestion to emphasize the maximum throughput of a corridor as the key performance objective. A corridor's forecasted operational speed for 2030 has to fall below 70 percent of the posted speed before it will be considered as a mobility and improvement need. WSDOT also identified bottleneck and chokepoint locations to focus scarce revenues toward reducing congestion and improving throughput.

WSDOT also implemented a tiered approach for addressing improvement needs to achieve the greatest reduction of delay at the least cost. The approach separates strategies into three investment tiers (operations strategies, modest cost projects and high cost projects) to be implemented incrementally over the life of the 20-year plan to maximize every dollar invested.

Currently funded projects are the result of planning studies (deficiency analysis, engineering analysis, and solution identification) and cost-benefit analysis. Many come directly from corridor planning studies that have been done throughout the last two decades. Others come from broader planning efforts such as development of the Washington Transportation Plan, the Highway System Plan, the Metropolitan Transportation Plan, and local comprehensive plans. Planning identifies the greatest need based on system performance criteria. Projects that have the highest benefit/cost ratio are submitted to the Legislature for consideration.

OFM Response: The idea expressed in this section of the audit that "*congestion is a choice rather than a condition*" does not fully consider the myriad of pressing demands upon scarce transportation resources. Solely addressing congestion relief at the expense of safety, for example, would not be in the state's or citizens' best interest.

Action Steps and Timeframe

- The Highway System Plan will be completed by the spring of 2008.

Auditors' Comment: The audit does not call for addressing congestion at the expense of safety, as implied by the OFM. Congestion relief should not be viewed as an independent action, however, and indeed it often supports other objectives, including safety, air pollution, economic growth, and rehabilitation.

Issue 8: WSDOT is not Managing Congestion Through a System of Measurable Performance Objectives

In collaboration with residents and the Legislature, WSDOT (or a new regional transportation entity) should determine the level of congestion to be designated as the regional policy objective. Setting such a target is partly a political decision and as such is likely to consider quality of life, the environment, and the creation of an economic environment in which businesses and residents can thrive. Available funds will be a primary factor given the variety of options available to address congestion. Specific goals reflect political values and are thus not easily agreed upon. Various views exist regarding whether congestion could — or should — be reduced. Once a specific goal is in place however, it provides a way for citizens to track how well their taxes are being spent. It also assists WSDOT in assessing which efforts are the most effective and provides the legislature the benchmarks that can help set funding levels and priorities.

Transportation is a means to an end. Transportation agencies implement transportation policy, they do no make policy. The community and its representatives should decide the level of congestion which is acceptable. However, the interdependence of communities and the interaction of communities with governmental entities require any decision to complement the social and economic interaction of the Region as a whole. This interdependence curtails the ability of an individual community to "opt out" of the congestion issue. Achieving a balance among conflicting objectives is a key institutional concern.

Transportation agencies must manage within these goals. Although a new concept for surface transportation, it is a common practice among private firms and some public agencies. U.S. DOT has set a congestion goal among its annual targets (as well as Texas and Georgia DOTs). The Washington Legislature had also set a congestion reduction goal for WSDOT (to ensure that the Puget Sound Region has a below average level of congestion compared to the rest of the country) — although little documentation exists regarding WSDOT's plan to achieving this objective. The Legislature dropped this specific objective in recent legislation but also called for the Office of Financial Management to develop a set of new performance measures and report on progress or lack of it toward those performance measures. It also calls for the development of a

cost-benefit based evaluation process. Given the right focus and direction, these and other elements of this new legislative package could be very supportive instruments in addressing congestion.

Objective-driven management focusing on associated benefits and costs should be an important part of any congestion program. Consistent and regular reporting of transportation system performance should have positive impacts on what transportationagencies do and how well they do it, while also providing useful feedback to the voters and their representatives on how well their taxes have been spent.

There are related examples of objective driven management in transportation as well as other industries. Texas' focus is completely centered on mitigating the congestion generated in response to the loss of many long-time in-state manufacturing facilities to other states with less severe congestion. The report of the Governor's Business Council (GBC) stated at the outset:

> *The most serious transportation threat to the state and its metropolitan areas is the continuing delay in passenger and freight travel activity brought about by congested road facilities. This challenge threatens to increase to dramatic levels in the future unless timely substantial responses are taken.*

As part of the work for the GBC, the Texas Transportation Institute adapted its nationally employed Travel Time Index to establish the TCI, the Texas Congestion Index. This index also measures the ratio of peak travel times to off-peak. Goals were set for a TCI ratio of 1.15 (a 15 percent increase for peak versus off-peak travel — where a 20-minute trip would take 23 minutes.). The measured TCI values are 1.33 in Dallas, 1.38 in Houston, and around 1.20 in Austin and San Antonio; these values are expected to go much higher as the state population continues to grow at twice the national average.

After adoption of the goal by the Texas State Governor and TxDOT, each metropolitan area developed plans to address these goals. In the process, the goals were slightly modified to accommodate technical needs but in all cases these goals were in the range of 1.17 to 1.20. Other smaller but rapidly growing metropolitan areas of the State (Laredo, Brownsville, and El

Paso) with current TCI levels less than 1.15 were charged with programs to assure they stayed below that level.

A package of other measures was developed to go with the TCI. A Delay Reduction Index was developed to assess each project's contribution to the goal of delay reduction. At the facility level speed objectives and a reliability index based on buffer times required to assure reliable arrival schedules were developed and a financial performance indicator was proposed. A third phase in the effort was recently started to expand on the performance measurement systems.

A series of similar actions occurred in Georgia where the Governor created a task force comprised of the major transportation agencies in the Atlanta region in order to address the severe congestion issues of that rapidly growing area. The Task Force set a Travel Time Index goal of 1.35. Just as significantly, perhaps, all agencies involved agreed on a common cost/benefit scheme with common criteria and weighting of those criteria. Any exceptions are to be explained and justified. The key performance metric was hours of delay reduced per dollar invested.

The United Kingdom has proposed an approach with a specific near-term focus. The Department for Transport establishes Public Service Agreements representing pledges or contracts with the public on service levels that they should expect to receive. PSA 1 focused on the nation's strategic network of highway facilities. This established short-term goals for those parts of the country with the worst congestion and then focused on addressing the worst 10 percent of the traffic on those facilities. For 2007-2008, the PSA states:

- The target will be achieved if the average vehicle delay on the Strategic Road Network's 10 percent slowest journeys is less in 2007-2008 than in the baseline period.
- The target includes the 10 percent slowest journeys over the year for each defined route, for each day of the week and for each time of day.
- The baseline is derived from a full year of data using the best available data at that time.
- This target is relatively short-term, and the PSA will be looking into developing new targets for the period after 2007-2008.

The key for the Puget Sound Region is not merely to measure and report performance findings but also to design them into action plans, prioritization, and financial programming. In addition, rewards and penalties need to be integrated into the process as they would be in the private sector regarding success and failure. This might include bonuses or other financial rewards for successful programs and negative actions for failures.

Recommendation 8: **We recommend WSDOT (or a new regional transportation entity) manage traffic congestion through a system of measurable performance objectives.**

WSDOT Response: WSDOT agrees with the concept of measurable performance objectives and has already fully embraced and implemented a performance management culture. The agency continuously seeks to improve and enhance its ongoing congestion measurement and analysis that tracks results for stated objectives. The agency publishes an annual congestion report that uses real-time data gathered from loop detectors to analyze system performance on critical corridors in the Puget Sound region.

However, WSDOT disagrees that it is not managing congestion through a system of measurable performance objectives. In the congestion report, the Highway Systems Plan, and in many other publications and presentations, WSDOT clearly states and emphasizes its key congestion management objectives: **maximize system throughput and enhance reliability.** These are quantifiable objectives that are tracked and measured. Results are summarized and published annually (also see response to #7 on using these objectives to identify transportation needs). WSDOT's congestion measurement efforts and reports are nationally recognized, as are its strategies to achieve these stated objectives.

For example, the most recent Urban Mobility Report (September 2007), published by the nationally recognized Texas Transportation Institute, specifically names WSDOT as a leader in the field of operation strategies (page 19). It goes on to say that WSDOT has improved its ability to control traffic flow to maximize safety and reliability. Stated performance objectives and comprehensive measurement efforts are at the heart of these and other congestion management strategies.

The Governor's Priorities of Government and the set of overarching state transportation policy goals adopted by the Legislature also provide closely aligned performance goals. For example, the newly adopted mobility goal specifically aims to **improve the predictable movement of goods and people *(reliability*)**. WSDOT works closely with the Governor, the Legislature, and the Office of Financial Management to track, measure, and evaluate results; implement strategies

to achieve stated objectives; and further refine the agency's existing objective-driven management efforts.

OFM Response: We fully agree that effective performance measures should inform us about what works and what doesn't. However, many factors that contribute to congestion are beyond the control of WSDOT. Congestion factors include population and employment growth, fuel prices, number of vehicles owned and number of miles driven, the age of the driving population, housing prices, income levels, changing technologies, available transportation alternatives, and the investments made in transportation systems at all levels of government and by the private sector.

WSDOT uses multiple congestion measures to evaluate the condition of 37 urban commuter routes, as well as some arterials. Examples of the measures used are average travel time on a route during the peak travel period, duration of congestion, and percent of days the speed falls below 35 mph.

The collection of indicators informs us about the traffic condition of particular roads and highways, and drives discussion about where investments are most needed. Yet there are many other things that also should be considered – like land use, for example.

The audit states that WSDOT should collaborate with residents in communities throughout the state and the Legislature to determine what level of congestion will be "designated as a regional policy objective." Our state Growth Management Act requires communities to adopt level of service standards on our roads and highways. However, transportation facilities of "statewide significance," including all major highways, are exempt from this requirement. The Legislature has recognized the difficulty of controlling land use and its related impacts on state highways.

<u>Action Steps and Timeframe</u>

- The audit provides two examples of aggressive target-setting strategies for congestion reduction in Georgia and Texas. However, these states have not yet implemented these approaches. WSDOT will observe how these strategies are implemented and funded.
- To enhance measurement efforts, WSDOT will work to increase the level of analysis done on congestion before and after improvement projects. This effort will require additional funding.
- WSDOT will evaluate the implementation of a comprehensive highway performance measurement tracking and reporting system that captures active travel time data, as well as modeled data and other data sources to provide specific and timely congestion performance information. WSDOT will submit this as a decision package in the 2009-11 biennium.
- WSDOT will evaluate the recently awarded Urban Partnership Agreement project to determine which measurements will be needed to assess project effectiveness. This review will be completed by the summer of 2009.
- OFM will convene a workgroup in the fall of 2007 to develop baseline performance measures, including measures for congestion, which will be included in an annual attainment report. The measures will be used to evaluate progress in achieving the five transportation

policy goals adopted by the Legislature in 2007. The congestion measures will be addressed under the mobility goal.

Auditors' Comment: We commend the intent to adopt measurable performance objectives. However WSDOT does not address how monitoring is turned into action responses or program modifications. While monitoring is essential, acting on this information is the key point.

Issue 9: A Lack of Traffic Signal System Coordination in the Puget Sound Region Contributes Significantly to Delays

PSRC performed a Traffic Operations Program Assessment in 2006 which concluded that a program that focuses on the overall regional operation of the traffic signal systems in the Puget Sound Region does not exist. In addition, the study found a limited focus on support for coordinated traffic signal operations at all levels of government. The observations from this report included the following "Top Ten" problems and opportunities to improve coordinated traffic signal effort:

	Observation	Recommendation
1	A Good Foundation Exists	Maintain, Reinforce, and Expand This Foundation
2	Inadequate Funding for Traffic Operations	Craft Program of Sustainable Funding for Traffic Operations
3	Regional Leadership Inconsistent	Develop Information Sharing Program
4	Little Regional Information Sharing	Develop Information Sharing Program
5	Shortage of Qualified People	Create Qualified Signal Operations Corps
6	Lack of Staff Qualifications Standards	Create a Standard for Personnel Certification/Qualification
7	No Formal Training Program Exists	Form Regional Training Partnership
8	No Process to Measure Success	Adopt and Implement Regional Performance Monitoring Program
9	No Regional Uniformity	Develop Uniform Guidance Documentation and Policy
10	National Guidelines and Standards are Lacking	Develop National Guidelines and Standards

The report also includes a self-administered scorecard that compares signal systems operations development across the Region and compares each with the national average prepared by the Institute of Transportation Engineers. Nationally, traffic signal coordination fared poorly, rating a D- with the Puget Sound Region rating slightly better with a D+. Bellevue had the highest scores among local jurisdictions at 43 percent above the national average with King County ranking 27 percent higher than the national average. Seattle scored 22 percent below the national

average. WSDOT was slightly above average compared with other state Departments of Transportation.

The finding that a "good foundation exists" reflects, in part, the fact that the Region has started to examine how well it is performing on traffic signal coordination. However, a basic tenant of the report is that further congestion relief will be found through coordinated arterial management. The report also emphasizes that agencies have apparently elected not to submit projects focused strictly on active operations of traffic signal systems. WSDOT also has not focused on the potential opportunities posed by aggressive traffic signal operations. A proposal to develop a data communication spine to support coordinated traffic signals across the Region has not been considered a "high priority."

Best practices show that improved signal coordination generates significant congestion gains. The National Traffic Signal Report Card estimates benefits from proper timing of traffic signals as:

- **Delay** - Decrease by 15 percent to 40 percent
- **Travel Time** - Reduction up to 25 percent
- **Emissions** - Reduction up to 22 percent
- **Fuel Consumption** - Reduction up to 10 percent

Three primary means of controlling traffic signal timing exist:

1. Conventional pre-set time-of-day timing based on historical data;
2. Actuated signal timing which can change green time per cycle based on information from loop detectors; and,
3. Coordinated signal timing in which multiple signals can be timed as a synchronized network.

The goal of signal coordination is to ease traffic flow through a series of intersections at a pre-determined speed in order to minimize stops. The value of improved and coordinated signal timing has been documented particularly through California evaluations. Before and after studies of the implementation of coordinated signal control during the Fuel Efficient Traffic Signal Management (FETSIM) program resulted in:

Travel time reduction:	11.4%
Delay reduction:	24.9%
Reduction in number of stops:	27%

Signal re-timing of coordinated signal systems demonstrated the following improvements:

Travel time reduction:	7.7%
Delay reduction:	13.8%
Reduction in number of stops:	12.5%

Benefits were found to exceed costs by a ratio of 17 to 1.

The City of Los Angeles Department of Transportation developed and deployed an improved Adaptive Traffic Control System (ATCS). Results indicate that ATCS resulted in: An improved signal control system in the

Travel time reduction:	12.7%
Delay reduction:	21.4%
Reduction in number of stops:	31.0%

Based on these experiences, delay reductions of 15 percent to 20 percent percent could be achieved. Since travel on arterials represents 37 percent of delay in the Region, this alone could reduce overall travel times by 6 percent to 7 percent.

The strength of the leadership greatly affects both funding and development of regionally-coordinated systems. The Los Angeles Metropolitan Transportation Authority has for many years supported efforts to link and coordinate signal systems in the county and 88 cities. The effort is led by the County of Los Angeles Department of Public Works. Groups of cities acting as traffic forums together with the County and Caltrans, have worked together to develop plans for signal system upgrades and coordination across agency boundaries. With the County in the lead, local funding has flowed from the Los Angeles Metropolitan Transportation Authority. The Los Angeles Regional ITS Architecture incorporates the full design for signal system integration. In addition, it includes the Regional ITS (RITS) network that is used for real-time data exchanges between systems across the Region. The leadership and funding of these efforts reflects recognition of their contribution to congestion mitigation.

Based on experience around the country and the relatively modest level of signal coordination in the Puget Sound Region, delays on major arterials could be reduced between 15 percent and 20 percent. Although a new regional transportation agency would facilitate coordination, more could be done with the existing leadership bodies — PSRC and WSDOT — without a new regional entity. Interest in the topic amongst traffic engineers seems real, although agreement in objectives varies The City of Seattle, for example, prefers to support traffic and pedestrian movements within the city rather than through traffic. A designated coordinating agency with the ability to prioritize such projects based on the expected rate of return for congestion relief would likely speed identification, funding, and implementation of high-value projects. There are federal funding sources available for such projects. Funds should be programmed into the State's Long Range Transportation Plan and be included in the Transportation Improvement Program (TIP) and State Transportation Improvement program (STIP). Congestion Mitigation and Air Quality (CMAQ) Improvement program funds may also be used as Puget Sound Region is a maintenance area. The systems would be required to demonstrate reductions in traffic delays. Finally FHWA Division offices can provide oversight and technical assistance.

Recommendation #9: **We recommend WSDOT (or a new regional entity) collaborate with the Puget Sound Regional Council and other local jurisdictions to implement a traffic signal coordination program for major arterials in the Region.**

WSDOT Response: We agree that signal coordination is beneficial in reducing delay. WSDOT owns and operates more than 1,000 traffic signals on state roadways. Virtually all of WSDOT's signals are fully actuated traffic systems, meaning they use loop detectors to determine when the signal light changes to green. Actuated signals take into account fluctuations in traffic volumes. Every two years, WSDOT develops a signal re-timing and coordination plan. The plan is based on the number of signals in an area, where each signal is located (i.e. suburban and rural), the volume of vehicles that travel through each signal, and the available staffing resources.

The collaboration suggested in the audit report has been formally underway within the Puget Sound region for the past year, as well as formal agency-to-agency operating agreements for the past several years. PSRC took the lead in initiating the Regional Traffic Operations Committee (RTOC) whose focus is collaboration and coordination on regional traffic operations investments and practices. Traffic signal operations are the primary emphasis, along with intelligent

transportation systems (e.g., ramp meters, loop detectors, cameras) and active traffic management.

WSDOT has other ongoing signal coordination efforts underway with multiple local and regional jurisdictions.

OFM Response: Although an additional $654,000 was provided in the 2007-09 Transportation Budget for signal coordination, we agree more needs to be done. The audit suggests that a modest level of signal coordination in the Puget Sound region should reduce delays by 15 to 20 percent. However, it is unclear what level of investment would be needed to reach this reduction.

Action Steps and Timeframe

- This is a high priority for the department. WSDOT will continue to collaborate with local jurisdictions throughout the Puget Sound region to integrate and operate traffic signals along interconnecting corridors. WSDOT will brief the Governor and the House and Senate Transportation Committees on the status of the Traffic Operations Committee's progress during the 2008 legislative session.

Managing Demand

Issue 10: HOT Lanes Offer an Untapped Method to use Available HOV Capacity and Improve Reliability

Variable tolling is one of four key strategies identified in U.S. DOT's National Strategy to Reduce Congestion. U.S.DOT envisions that tolls offer the potential to reduce peak-hour demand and thus reduce congestion. Congestion pricing (sometimes called "value pricing"), encourage users to change their peak-hour highway travel, either by shifting to other transportation modes or shifting travel to off-peak periods. In some instances, it could discourage peak trips completely. In some instances, it could discourage trips completely. By removing a fraction of the vehicles from a congested roadway, pricing enables traffic to flow much more efficiently, allowing more cars to move through the same physical space and reducing the time periods when traffic is congested. Similar variable pricing schemes are used by other industries for their products and services such as airline tickets, cell phone rates, and electricity rates.

HOT lanes make it possible for single occupancy cars to use extra space in HOV lanes by paying a price that varies based on the amount of congestion. This makes it possible to assure travelers

a certain level of service (for instance, a speed of 50 mph). HOT lanes provide a way to take advantage of other-wise unused portions of HOV lanes and provide a premium service for those who need a reliable travel time for a particular trip. The price varies with traffic volume to assure free flow on the HOT lane.

Four types of pricing strategies are under consideration in the US, Europe, and Asia:

Variably Priced Lanes	Variable tolls on separated lanes — such as Express Toll Lanes or HOT Lanes — within a highway
Variable Tolls on Entire Roadways	Tolls on toll roads and bridges, as well as on existing toll-free facilities during rush hours
Cordon Charges	Variable or fixed charges to drive within or into a congested area within a city (these charges have been implemented in London and Stockholm and are proposed for NYC)
Area-wide Charges	Per-mile charges on all roads within an area that may vary by level of congestion (being explored by Oregon DOT among others)

Scheduled for 2008, WSDOT's HOT lane pilot on SR-167 is an example of variably priced lanes. This pilot project will include a variably priced lane alongside two general purpose lanes for nine miles in each direction. The price to use the HOT lane under different traffic conditions has not yet been set but drivers will be able to use the same electronic toll tag that has been recently introduced for the Tacoma Narrows Bridge. The SR-167 pilot will be operational in the spring of 2008 and is funded by $12,740,000 from the 2005 Washington State Gas Tax and $5,130,000 from FHWA.

Although there is no requirement for WSDOT to undertake the SR-167 pilot project, the Agency is providing funds in order to determine how HOT lanes could be used to improve traffic flow region wide, what modifications will be needed, and the level of public acceptance. Lessons learned will be used to consider further expansion of a HOT lane network in the Puget Sound Region. WSDOT will provide annual reports to the Legislature and the Transportation Commission.

The FHWA is also partially funding this pilot to ensure that other locations across the nation can share these lessons learned. FHWA'S most recent report on value pricing projects describes 70 initiatives across the nation including completed and ongoing projects. Eight of these projects, including WSDOT's SR-167 pilot, specifically relate to the conversion of HOV lanes to HOT lanes. An additional 19 projects relate to pricing of new lanes.

The use of HOT lanes and variable pricing in general has attracted considerable interest in the United States and around the world. Examples include:

SR-91 Express Lanes in Orange County

SR-91 Express lanes opened in 1995. This facility is not an HOV lanes conversion but a new four-lane HOV toll facility in the median of a 10-mile section of a heavily congested highway. SR-91 has been in operation for more than a decade and is an important reference point for WSDOT and others considering HOT lanes.

Tolls on the express lanes vary between $1.10 and $7.75 with prices occasionally increasing to $9.00 on Friday afternoons. Tolls are set by time of day to reflect the level of congestion delay avoided in the adjacent free lanes and to maintain free-flowing traffic conditions on the toll lanes. With some exceptions, vehicles with three or more occupants travel free. The express lanes carry more than 40 percent of the total SR-91 traffic during heavily congested periods although they comprise only one-third of the total freeway capacity. This amounts to a 33 percent higher throughput per express lane relative to the general-purpose lanes.

The Orange County Transportation Authority purchased the SR-91 lanes from a private developer in 2003 and reported in 2006 that, despite constantly increasing numbers of vehicles choosing the 91 Express lanes, traffic continues to flow smoothly and motorists continue to save time. Toll-lane drivers report saving approximately a half hour each way on their daily commute.

I-15 HOT Lanes in San Diego, CA

I-15 HOT lanes in San Diego opened in 1996. Seventy-five percent of weekday traffic in the HOT lanes meet the HOV requirement and travel for free. Twenty-five percent are SOV drivers who pay a toll between $0.50 and $4.00 per trip. This can increase to $8.00 during very congested periods in order to assure free flowing traffic.

A 1999 evaluation report indicated that pricing resulted in a redistribution of a portion of the peak period traffic volume. While the project had not resulted in a noticeable impact on traffic congestion on the general purpose lanes of I-15, more than 95 percent of users are solo drivers who would otherwise use I-15 general purpose lanes. The Region has begun construction of a major expansion of the HOT lane network including new lanes integrated with a bus rapid transit system.

I-10 HOT Lanes in Houston, TX;

I-10 HOT lanes in Houston opened in 1998 and extended to US-290 in 2000. The HOV lanes are reversible and restricted to vehicles with three or more persons during peak hours. The pricing program allows a limited number of two-person carpools to buy into the lanes during peak hours. Participating two-person carpool vehicles pay $2.00 per trip toll while vehicles with higher occupancies continue to travel free. Single-occupant vehicles are not allowed to use the HOV lanes.

Results from surveys conducted on I-10 indicate that the primary source of participants is persons who formerly traveled in single-occupant vehicles on the general purpose lanes.

I-394 HOT Lanes in Minneapolis, MN

The first phase opened in 2005 with the second phase currently in the planning stage. Toll rates average $1.16 per trip. The lanes, which are dynamically-priced, remain free to HOVs and motorcyclists during peak hours and are free to all users in off-peak periods.

I-25/US-36 HOT Lanes in Denver, CO

I-25/US-36 HOT lanes in Denver opened in 2006. This underutilized two lane reversible facility handles 1,800 toll-paying vehicles in the morning peak period and 1,500 toll-paying vehicles in the afternoon peak period in addition to those vehicles that meet HOV requirements. Toll rates average $2.00 per trip and vary to maintain free-flow conditions.

A number of common themes have emerged from these projects. Considerable effort was spent on planning and public outreach prior to implementation. Tolls vary depending on traffic conditions to ensure free-flow conditions which maximizes throughput. Spare capacity is used by toll-paying vehicles while HOVs generally have access free of charge. Experience has shown that equity issues have not emerged and HOT lane users represent a cross section of income levels. On the SR-91 express lanes, many frequent users are low-income while many high-income commuters are infrequent or nonusers.

While revenue maximization is not an objective, revenues raised are used to support operation of the facilities. Tolls are collected electronically and do not involve cash transactions. These approaches generally do not raise substantial sums of money but the prices serve to meter traffic and to support the costs of the facility.

WSDOT has taken the initiative in developing the SR-167 in the belief that congestion pricing is a practical tool to help address congestion in the Puget Sound Region. However, WSDOT is not the only agency with an interest in congestion pricing. King County recently published a report that called for a regional system of variable pricing for all users of freeways and selected major arterials throughout the Puget Sound Region. This would be larger in scale than converting HOV lanes to create an HOT lane system and the report projected total revenue of $1.1 to $1.6 billion a year based on a maximum fee of $8.00 per trip in the peak period. Over a twenty year period, the authors estimate the program will have a net present value of $24 billion. The program has four objectives:

1. Address the regional transportation funding deficit,
2. Provide immediate congestion relief,
3. Support alternative modes of transportation, and
4. Enhance environmental sustainability.

Fees result in users paying for repair, replacement, and enhancement of the transportation infrastructure that they actually use. User fees would be highest where congestion is highest. While the scale of the King County concept means it will create a funding source, it will also reduce peak hour demand by encouraging certain trips to shift to less congested times of the day. The King County report recommends more research into alternative designs, regional governance, cost estimates, and revenue distribution.

The King County proposal is a logical, albeit long-term, extension of the SR-167 pilot. However, both King County and WSDOT recognize that public education and acceptance of the principles of congestion pricing is an important precursor to future expansion. While WSDOT is clearly supportive of the HOT lane concept, plans for future development of a HOT lane network are uncertain. As a minimum, conversion of existing HOV lanes to HOT lanes is an option where capacity is available in the HOV lanes.

WSDOT should be recognized for its initiative with the SR-167 HOT lane pilot project. Building on the experiences of similar deployments across the nation, the concept of congestion pricing is worthy of further detailed examination and consistent with U.S. DOT's strategy for congestion management. If the pilot is successful in terms of technical feasibility, public acceptance, and operational impacts, the future HOT lane conversions should be aggressively pursued by WSDOT. While FHWA has set a four-year period to evaluate the pilot, WSDOT should not wait until the end of this time period before moving forward with other HOT lane deployments if it becomes apparent that the pilot is successful.

Conversion of HOV lanes to HOT lanes does not require extensive construction activity. Existing WSDOT right-of-way will likely be sufficient in most cases. Construction activities will be mostly limited to deployment of new field devices such as: toll-tag readers, fixed and dynamic signage, communications equipment, and re-striping. The SR-167 pilot and the Tacoma Narrows Bridge projects have facilitated the creation and rollout of a toll-tag system and an associated "back office" for clearance of electronic financial transactions and enforcement.

Public education will be necessary to encourage new toll-tag customers and to explain the system to potential HOT lane users.

WSDOT has identified various options to develop HOT lanes. The potential to implement additional HOT lanes within the next five years appears to be very reasonable. WSDOT estimates that converting existing HOV lanes in the Central Puget Sound Region to HOT lanes is could cost in the range of $530 million to $710 million, not counting revenues from users. However, the development of other comprehensive approaches is less likely to be implemented in the next five years. These approaches include:

- Convert HOV lanes to HOT lanes and add a HOT lane in heavily congested locations, with an estimated cost of $15 to $22 billion
- A variation of the above with narrower shoulders with an estimated cost of $10 billion

Recommendation 10: **We recommend WSDOT deploy future HOT lane projects aggressively if the SR 167 pilot is successful.**

WSDOT Response: We support this suggestion, and WSDOT will likely propose additional HOT lane deployments if the SR-167 pilot project is successful pending direction from the Governor and the Legislature.

OFM Response: The transportation community will evaluate the effectiveness of the SR-167 HOT lane pilot project and determine whether to proceed with the conversion of other HOV lanes to HOT lanes. Preliminary estimates by the Department of Transportation for such conversion indicate a price range of $10 billion to $22 billion.

Action Steps and Timeframe

- WSDOT will report on the preliminary results from the HOT lane pilot project in the 2009 legislative session.
- WSDOT will examine several potential projects that could use system management strategies such as HOT lanes and speed harmonization. The assessment will be completed for consideration in the 2009-11 budget.

Issue 11: Current Legislation Limits Expansion of HOT Lanes and use of Tolls

The previous section discusses WSDOT's pilot HOT lane deployment on SR-167. Should this pilot prove to be successful, HOT lanes and variable tolling (or "congestion pricing") will likely become an important component in WSDOT's congestion management tool

box. Under these circumstances, it is reasonable to assume that new HOT lane projects will be developed.

Legislation was passed in 2005 authorizing the SR-167 pilot. RCW 47.56.401 defines High Occupancy Toll Lanes (HOT lanes) as "one or more lanes of a highway that charges tolls as a means of regulating access to or the use of the facility, to maintain travel speed and reliability." RCW 47.56.403 defines the specific arrangements for the pilot, including financing, toll setting, monitoring, mitigation of safety and other negative impacts, expiration of tolling authority, toll collection, violation and procurement. Authorization to impose tolls for the SR-167 pilot project will expire four years after toll collection begins.

As part of the same legislation, the legislature added a provision to RCW 47.56 stating that; "No tolls may be imposed on new or existing highways or bridges without specific legislative authorization, or upon a majority vote of the people within the boundaries of the unit of government empowered to impose tolls."

Given the level of interest and apparent success of HOT lane deployments in other cities and the recognition by U.S. DOT that HOT lanes and congestion pricing are a valuable component of congestion management, WSDOT should not be inhibited from expanding the HOT lane concept to other locations in the event of a successful SR-167 pilot.

The RCW 47.56 legislation highlighted above will prevent continuation of the SR-167 pilot beyond four years after it commences operation. More significantly, no new HOT lane or congestion pricing projects can commence without legislative authorization. While there is no suggestion that specific approval to continue (or to make permanent) the SR-167 HOT lane project will not be granted if requested, it is essential that the process to achieve this commences in a timely fashion. What is less clear is whether any future expansion of HOT lanes will require case by case approval from the legislature, or whether some broader authorization will be granted to implement them across the Puget Sound Region. Given that this may be more complex than approving a specific pilot, it may be necessary to start this legislative process well

before the SR-167 pilot has been in operation for four years, especially if the pilot is determined to be successful. If this legislation slows down the implementation of HOT lanes, any congestion relief they can provide to the Puget Sound Region will be deferred.

Recommendation 11: **We recommend the Washington State Legislature implement new legislation to facilitate the expansion of road pricing should WSDOT's HOT lane pilot be successful.**

WSDOT Response: WSDOT defers to the Legislature on this recommendation.

OFM Response: The Legislature has made it clear that authorization to charge a toll on SR-167 is for a four-year pilot program. It also has made it clear that specific legislative authorization is needed to impose tolls. (Tolls may also be imposed by a majority vote of the people within the boundaries of an area authorized to impose tolls.)

The 2008 Legislature is expected to adopt a comprehensive tolling policy bill. We do not agree with the audit statement: "If this legislation slows down the implementation of HOT lanes, any congestion relief they can provide to the Puget Sound region will be deferred." In fact, we believe a steady and deliberative approach is exactly what is needed to determine the costs and benefits, including public acceptance, of this and other tolling initiatives.

Action Steps and Timeframe

- This recommendation is beyond the control of WSDOT.

Issue 12: No Single Entity in the Puget Sound Region has the Authority or Resources to Implement Solutions to Congestion-Related Issues

A major challenge faced by transportation agencies when addressing traffic congestion is that they can only manage their respective "real estate." This ultimately results in no single entity being responsible for traffic congestion nor having the motivation or authority to implement solutions to congestion-related issues. The Puget Sound Region is no different.

The variety of agencies in the Puget Sound Region is a constant factor in the complexity of addressing congestion since it does not respect government boundaries. Each municipality/entity has separate governance with a focus on its specific area needs. The natural tendency to focus on

sub-area equity limits the prospects for actions that will benefit all. Such conflicts are most typical when the vision guiding programs or planning is weak with no wide-spread challenge facing all. This narrow focus presents a major stumbling block to concerted action to reduce congestion in this Region.

To enhance the Region's focus on congestion and develop a coordinated effort, a single body should be established to act in the Region's best interests and represent all facets of the interests involved. This body should be charged with the overarching responsibility for transportation effectiveness. WSDOT would be the natural choice in leading this arrangement and provide planning, design, funding, and operations responsibility for highways and transit. Alternatively a new regional entity could be created to handle these functions. Such an arrangement should also have clear targets to improve congestion and the ability to access appropriate financing. Arguments against a regional authority include concerns by some existing entities that their current authority might be diluted within a new, multi-modal body. Also, the RTID and SOUND2 proposals were developed on the assumption that WSDOT and SOUND Transit would carry out each program, making a new, integrated authority less relevant.

While several options exist for how such an entity might be organized, one option is covered in the report prepared for the Legislature last year by the Regional Transportation Commission (RTC). While the report's Appendix provides a guide to other options, the RTC's primary recommendation proposed a much stronger centralized agency with a purview encompassing highways and transit and other modal sectors for planning, prioritizing, and funding needed transportation. In a very effectively worded statement the Commission noted:

> *Formal and informal discussions with over 100 individuals and 50 agencies reveal the difficulties that these individuals and agencies face when attempting to prioritize regional interests in transportation infrastructure. These officials bring hard work, intelligence and insight to their roles. However, they are charged with advancing the interests of an individual agency, district, city, county or the state as a whole, or with protecting the interests of a particular mode of transportation, such as roads or transit.*

A key element in any coordinating body's role will be in assuring that transit investment decisions are integrated into the broader transportation planning, prioritization, and programming

process. The RTC also proposed a study by this new entity or the State Auditor of combining the area transit systems into a single organization.

The RTC reviewed in its work comparable resolutions to these institutional questions in the west scanning Portland, Phoenix, and Vancouver British Columbia. The Legislature may want to view the options available in a broader search looking, for instance, at Texas metropolitan areas, Minneapolis, and others.

Recommendation 12: **We recommend the Washington State Legislature empower a single body — either WSDOT or a new regional transportation entity for the Puget Sound Region — to allow for a more integrated approach to planning for congestion reduction.**

WSDOT Response: WSDOT defers to the Legislature on this recommendation.

OFM Response: We believe this is outside the scope of the audit of WSDOT.

Action Steps and Timeframe

- This recommendation is beyond the control of WSDOT.

Auditors' Comment: We recognize that a regional entity would require action by the State Legislature. At present no single entity has "ownership" of solving congestion in the Puget Sound region. Highlighting this institutional concern is an important part of our audit in addressing the cause of congestion.

Issue 13: WSDOT is not Expanding its Successful Commute Trip Reduction Program

Washington State is a known leader in travel (or transportation) demand management (TDM) and has documented much success for a $5.6 million program investment in Commute Trip Reduction (CTR). While WSDOT is considered as one of the leaders in TDM best practices in the nation, the severity of congestion in the Puget Sound Region requires that much more be done. However, WSDOT has

no current plans to expand the scope of the commuter trip reduction program and has not identified additional sources of funding beyond those allocated by the Legislature. The counties themselves, including King County, spend more on demand management than WSDOT. Moreover, the CTR's exceptional benefits for a relatively low investment seem to be unadvertised beyond that which is done at the local level.

While WSDOT is the leader in state-of-the-practice TDM applications, the growth in congestion in the Puget Sound Region requires that more be done. TDM in general can continue to be encouraged by using technology to collect and disseminate accurate and timely traveler information, providing additional incentives and disincentives to encourage mode or travel time shifts, and by marking regional TDM alternatives.

Accurate and Timely, Traveler Information for non-SOVs and SOVs

According to the FHWA Office of Operations Travel Demand Management Program, "The availability of information about transportation services and conditions has been shown to influence travel demand by influencing the choices that people make about how, when, and where to travel. Managing demand can no longer stop at encouraging travelers to change their mode from driving alone to choosing a carpool, vanpool, public transit vehicle, or other commuter alternative. Managing demand today is about providing all travelers, *regardless of whether they drive alone*, with choices of location, route, and time, not just mode of travel."

Applying technology, ITS, and other operations-based data can have valuable effects for demand management for all highway users. According to a 2001-2002 study of real-time traveler information users in Pittsburgh and Philadelphia, 68 percent and 86 percent of highway users respectively, changed their commute route choice and departure time in the presence of real-time traveler information. This underscores the application of TDM for adjusting SOV "commute" trips that must be made, but could be made at alternative or off-peak times.

Analysis completed for this audit further highlights the importance of applying TDM to influence commute departure times. Data show that congestion in the Puget Sound Region has gotten much worse in the past 10 years, but vehicle miles traveled have not increased proportionately. This suggests that travel (among other factors that may include system design) has increased during peak hours, but has lessened throughout the rest of the day. Providing accurate and timely traffic information coupled with alternative route information can have important effects on system demand by shifting commute trips to off-peak or helping better distribute peak hour demand across the system. For this reason, it is critical that TDM for the commute trip be closely linked with traffic operations with a focus on both non-SOV and SOV users. Predictive travel times can also be used to provide better information on ideal departure times.

Traveler Incentives/Disincentives

In order to encourage additional non-SOV travel, current SOV users must have some incentive to change modes. Recent studies on carpooling suggest that increases in HOV lanes are not necessarily correlated to a reduction in SOV users; more likely, families traveling together to work and even parents toting babies to daycare or children to soccer practice. The characteristics of these users have certainly contributed to increases in HOV vehicle miles traveled; however, the reduction of vehicle miles traveled or congestion on general purpose lanes remains to be seen. It is likely that these users are not captured from those changing mode and would travel together regardless of HOV availability. Additionally, transit will likely have to provide a travel time incentive to capture SOV users over and above those already using transit to commute.

While the HOV network in the Puget Sound Region is extensive, poor design considerations in many areas as well as passenger requirements (HOV-2) contribute to HOV lanes that, in many cases, are just as congested as general purpose commuter routes. Without travel time savings in these areas, financial incentives can and do help provide a modal shift that would likely not otherwise occur. Through its Trip Reduction Performance Program (TRPP), WSDOT currently pays companies up to $460 for every

SOV commute trip reduced. The exact amount is based on a competitive bidding process. Some companies are taking an even more aggressive stance in providing financial incentives. Microsoft is considering paying up to $1,000 for non-SOV users commuting to its Redmond facility and other businesses provide even larger financial incentives for employees who walk, use transit, or carpool, suggesting that WSDOT could consider higher financial incentives.

Related to financial incentives are financial disincentives, including pricing and parking policy. Transportation agencies in the Puget Sound Region have taken limited steps to reduce the availability of inexpensive, discounted, or subsidized parking spaces. Parking management is a congestion management tool that transportation agencies in the Puget Sound Region should be encouraged to consider. A recent report published by WSDOT's Commute Trip Reduction Task Force highlights the importance of managing parking supply, either by limiting supply or pricing, to curb transportation demand. The report provides new guidelines for parking management that would support regional CTR goals; however, the guidelines provide policy direction only with recommendations, not requirements, as WSDOT cannot mandate their implementation.

Marketing and Education

FHWA notes that, "A critical element of successful demand-side strategies is often a well-designed and executed marketing and education program. Even in communities where high-quality transportation modes, routes, and time choices are currently available, travelers who remain unaware that these choices exist, or are unconvinced that these choices are viable and/or reliable, even modest shifts in travel behavior and transportation efficiency are unlikely."

WSDOT does a good job marketing TDM and its CTR program and has developed an extensive vanpool market plan. WSDOT also works with the private sector to provide financial incentives, which is an excellent marketing strategy with positive financial and

trip reduction returns. However, with such a small program budget with such high return, additional investment and a regional marketing campaign could have added benefits for recurring congestion as well as congestion associated with anticipated construction. Again, at least doubling the size of WSDOT's current marketing budget for TDM and implementing a regional marketing campaign for TDM are recommended.

WSDOT's CTR program plays an especially important role in the Puget Sound Region, where in 2005, CTR had reduced 14,200 vehicle trips each weekday morning and reduced travel delay by an estimated 11.6 percent. For $5.6 million, this program certainly gives WSDOT a high level of congestion-reduction benefit for the cost. However, WSDOT has no current plans to expand the program beyond the goals of the Legislature. The Audit Team therefore recommends that WSDOT consider providing public and private entities with more then the current $460 per maximum focusing on providing traveler information and implementing a regional "look before you leave" marketing campaign to encourage commuters to consider traffic conditions and route before they choose commute modes.

That said, it is unlikely that doubling the program size will double the benefits unless more aggressive options are approached. At the same time, studies on the various components of TDM suggest that there is room for improvement, mainly in improving system reliability. For example, a 2001 study found that disseminating pre-trip congestion information increased travel time reliability by 77 percent.

Recent experiences also show the importance of linking "everyday" TDM strategies to those used for "special" days. The construction on I-5 during summer (2007) provides perhaps the best example of the potential impacts of demand management on congestion in the Puget Sound Region. An August 15, 2007 article in The Seattle Times noted that, as a response to an aggressive TDM program related to I-5 construction, "Half of the motorists who usually take northbound I-5 to Seattle vanished Monday as state officials hoped, and a potential traffic nightmare turned into one of the easiest drives of the year." The article further states that, "as far as driving only 3,300 motorists an hour used northbound I-5 in the work zone, about half the

normal volume." Additionally, "Thousands of people switched to transit, or left home earlier." This is precisely the objective TDM.

Can these same strategies be applied to everyday TDM? The former director of the U.S. DOT Joint Program Office (JPO) noted in a presentation at the TRB 2001 Annual Meeting the importance of managing demand everyday as is done for special events: "If we can make the system run smoother and better in a big event — what would it take to make everyday a special event in states and cities across America?" The presentation provides support for taking action, citing that more people and more volume are handled during special events and people behave differently when they are informed, which in turn, causes significant changes in demand. Additionally, the session notes provide solid evidence that demand management (when combined with systems operations strategies) will reduce traffic delays, improve reliability, and increase safety by reducing injuries and fatalities.

Recommendation 13: **We recommend WSDOT's Commuter Trip Reduction Program be expanded to include increased financial incentives, additional financial disincentives, and regional marketing.**

WSDOT Response: WSDOT agrees that the Commute Trip Reduction program is successful. It has recently implemented new legislation that offers financial incentives to entities that reduce single-occupancy vehicle trips.

The Legislature has recently invested in commute reduction strategies as follows:

- In 2003, it created the Vanpool Investment Program and the Trip Reduction Performance Program (TRPP) which encourages entrepreneurs, private companies, transit systems, cities, non-profit organizations, developers and property managers to provide services to employees that result in fewer vehicle trips arriving at worksites.
- The 2005-07 transportation budget includes $3.9 million to purchase 150 new vanpool vans,
- The 2007-2009 transportation budget includes $2.6 million for additional vanpool grants and $2.4 million to WSDOT to implement the new Growth and Transportation Efficiency Center program.

OFM Response: Issue #13 is closely related to a number of recommendations made in this section of the audit including: a) increasing the CTR incentive beyond the current maximum

allowable bonus level of $460 to $1,000 for each additional commute trip reduced beyond targeted goals, b) doubling the size of the overall program, and c) implementing a regional "look before you leave" campaign to influence travel choices.

Certainly more can be done to work with private and public employers to decrease dependence upon single occupant vehicles. WSDOT's vision and leadership can help to further guide programs and projects in multiple jurisdictions, in both the public and private sectors. CTR is one of many efforts to accomplish this.

Action Steps and Timeframe

- The Commute Trip Reduction Board will report on the effectiveness of the new, recently funded CTR initiatives in a briefing to the Governor and Legislature by January 2009.

Auditors' Comment: While WSDOT should continue to coordinate with the CTR board, the importance of demand management and the success of this program show that WSDOT should actively pursue demand management and telecommuting programs on its own.

Issue 14: WSDOT's Commute Trip Reduction Program does not Include an Aggressive Telecommute Component

WSDOT's Commuter Trip Reduction (CTR) Program includes telecommuting as a potential CTR program element and WSDOT's Urban Partner Project for SR 520 includes a telecommuting component. However the current CTR program does not include an aggressive telecommute component. Telecommuting (or telework) is a work arrangement in which employees are permitted flexibility in working locations and hours. While telecommuting is an important part of TDM in general, WSDOT has not encouraged the practice beyond providing previous funding for telecommuting centers. WSDOT believes that private firms have already installed all the equipment needed to support telecommuting providing a limited role for public sector support. In Washington, companies and managers make decisions about teleworking that are productive for their businesses but may still fall short of benefits for the traveling public.

Other State DOTs have shown a vested interest in promoting telecommuting because of the inherent congestion reduction, safety, air quality, and quality of life benefits of this mode choice. From encouraging telecommuting to the development of an extensive fiber-optic network throughout the state, the Minnesota Department of Transportation (Mn/DOT) is very interested

and involved in encouraging telecommuting as a peak-hour travel option that may reduce current traffic growth patterns. The ultimate goal of using telecommuting is to enhance the delivery of government services to citizens of the State of Minnesota. This includes a telecommute program for the DOT itself. Florida DOT has also implemented an aggressive telecommute program for its employees.

Mn/DOT's interest in developing telecommuting as a mode choice is also part of its Urban Partnership Agreement (UPA) with the U.S. DOT FHWA (2007). Mn/DOT was selected as one of five metropolitan areas across the country to participate in a new federal initiative to fight traffic gridlock. Mn/DOT's plan recognizes that each "T" from U.S. DOTs UPA program – tolling, transit, telecommuting, and technology — may have limited impact alone, but when combined, these applications achieve a "benefit multiplier" through the simultaneous and coordinated applications.

The potential benefits of telecommuting are well-documented and summarized in a recent Virginia Department of Transportation (VDOT) Telework Study:

- Increased teleworking can decrease traffic congestion related costs. In the Northern Virginia area, a cost reduction of $53 million is estimated for an increase in teleworking from 15 percent to 25 percent.
- In the Washington, D.C. metropolitan area, increasing teleworking by 5 percentwill result in nearly a 2 percent reduction in VMT. (Currently 15 percent of the Northern Virginia workforce telecommutes.)
- In the Phoenix metropolitan area 93,800 people work at home at least one day per week. Surveys have shown that this reduces daily vehicle miles traveled by 900,400 miles per day and reduces emissions by more than 32,000 pounds per day.
- Washington State has found that the average telecommuter in the Seattle accounts for 36 fewer miles per day in daily travel and 50 percent to 70 percent reductions in pollutant emissions.

The following illustration identifies the importance of the work-from-home option as a transportation mode choice in the Puget Sound Region. As an example of the role that working

at home can play, approximately 4.4 percent of workers in the in the Puget Sound Region work at home as their regular work site — higher than the national average of 3.3 percent. Working at home is the most significant growth "mode" of transportation nationally. Telecommuting could add to this percentage if, even on an occasional basis, people worked at home. It should be noted that these workers make no peak-hour demands on the transportation system.

Puget Sound Region Journey to Work

	Metro	King	Kitsap	Pierce	Snohomish	Thurston
	Percentage Mode Share (%)					
Drove alone	72.5	69.1	67.9	78.5	76.2	79.4
Carpool	11.7	10.9	14.9	12.3	13.3	12.0
Public Transportation	6.9	9.4	9.2	3.2	3.5	1.6
Taxicab	0.1	0.1	0.1	0.1	0.1	0.0
Motorcycle	0.3	0.3	0.5	0.3	0.6	0.1
Bicycle	0.7	1.1	0.9	0.2	0.3	0.8
Walked	2.6	3.4	2.4	1.7	1.5	2.1
Other Means	0.6	0.6	1.0	0.5	0.7	0.4
Work at Home	**4.4**	**5.1**	**3.2**	**3.2**	**4.0**	**3.6**

Note: Figures do not add to 100% due to rounding.
Source: US Bureau of the Census; Decennial Census and Annual American Community Surveys

As identified in the above illustration, over 72 percent of all commuters currently drive alone in the Puget Sound Region. Carpooling and transit capture 18.5 percent of commuters including those that are targeted by WSDOT's CTR program among many others. When encouraged by state policy, WSDOT, and employers, commuters may be more likely to switch commute modes to the scheduled work from home option, either during peak hours or for an entire day.

The availability of technology and the growing number of telecommuters in the United States have reduced telework barriers. Estimates of the number of workers who do at least some work from home vary from 12.4 million[3] to 24.1 million[4]. Future projections indicate that telecommuting will grow dramatically. A recent study[5] estimates that in three years, over 100 million individuals will do some work from home. Based on government estimates of 149.3

[3] 2006 study by WorldatWork
[4] 2004 study by the Dieringer Research Group
[5] 2006 study by WorldatWork

million workers in the United States labor force, this data correlates to approximately 8 percent of workers having an employer that allows them to telecommute one day per month and almost 20 percent of the workforce engaging in some form of telework.

The rising trend in the past two years is likely a combination of factors including the proliferation of high speed/broadband and other wireless access (which has made it both less expensive and more productive to work remotely) and the willingness of more employers to embrace flexibility and work-life balance. In addition, new technologies from Cisco Systems and HP will support a new virtual workplace with upgraded video capabilities. State DOTs can play an additional role in supporting telecommuting by looking to partner with the private sector to support the availability of technologies needed for telecommuting as is being done in Minnesota.

While telecommuting has much promise and is available to large portions of the population, government agencies are much slower to embrace telecommuting policies. Additionally, many private sector companies have failed to overcome cultural challenges associated with telecommuting. This leaves little as far as best practices, but provides WSDOT with an opportunity to take the lead in encouraging this commute mode choice. WSDOT, for example, sites that only 1 percent of its workforce telecommutes regularly. However, compressed workweeks are used extensively suggesting that a program that incorporates both approaches may be more successful.

Telecommuting is one of the U.S. DOT's "4T's" in its Urban Partnership program where tolling, transit, telecommuting, and technology have been documented as congestion solutions at the federal level. The availability of a telecommuting option coupled with the potential impact of this alternative on congestion reduction indicates that WSDOT can take a leadership role in encouraging telecommuting in the Puget Sound Region. While telecommuting is expected to grow, programs and policies to support this mode choice will increase the commuter share at a quicker rate. A variety of options to enhance telecommuting exist, including applying employee

incentives and monetary payments similar to those currently provided to workers choosing non-SOV mode choices.

A large pool of potential participants for a regional telework program exists in the Puget Sound Region. A strategy implemented by WSDOT, the Region, and the Legislature to increase telecommuting in the Puget Sound Region could have an immediate impact on congestion. WSDOT could set a realistic goal of doubling the current work-from-home mode share in the Region by encouraging telecommuting and should take the lead on an aggressive regional telecommute strategy. Additionally, WSDOT could implement a regional "look before you leave" program, where commuters are encourage to choose departure times are based on traffic conditions. This can result in commuters working from home during peak hours and traveling to work in the off-peak. With only 1 percent of its workforce using telework as a commute alternative, WSDOT should implement and study the effects of aggressive telecommuting strategies among its own employees. This would be a logical first step for implementing a regional or statewide telecommute program. Providing incentives and other methods will likely have the largest effects on encouraging telework.

Doubling the current telecommuting mode share in the Puget Sound Region could potentially reduce SOVs by more than 6 percent, which will increase peak hour throughput and reliability. However, WSDOT, the Puget Sound Region, and the legislature should consider setting more aggressive goals for telework programs due to the severity of congestion in the Region.

Recommendation 14: **We recommend WSDOT implement a telecommute program focusing on telework incentives.**

WSDOT Response: WSDOT supports all efforts to improve the efficiency of the state highway system. Telework practices continue to expand at CTR worksites and many employers' CTR programs include a telework component. It is important to recognize that the decision to allow employees to telework is a business decision that the state cannot dictate to the private sector.

The Trip Reduction Performance Program is currently funding one employer-based telework project. Results for this two-year project will be available in 2009.

Issue 15: WSDOT's Real-Time Traffic Information is not Available for Most Arterials and Some Key Freeways

The audit references the Minnesota Department of Transportation as an example of a DOT that explores telecommuting strategies as part of its recently awarded Urban Partnership Agreement (UPA) grant. Please note that the Seattle region/WSDOT was also one of the five states that competed for and received an Urban Partnership Agreement grant for its proposal that includes a progressive telecommuting component. In addition, WSDOT was one of the first agencies in Washington State that implemented a formal telecommuting program for its employees.

OFM Response: The Internet has transformed where, when, and how we work and communicate. As the audit points out, future projections indicate that almost 20 percent of the workforce will engage in telework. Telecommuting not only helps reduce congestion by removing commuters from the road, but offers potential social benefits by allowing employees to balance their work and personal lives. Thus, expanding employee incentives and applying monetary payments similar to those currently provided to workers choosing non-SOV mode choices may not be necessary.

Action Steps and Timeframe

- WSDOT will continue to develop the telecommuting strategies identified in the Urban Partnership Agreement and evaluate the referenced CTR telework projects. WSDOT will brief the Governor and the Legislature by January 2009 on the status of these efforts.

WSDOT has a reliable source of real-time traffic information for most of the urban freeway network in the Puget Sound Region (SR 99 is an important exception). WSDOT also utilizes a wide variety of traveler information outlets to disseminate real-time traveler information including their own popular web site, a 511 service, and several private firms. This information however, is not available on key arterials and is not always current (as sometimes occurs with the Washington State 511 system), and does not include transit or ridesharing alternatives.

Riders have demonstrated that they benefit from traveler information services and well-designed traveler information systems receive a positive reception from the traveling public. The key to success however, depends on high-quality traffic information and effective and timely means of communicating this information. Examples of the latter are easier to find in the United States

than examples of network-wide high quality traffic data. There are a growing number of private firms that provide real-time traffic information to customers. This can be done via in-car navigation systems, special purpose devices, or via cell phones and PDA. For example, Traffic Gauge in Seattle provides traffic information on regional Interstates. SAFTEA-LU calls for a national system of real-time traffic information on expressways and arterials by October 2009, although no specific funds are provided.

However, traveler information on arterials is limited, both in Seattle and other in United States cities since fixed sensors are expensive to install and maintain. Most DOTs, including WSDOT, focus on the more heavily traveled freeway. Arterial congestion information is now being added to information services in Los Angeles and Chicago and Bellevue has some arterial data.

Adding traditional fixed sensors (whether loops or other sensors) can be expensive to deploy and operate along arterial routes. Interest is growing in using vehicles as a source of traffic data. This can be done via GPS-equipped vehicles or by various ways to collect data from cell phones. In the U.S. these systems are still being tested and have yet to be integrated into traffic information systems although regional systems exist in Baltimore, Missouri, Atlanta, and Tampa Bay with small scale tests in other urban areas. Inrix, a Puget Sound-based firm, uses GPS data to support a national traffic information system. Experience abroad is more robust with commercial systems in place in the United Kingdom and Israel and being deployed in Belgium, Sweden, Australia, and Shanghai, China.

More than just deploying these systems is the importance of disseminating accurate and reliable traveler information. A study of Seattle commuters conducted by the U.S. DOT FHWA indicates that 11 percent of commuters actually changed or postponed their trips altogether in the presence of “real time” traffic information. Seventy-eight percent of survey participants used the radio either en-route or pre-trip to make some travel decisions. Commercial radio stations use the WSDOT traffic web site continuously and provide real time traffic highlights as frequently as every 10 minutes. They also give travel times for freeway routes based on WSDOT data. FHWA refers to WSDOT’s Web site as “award winning” however, only 6 percent of people

cited in the same study used the WSDOT internet for traffic information. Even so, the web site is one of the top sites for traffic information nationwide.

Even though message signs are used mainly to report critical information on road closures, incidents, and other non-predictable situations, a few transportation agencies have begun to develop travel time information and use the signs to display it when no other critical information takes priority. Most transportation agencies that display travel time information have an automated algorithm that calculates the distance and the speed from sensors and provides travel times for specific corridors and/or landmarks. Commuters can decide if an alternate route should be taken based on the travel time displayed and, at the very least, commuters receive information which helps remove the uncertainty or worry about how long a trip might take. In France, DMS have been installed at 204 locations on the Paris ring freeway, its ramps, and the inner city ring freeway. Up-to-the-minute travel time is calculated with data from a network of 680 sensors that monitor traffic flow. Drivers find the real-time travel time information much more useful than general messages such as "congestion ahead." WSDOT does show travel times on its VMS.

Real-time traffic information can provide tangible benefits. For example:

- Eighty percent of the customers for Traffic Gauge in Seattle report that they save two hours or more a month in commuting time.
- According to a 2001-2002 study of real-time traveler information users in Pittsburgh and Philadelphia, 68 percent and 86 percent of highway users, respectively, changed their commute route choice and departure time in the presence of real-time traveler information.
- A 2001 study found that disseminating pre-trip congestion information increased travel time reliability by 77 percent in the Washington, D.C. metropolitan area.

In addition to these more tangible congestion reduction benefits, accurate and timely regional traffic data will help reduce costs and improve the effectiveness of many WSDOT responsibilities where congestion is a problem, including:

- Speed and reliability reporting
- Historical trend analysis

- Model development, calibration, validation
- Air quality model inputs
- Safety analyses
- ITS/operations planning
- Freight planning
- Economic analyses
- Customer service planning
- Investment decision support

These benefits will likely support the ability of WSDOT and others to implement other congestion-related recommendations. Implementation costs vary, with advanced technology providing lower-cost alternatives. While fixed sensors are expensive, non-intrusive methods such as GPS and cellular-based systems could be implemented regionally for $1 to 2 million or so per year. Data collected under the WSDOT umbrella could be used by PSRC, local transit authorities, as well as by the traveling public.

Recommendation 15: **We recommend WSDOT use available technology to expand coverage of real-time traffic information to all freeways and major arterials.**

WSDOT Response: We agree that technology is enhancing the opportunity for government entities to monitor traffic patterns and freeway/roadway conditions. WSDOT is currently exploring available technologies to expand traveler information as well as the role that the private sector may play in providing this information. WSDOT has focused on collecting traffic data for the primary purpose of system management, primarily ramp metering, with traveler information being the secondary benefit. Operational data require a higher level of infrastructure investment than collection of data focused solely on real-time traffic information. It is necessary to consider the entire approach to managing the system to determine which methods best apply to each facility.
WSDOT offers a comprehensive "Statewide Traveler Information" website at www.wsdot.wa.gov/traffic. It includes a map of travel conditions (flow map) and real-time travel times for key commute routes at www.wsdot.wa.gov/traffic/seattle/traveltimes/, and 95% reliable travel times for selected routes at www.wsdot.wa.gov/Traffic/Seattle/TravelTimes/reliability/. In addition, WSDOT operates 80 active, variable message signs (VMS) in the Puget Sound area and displays real travel times on some of these.

WSDOT has begun using Automated License Plate Recognition (ALPR) technology to collect real-time travel data on some arterial routes (e.g., SR-522). Traffic signals and closely spaced

access points on these routes interrupt traffic flow, making it less favorable for other data collection technology.

WSDOT is actively working with its national partners and peers – both private and public – to identify and test cost-effective and reliable traffic data sources.
OFM Response: We agree that coordination between local, regional, and state governments to maximize traffic signalization on key arterials and freeways is a necessary and laudable objective.

Action Steps and Timeframe

- WSDOT will evaluate new technologies to collect traffic data throughout the 2007-09 biennium and make recommendations in its 2009-11 budget submittal.

The Washington Transportation Plan 2007-2026 identifies the following unfunded high priorities that relate to operations and maintenance of systems critical to preserving the management of the freeway and state highway network:

- Address increased maintenance and operations responsibilities with additions to the highway system ($292 million),
- Add maintenance facilities to support the increased need for maintenance and operations of highway system additions ($2.1 million),
- Add traffic management centers at high-volume locations to improve throughput and increase real-time travel information ($16.3 million),
- Integrate, maintain, and operate new technology ($68 million),
- Complete the 10-year ITS plan for capital and operations ($600 million),
- Address the incident response shortfall ($8 million), and
- Expand the commute trip reduction tax credit program, increasing the number of small employers in the program ($20 million).

Issue 16: Lack of Funding Limits Many Useful Congestion-Related Operations Projects

While significant investments have been and continue to be made in operations and maintenance, as systems are expanded, insufficient provision is made to ensure that their potential benefit is fully exploited. Preservation of existing systems so that they can continue to operate as intended is essential in producing the full desired performance results. Electronic and software systems in particular have a relatively short life before they need replacement.

Issue 17: WSDOT Ramp Metering Coverage is not Complete

A policy that emphasizes congestion management as a primary goal would include expanded provision for operations and maintenance associated with capital investments. As capital budgets are developed accompanying maintenance and operations budgets that reflect the additions and improvements need to be included. Cost/benefit measurement should be developed that would allow the declining impact of the investment on congestion management to be estimated as operational performance becomes degraded.

Recommendation 16: **We recommend WSDOT work to fully fund operations programs that emphasize congestion management.**

WSDOT Response: WSDOT agrees that additional funding for high benefit/cost operational strategies would be beneficial. However, WSDOT operational programs have received incremental funding increases over the years. During the past 10 years, for example, WSDOT has received an additional $33 million (from $21 million to $54 million) to strengthen operating enhancements such as minor widening of freeway ramps, incident response vehicles, ramp metering, signal timing, bicycle and pedestrian projects.

OFM Response: We agree.

Action Steps and Timeframe

- WSDOT is currently completing an assessment to evaluate the potential benefits of additional operational strategies such as active traffic management strategies and intelligent transportation system investments (e.g., the supporting hardware). This evaluation will be completed in time for the 2009-11 budget submittal.

In September 1981 WSDOT implemented 22 ramp meters on I-5 north of the Seattle Central Business District. These meters were operated under central control. Initial studies over the first six years of operation showed volume increases of 86 percent northbound and 62 percent southbound. Travel times were reduced from 22 minutes to 11.5 minutes and the accident rate decreased 39 percent. Currently 135 ramps are metered in the Puget Sound Region area using a Fuzzy Logic algorithm developed in the late 1990's. This algorithm's operation is based on freeway and ramp conditions. The importance of ramp metering for combating congestion and maintaining throughput has been rightly recognized and supported by WSDOT. However the value of continuing to improve the program should not be underestimated. Other studies including the landmark study in Minnesota confirm similar gains to those reported in Seattle.

Minnesota turned off ramp meters for an evaluation period and found that, without metering, there was a 9 percent reduction in freeway volume and a 14 percent reduction in peak period throughput.

The study concluded that with meters there was a 22 percent decrease in freeway travel times. The study calculated that in Minnesota, meters result in an annual system wide saving of 25,121 hours per day. Following the experiment in March 2002, the Mn/DOT activated automated ramp meter timing systems and a Traffic Management Center (TMC) was used to collect vehicle detector data every 30 seconds and to adjust ramp meter timings automatically based on freeway conditions and changing ramp meter queue lengths.

Other examples of automated and centrally controlled-ramp meter systems are Atlanta, Portland, and Los Angeles. In the case of Los Angeles, Caltrans is increasing the number of metered ramps over a 50-mile corridor of the heavily congested I-210, metering two sets of freeway-to-freeway connectors, adding metered HOV lanes at highly congested ramps and converting some lesser-used HOV lanes at ramps to general purpose lanes. Benefits of increased throughput and reduced travel time are expected to be significant. An evaluation report will be available in 2008.

Currently WSDOT's ramp metering is operated whenever congestion occurs including peak hours, off peak hours, and weekends. WSDOT relies on operator judgment to help determine location and extent of required meters. This means that operators must be constantly monitoring their entire system for the build-up of congestion that would warrant the activation of meters. Such manual response requires an operator to recognize transitional periods before they reach capacity at multiple locations. Automation increases speed of response and accuracy by allowing transitional periods to be more easily recognized. Even in an automated system, operators can still override the automated function if need be, but will have more time for other monitoring tasks.

Ramp meters are a proven means of smoothing flows and increasing throughput. WSDOT's use of a fuzzy Logic algorithm is an advanced methodology and effective in balancing ramp flows based on ramp demand and local and near local mainline traffic conditions. However, other algorithms may provide better overall performance. A more system-wide algorithm would balance freeway flows more effectively while still controlling ramp queues. It appears that WSDOT has not yet maximized the use of ramp meters. Further, ramp geometrics may be limiting the program. Current un-metered ramps should be evaluated based on need and feasibility. Need is based on the quality of traffic flow on the mainline which is typically expressed in terms of the Level of Service (LOS), which is a function of traffic engineering parameters such as density, average travel speed, v/c (volume to capacity) ratio, and the maximum service flow rate. Accident statistics are also used to evaluate traffic flow quality. Feasibility of ramp metering is largely based on a ramp's geometric layout including storage area, grade, width, acceleration lanes, signalization, and shoulder area.

WSDOT should continue to enhance its ramp metering operations by assessing other available algorithms that recognize and respond to changing demand on a corridor and regional basis.

Recommendation 17: **We recommend WSDOT:**

- **continue to improve its ramp metering system.**
- **expand it to other locations.**
- **assess its ramp-control algorithms.**

WSDOT Response: WSDOT agrees that expanding the geographic coverage of the freeway ramp metering system is beneficial. The estimated long-range need for additional ramp metering on state-owned highways in King, Snohomish and Pierce counties is approximately 140 ramp meters at a cost of $180 million.

WSDOT will continue to assess its existing ramp metering system and balance between the problem of backing traffic onto local roads and keeping traffic running smoothly on the state system. WSDOT has extensive experience in ramp metering and is continuing to improve its operations. There have been ramp meters in the Seattle area since 1981. The majority of ramp meters are located on the busiest highways in the Seattle area: I-5, SR-520, I-90, I-405 and SR-167. Typically, ramps are metered from 6 a.m. to 9 a.m. and from 3 p.m. to 7 p.m. These times may vary depending upon the level of traffic congestion.

WSDOT's ramp-control algorithm is the most advanced in the country, using historical traffic data as well as system-wide, real-time traffic data from the metered freeway and connecting

ramps. We actively manage the system on a daily basis and perform a full review of each metered location every six months, adjusting system inputs where necessary.

OFM Response: OFM will work with WSDOT to understand any gaps in the system and what it would cost to close those gaps.

Action Steps and Timeframe

- WSDOT is converting its traffic management software, including exploring potential enhancements to the ramp metering algorithms. Expected to complete by next biennium.
- OFM will work with WSDOT during the summer of 2008 to identify system needs and complete an assessment for consideration in the 2009-11 budget.

The Northwest Region operates 65 permanent Variable Message Signs (VMS) and the Olympic Region operates 15 VMS. VMS are used for the distribution of incident data via event specific messaging (e.g. weather events, AMBER alerts, incidents, construction activities, and congestion data) in the form of travel times. Locating VMS upstream of motorist decision points maximizes the effectiveness of the VMS placements by giving critical information to motorists well in advance and allowing the motorists to make active decisions between continuing on their current routes or perhaps finding alternate driving routes or mode choices. Timely, accurate information is of the utmost importance if motorist are to rely on and respond to such information.

Issue 18: WSDOT Manual Response to Freeway Operations Decreases Efficiency

Currently, WSDOT operators manually choose which event messages to place on VMS. WSDOT has a long-term practice of utilizing students from the University of Washington's engineering department as operators. These students have an interest in the transportation industry and thus make an active and attentive operations staff. However even the best-trained staff will have difficulty in simultaneously verifying incidents using the flow map, CCTV cameras, viewing the WSP Computer Aided Dispatch (CAD) log (another separate system) and composing and posting multiple messages without any possibility of error. The same is true for using the Highway Advisory Radio (HAR) which is another completely separate system. Total reliance on manual operations reduces the timeliness and accuracy of the response to various information outlets. Use of automation not

only contributes to speed and accuracy of response, but, even more importantly, it frees up operators for more important tasks.

Several current freeway management tools could perform better if they are automated and integrated. For example, automatically turning on and off ramp metering based on freeway traffic conditions would be more efficient than a subjective operator interpretation of a large system. Having the system look at real and historic traffic data across the entire system would provide an effective method for managing VMS activation. Additionally, efficiencies would be gained by generating automatic messages for incidents based on operator or CAD provided incident information (e.g. type, location, lanes blocked, impact, etc.). The system could automatically select DMS and create appropriate messages thereby providing more timely and accurate responses.

Automated freeway management systems of varying levels of complexity are deployed throughout the nation. Integrated response plan systems integrate multiple sources of information to make recommendations for responses which, following approval, are capable of selecting locations and posting signs almost instantaneously. Examples include: San Antonio's TransGuide, Los Angeles (Caltrans District 7), and the Illinois Tollway and Incident Management System.

All automation should be subject to operator intervention. However, the time spent for tasks that could be automated would be better served for management of incidents and other more critical activities.

Integration of systems including CAD systems and automation of responses in metropolitan areas can both recommend the intelligent selection of and messaging for the VMS response to incidents. Similarly, the response and dissemination of information to VMSs, HAR, WSDOT web pages, and 511 can also be accomplished through a single point of data entry through integration of the systems.

Recommendation 18: We recommend WSDOT automate all freeway management tools.

WSDOT Response: We disagree that an all-automated freeway management system will provide the benefits suggested. WSDOT uses a combination of automation and engineering judgment to support safe and effective operations. We believe the current practice of using operating engineers to actively monitor/manage the freeway operations systems is the best practice.

OFM Response: See WSDOT's response.

Action Steps and Timeframe

- WSDOT will complete the operating system conversion by May 2008. At that point, software enhancements will be easier to implement. Further system automation of some Traffic Management Center functions will be one deliverable of this conversion.
- OFM will ask the department to evaluate the integration of freeway management systems through the use of a single point of data entry for dissemination of traffic information.

Auditors' Comment: The intent of this recommendation is for WSDOT to implement a level of automation for each of its freeway management tools to assist operators.

Non-recurring congestion caused by long-term incident closures contributes to long delays for motorists, lost income for commercial companies, and increased air pollution. Long closures also contribute to a higher probability of secondary crashes, impact meetings, appointments, and air travel of motorists, and decrease the public's support for the agencies involved.

The primary intent of traffic incident management is to prevent incidents from reducing capacity. However, when they do, the focus is to restore capacity as quickly as possible. This prevents backups, significantly decreases the occurrence and severity of congestion, and decreases the possibility of secondary crashes. WSDOT's

Issue 19: WSP Staffing Issues Hinder Efficient Incident Response

Traffic Incident Management program is a joint operation with Washington State Patrol (WSP).

It includes roving WSDOT Incident Response Team trucks that respond to and clear incidents as quickly as possible. The fleet includes WSDOT operated tow trucks that clear incidents from the SR520 and I-90 Bridges. Trucks rove the urban freeway system seven days a week from 5:00 a.m. to 7:00 p.m. (or 8:00 p.m. depending on the route). WSDOT and the WSP have coordinated one of the most comprehensive towing programs designed for quick clearance in the nation. It is made up of three key components:

1. Bridge tow trucks, I-90 floating bridge ,and SR-520 bridge
2. Immediate Dispatch — camera verification is followed by immediate callout of tows
3. Heavy Duty Towing Incentive program — clearing crashes in less than 90 minutes results in bonus payment while exceeding three hours calls for a liquidated damages payment to WSDOT

After hours response is provided by trained maintenance technicians from their residences with fully equipped trucks for traffic control. New dynamic signs have been added to these trucks to assist with traffic control, prevention of secondary crashes, and motorist information.

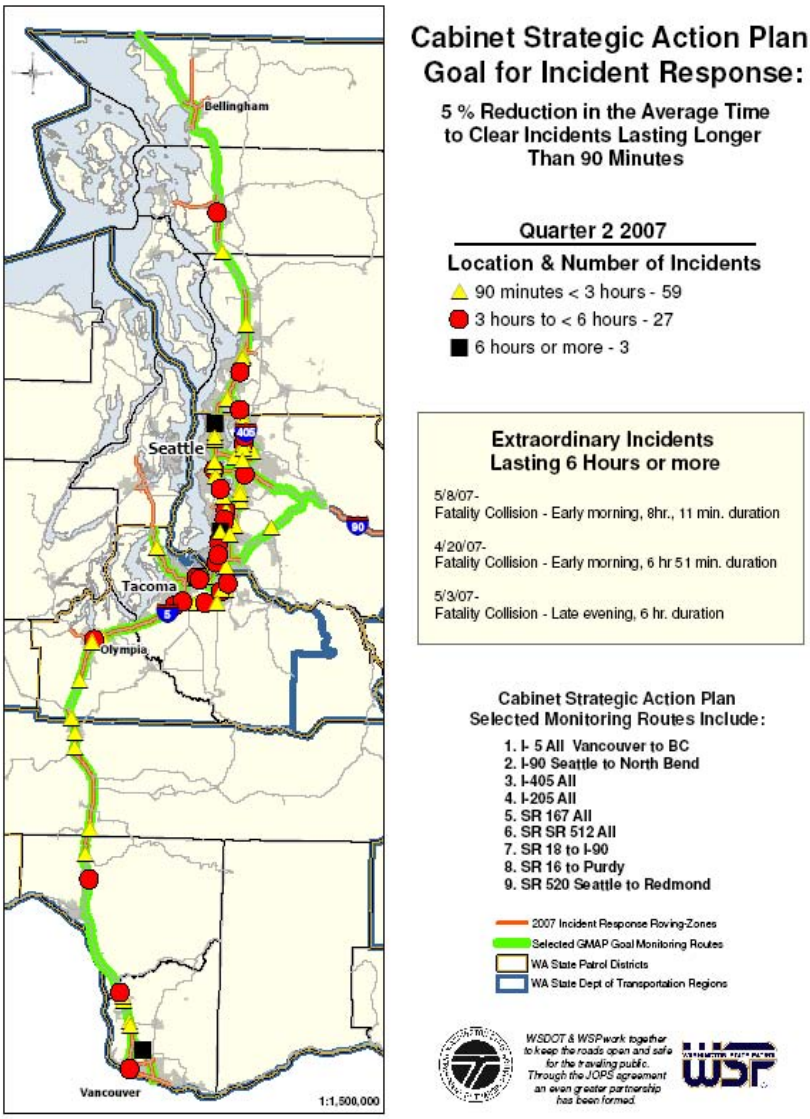
Joint communications including direct radio contact, direct CAD access for the TMC's, and direct radio contact with media aircraft are part of the program. A Joint Operations Policy Statement (JOPS) agreement, first instituted in 2002, is in place which outlines joint operating policies including a 90-minute clearance goal for all incidents. The performance goal agreed to by the WSP and WSDOT is to clear all incidents from the lanes within 90 minutes of occurrence. Quick safe clearance is a part of the National Unified Goal for traffic incident management and WSDOT goals are consistent with that standard.

However, the 90-minute clearance goal is not being met several hundred times a year statewide. Recent reports indicate little change in the number of incidents over 90 minutes and the average

duration of those incidents. The following illustration depicts the long period incidents that impacted traffic in the second quarter of 2007 in the study area. The total number of incidents exceeding 90 minutes in the study area appears to exceed 40 incidents with 18 incidents over three hours. It is not known which of these incidents are fatalities or commercial vehicle crashes. That information would determine what types of incidents are taking the longest to clear. These closures can add 1 or 2 more hours to motorist's trips causing extreme congestion on local roadways and alternate routes since motorists cannot plan for these emergencies.

WSDOT has expanded its on roadway response program to 47 trucks statewide. The response program team covers from 5:00 a.m. to 8:00 p.m. in key congested areas. These vehicles handle as many incidents as possible (approximately 4,000 per month) and the clearance times have been reduced on minor incidents from 30 minutes to 16 minutes under this program.

WSDOT can only do as much as is allowed by the WSP related to quick clearance on crashes they must investigate and on larger incidents as WSP controls investigations and the towing program.



The cause of the problem has partly been attributed to WSP staffing issues. The lead agency for most roadway incidents is the WSP. The urban area has a high turnover rate for troopers and often experiences a shortage. The WSP was short 39 troopers in May 2007 for Seattle and Tacoma combined. A new class of troopers has been assigned with approximately 19 vacant positions remaining in Tacoma and Seattle.

Inexperienced troopers are also a factor in lengthened clearance times and contribute to slow clearance of incidents. Troopers are often assigned to the urban areas after completing initial training and leave when they are able to transfer to other parts of the state. A recent change authorized by the 2007 legislature pays a premium of 10 percent for troopers working in King County, 7 percent in Snohomish County and 3 percent in Pierce County.

Priority must be given to this trooper inexperience. Maintaining an appropriate level of WSP staff could help reduce the length of these closures. Consideration should be given by the WSP in making congestion mitigation a part of the deployment model for troopers.

WSDOT should also support WSP efforts to obtain better tools and training. Tracking the incident types could also help determine the cause of long closures. An after-action review process should be implemented for every closure over 90 minutes and include all the agencies that were involved in the incident management process.

WSDOT should maintain and expand its current tow program for availability for all major construction projects.

Recommendation 19: **We recommend WSDOT, in conjunction with the Washington State Patrol, improve its current incident response system through resolution of WSP staffing issues and an all agency after-action review process for every closure over 90 minutes.**

WSDOT Response: We agree that adequate staffing and continuous evaluation of incident response effectiveness is critical. Within the Northwest region, monthly meetings are held with WSP to review incidents lasting more than 90 minutes. In districts with fewer incidents, meetings are scheduled within seven days of major incidents. An effort is made to involve emergency response agencies beyond WSP where appropriate but this is an ongoing effort.

OFM Response: The Washington State Patrol has implemented a new marketing and recruitment initiative as of August 2006. It includes ways to educate the public about career opportunities with the Patrol and draw quality applicants to the agency. These efforts have resulted in a 106 percent increase in applications received, compared to the previous 12 months. This increase in applications allowed the agency to hire 134 trooper cadets for the December 2006, May 2007, and September 2007 classes.

These efforts to reduce trooper vacancies, coupled with the regional incentive pay for King County (10percent), Snohomish County (seven percent) and Pierce County (three percent) should improve the Patrol's ability to retain experienced troopers in the urban core.

State Patrol district commanders review every 90-minute closure internally and if they believe there were any coordination problems that affected road clearance, they contact the Department of Transportation to conduct a fuller review with all involved parties, (e.g., tow companies).

Action Steps and Timeframe

- WSP and WSDOT are jointly working on attaining a specific target to reduce incidents lasting more than 90 minutes by five percent by December 2007.
- WSDOT will partner with WSP to further seek opportunities for the Patrol to expedite its investigations by using technology that has recently been funded, and encouraging quicker

accident investigations. WSDOT and WSP will jointly report to the Governor and her leadership team in the Governor's 2008 accountability forums.

Issue 20: The State of Washington has not Taken Advantage of Private Sector Financing Options

Unlike many other states, WSDOT faces several legislative hurdles to being able to secure private sector finance for transportation infrastructure improvements. These hurdles include the need for the legislature to authorize tolling and restrictions on the use of private-sector financing for transportation infrastructure improvements and operations.

The growth in public-private partnerships offers a tool to finance transportation infrastructure improvements that WSDOT has available to consider. There should be no specific requirement for WSDOT to enter into such agreements or to raise private sector financing through such agreements. However, WSDOT should develop specific criteria to define the circumstances under which they would request proposals for private sector partnerships and the criteria for bidder selection.

In recent years, a growing number of transportation agencies have used public-private partnerships to secure financing in exchange for providing private companies with the rights to collect toll revenues on specific facilities for a pre-determined period of time. While WSDOT can participate in public-private partnerships, any financing that relies on toll revenues must be provided by the State Treasurer — which means that all toll projects must not only be publicly-financed, but also, the issuer must be the State of Washington.

In effect, WSDOT has not had the opportunity to use a source of financing which is available to and actively used by other state DOTs. The State of Texas, for example, has entered into agreements whereby private firms may pay several billion dollars for the right to fund, build, and then operate new roadways. For example, one consortium bid $1.2 billion for the right to build and operate a $6 billion highway in Texas. The state DOT can then make use of the up-front payment to fund other transportationinvestments that cannot be supported by tolls. Also, as part of the partnership agreement, the private developer must maintain the roadway to fixed standards

and the roadway must meet specific quality standards when it is returned to state DOT control. Thus, these agreements require private financing for both operations and maintenance.

Public-private partnerships have become an important part of many toll road initiatives. The International Bridge, Tunnel, and Turnpike Association (IBTTA) reports that newly constructed tolled highways represent more than 35 percent of the total limited access centerline miles added to the national inventory from 1992 to 2006 (700 of 1,900 miles.)

Long-term lease agreements are an option that some states have used to generate capital to support other public investments. All of these involve the lease of existing toll facilities and so have limited immediate value for Washington today. However, this value will change as the state builds more toll facilities — the Tacoma Narrows Bridge opened this summer and tolls appear likely for the SR520 and I-90 bridges.

Recommendation 20: **We recommend the Washington State Legislature review whether new legislation is required for public private partnerships for transportation infrastructure and implement any necessary changes.**

WSDOT Response: We do not believe that changes in the public/private partnership law are required to continue exploring toll-based or concession-based private financing options on a case-by-case basis. However, we defer to the Legislature on this issue.

OFM Response: We agree there may be opportunities to take advantage of private financing options. The main benefits of private financing include more upfront construction funding, longer debt repayment opportunities, and using market driven expertise. A car-only tunnel under Seattle is an example of a public-private partnership offered in the audit. However, it does not provide the financial analysis to demonstrate the benefit of public vs. private financing.

Action Steps and Timeframe

- WSDOT will continue to assess private financing structures for the most cost-effective alternative.

FUTURE OPTIONS

Issue 21: Persistent Congestion Problems on I-5 Through Downtown Seattle Will Require an Assessment of All Potential Solutions

The I-5 corridor is the busiest and arguably most strategic, corridor in the state, yet efforts to add capacity over the last quarter of a century have been limited. Between 2011 and 2015, traffic volumes on I-5 are expected to reach 320,000 trips per day. This corridor also has national importance given its role in serving international and interstate freight movements.

I-5 is currently extremely congested. The worst bottleneck in the state, located on I-5 at the I-90 interchange, affects more than 300,000 vehicles per day and results in more than 14 millions hours of delay a year, costing $350 million in lost productivity. The I-5 bottleneck results from a number of factors including:

- North-south transportation movements depend on Interstate 5 which connects most of the major cities on the Puget Sound and connects Seattle with Oregon and California to the South and British Columbia to the North.
- The original I-5 facility was built in the early 1960s. Adding new roadway capacity is now more difficult.
- The original facility was designed to meet the design standards of the time (these have since been significantly improved and enhanced).
- The demand and projected growth on I-5 at the time it was originally designed, has since been exceeded many times over.
- The original close spacing of intersections was not necessarily dictated by design standards.

Although the TPA and Nickel programs address some of Puget Sound's congested routes, none of the projects address the State's most critical bottleneck the I-5/I-90 Interchange.

Much of the rationale behind the postponement or avoidance of major improvements and capital improvements along the downtown section of the I-5 has been the belief that the planned Light Rail improvements will mitigate existing and future congestion. The addition of light rail to the I-5 corridor will have a measurable, but limited effect on traffic congestion:

> *"By 2020 with full operation of the LRT from S.200th to Northgate, Central Link is estimated to carry only 14 percent of the person trips per day carried by I-5 in year 2000."* (James W. MacIsaac, P.E., on March 25, 2003)

Because of the physical constraints along I-5 in downtown Seattle such as topography, bodies of water, and urban development, most of the current tools are unlikely to reduce traffic delays along the corridor compared to today's congestion levels. Other, more nontraditional options are therefore recommended.

Larger-scale projects, which include the construction of grade-separated freeways and/or tunnels may be more appropriate for the I-5 problem.

> *"The biggest move to make highways more acceptable is likely to be moving some of them underground. A lot of this is already happening overseas in Europe and Australia where urban highways were less developed than in the United States until recently. Where we have need for increased capacity in bottleneck corridors we'll need to look at under grounding — either beneath the existing corridor or parallel to it several miles away — because no surface facility or elevated structure is acceptable. Under grounding ranges from entrenching within walls, to caps, cut-and-cover, and more extensive mined tunnels or those built with tunnel boring machines."*[6].

Underground "entrenched" or tunneled sections are becoming increasing popular. Worldwide applications include several underground sections of freeways in Japan including most of the seven-mile long Shinjuku section of the Central Circular Expressway and two-miles of the Oji section. Freeway tunnels are also becoming more prevalent in America with examples such as the Vine Street Expressway (I-676) in downtown Philadelphia, which links the Ben Franklin Bridge and the Schuykill Expressway (I-76) and provides access and egress at three points in the central city area. In Europe, Asia, and Australia where there is strong objection to land acquisition and construction of surface roads there are several examples of urban tunnel highways being built.

The FHWA typically only supports mixed-traffic (car and truck) facilities. However, the concept of cars-only freeways should be given further consideration. There are several examples of freeway sections with reduced width lanes such as The Holland Tunnel in New York City

[6] *Innovative Roadway Design: Making Highways More Likeable* Peter Samuel, Reason Foundation

which has 20-foot wide roadways with 10-foot lanes or the Goethals Bridge (which carries I-278 linking the New Jersey Turnpike to the Staten Island Expressway) with a 42-foot roadway carrying four expressway lanes of 10.25 feet each. The plans for the major tunnel under Versailles outside of Paris also reduced ceiling heights to about 8.33 feet. By decreasing the maximum lane width and height, the required tunnel diameter would be decreased, thereby reducing costs.

WSDOT is encouraged to examine non-traditional options. The construction of additional lanes are potential options and, while expensive, a car-only tunnel through Seattle's central business district could be designed with a smaller profile than traditional full-service tunnels and could help move through traffic. Average tunnel costs range from $250 million/mile to $500 million/mile. Opportunities for potential public-private partnerships may also exist to build additional lanes or a car-only tunnel.

Recommendation 21: **We recommend WSDOT and the Region pursue potential enhancements to I-5 in downtown Seattle.**

WSDOT Response: WSDOT agrees that I-5 through Seattle has persistent congestion, and that creative solutions will be necessary. WSDOT is continuously looking for incremental improvements on I-5. For example, the ongoing pavement rehabilitation effort on I-5 through Seattle includes minor reconfigurations and operational efficiencies. Please also consider WSDOT's response to Recommendation #3.

OFM Response: The audit recognizes the severe congestion in the downtown Seattle area and recommends innovative non-traditional options. Although the audit recommendation of an underground car-only tunnel through the central business district is intriguing, adding capacity in the downtown area would be difficult given geographic constraints, the location of the Convention Center, environmental challenges, and prohibitive costs. Therefore, the other two methods of addressing congestion – operational efficiencies and demand management – must receive enhanced consideration.

Action Steps and Timeframe

- WSDOT will continue to assess improvements and operational efficiencies.

Issue 22: The Puget Sound Region has an Extensive HOV Network, but the Policy for how it is Operated has not been Reviewed for Some Time

With approximately 213 miles of HOV lanes, the Puget Sound Region is a national leader in the extent of its High-occupancy vehicle (HOV) network. HOV lanes have been deployed in order to help move more people faster by giving priority to high occupancy vehicles including buses, vanpools and carpools. It was also hoped that a faster, more reliable commute would encourage people to switch from using single occupancy vehicles. This second objective has had limited success, but the first objective of moving more people faster remains valid.

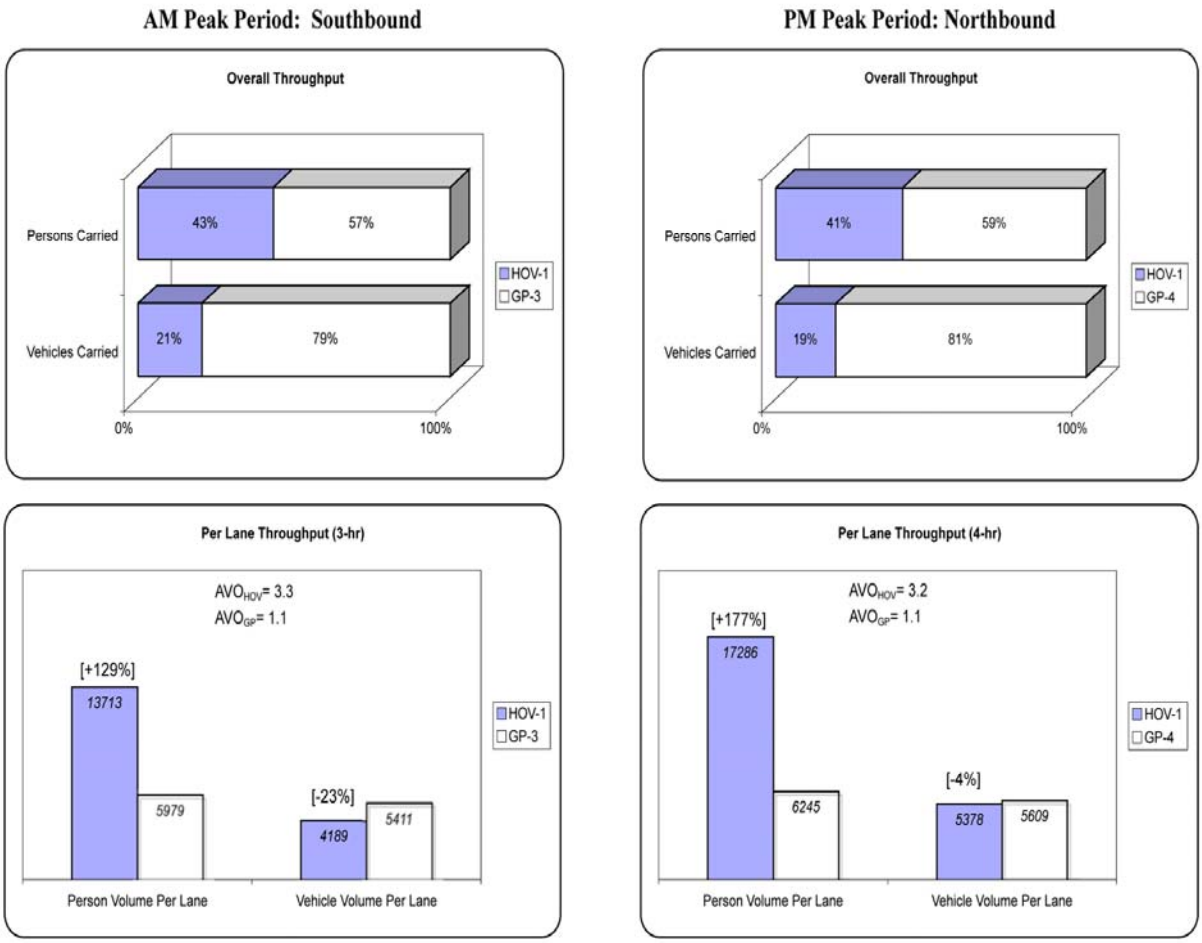
According to WSDOT's Gray Notebook (based on TRAC data), regional HOV lanes carry, on average, 29 percent of all the people on the regional freeway system in the morning and almost 33 percent in the afternoon. The study area has approximately 1,058 lanes of freeway of which 213 lanes (20 percent) are HOV lanes. Therefore, 20 percent of the lanes carry 33 percent of the people during peak periods.

Some segments of the HOV system nearest to Seattle carry an even larger percentage of travelers. At Northgate, the HOV lanes carries approximately 43 percent of the morning throughput (13,713 people) while each general purpose lane carries 5,949 people. During afternoon peak hours, the HOV lane carries 17,286, and each general purpose lane carries 6,245 people. Similar data holds for the Route 405 HOV lane and the South King County HOV lane.

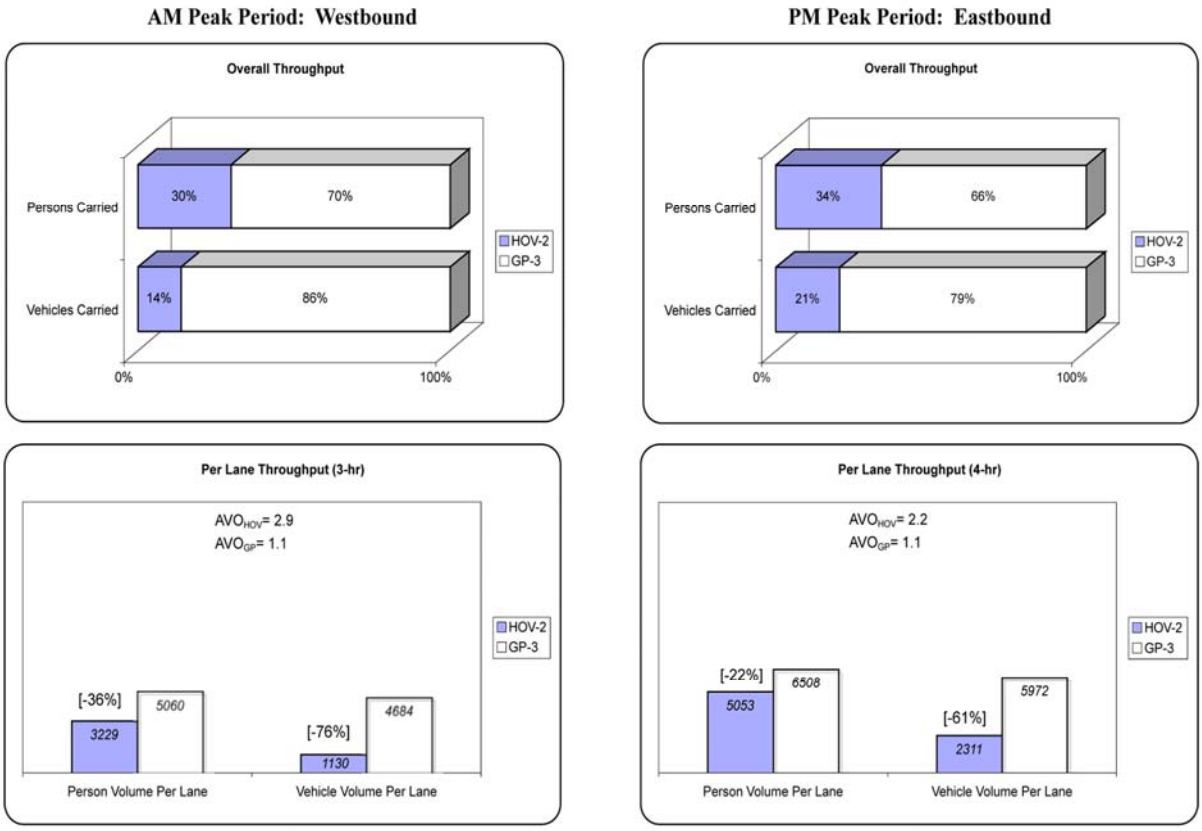
Data show that Interstate 90 is at the other end of the HOV spectrum. Here, the HOV lane carries 3,229 people during the morning peak while each general purpose lane averages 5,060. In the afternoon peak, HOV carries 5,053 while each general purpose lane carries 6,505. One reason for this poor performance maybe the ability of residents of Mercer Island to use the HOV lanes while driving single occupant vehicles.

A review of each segment of roadway indicates that the maximum throughput of vehicles per general purpose lane during peak periods in 1,567 in the morning peak and 1,507 in the afternoon peak. In 2005, however, significant portions of the freeway HOV lane system actually

operated above these capacity estimates. This phenomenon is similar to what happens with other single-purpose lanes. For example, the left-hand or fast lane often has a capacity higher than other freeway lanes.



GP vs. HOV Throughput Comparison (2005): I-5 near Northgate



GP vs. HOV Throughput Comparison (2005): I-90 Floating Bridge

WSDOT and PSRC have adopted a performance standard for freeway HOV lanes:

> *90 percent of the time, the HOV lane should maintain an average speed of 45 mph or greater during the peak hour.*

Six HOV lane segments are now so congested that they fail the standard in the afternoon peak period and four fail the standard in the morning period. In 2004, five corridors failed this standard in the afternoon peak period and three in the morning peak period, reflecting the deterioration of the general overload of traffic on the regional highway network in recent years.

The overload of traffic volumes on the HOV network mirrors the corridors that are the worst for general capacity throughput. TRAC data show that all I-5 HOV segments analyzed fall below performance standards in either the morning or afternoon peak, with the I-5 at I-405 interchange

falling below standard during both peak periods. Likewise, analysis completed for this audit shows severe afternoon peak problems, particularly at:

- Northbound I-5 north of Northgate,
- Southbound I-5 near I-90,
- Southbound I-405, south of SR-520 and continuing for some stretches south of I-90, and
- Northbound I-405 north of SR-520.

Analysis completed for this audit confirms that these HOV segments also move the most vehicles per lane per hour during the peaks, at more than 1,300 vehicles per lane per hour. With average vehicle occupancy of 2.2 passengers, a single HOV lane still moves more people than its general purpose counterpart. However, with degrading levels-of-service in HOV facilities, it is highly unlikely that the HOV lanes will attract *new* carpoolers.

A recent WSDOT survey reports that HOV lanes provide enough travel time savings to encourage carpooling by 15 percent to 18 percent of current HOV users. These people said that they would probably switch to driving alone if HOV lanes were not available. That leaves 82 percent to 85 percent of current HOV users who would likely carpool regardless of HOV status.

Additionally, the same study shows that about two thirds of carpools (67 percent of peak period carpools, and 72 percent of mid-day carpools) are people from the same household. The TRB study (Commuting in America III) however, concludes that these family carpools, or "fampools," are more likely to continue carpooling without the presence of HOV. A recent article in the L.A. Times also cites that the "commuter carpool has functionally disappeared in America," where, "80 percent of carpools consist of family members who would likely be traveling together anyway."

Therefore it is unclear if the presence of HOV really encourages commuter carpooling for as much as 85 percent of passengers. Regardless of the effects on general purpose lane throughput for commuters, HOV lanes exceed general purpose lane throughput in Puget Sound on all but four regional corridors.

WSDOT has committed to increasing the efficiency of the HOV network as a primary component of its strategy for regional congestion reduction. The inefficiency of the HOV system in some locations is likely related to missing sections; therefore, completing the HOV system as planned may increase the user level as new HOV sections become available to users.

WSDOT is building direct access ramps to many HOV lanes throughout the Puget Sound Region for Sound Transit so that buses, carpools and vanpools have direct access to HOV lanes from park-and-ride lots and local streets giving these users added travel time benefits. Five HOV direct access ramps have recently opened and 14 more are planned. TRAC data shows that the largest travel time savings for these enhancements is potentially 8 minutes at the Lynnwood ramp, with an average of less than four minutes of time savings for all other ramps.

Considering the cost of these ramps and the time required to complete them, WSDOT should analyze other planned HOV investments closely. Comparing key measures — such as travel time savings per million dollars of investment — with all solutions, particularly the addition of general purpose capacity, would provide a more telling analysis of the relative benefits of such expansion. For example, the Ash Way ramps, which are restricted to transit vehicles, carry only approximately 200 vehicles per day, and investment in direct access ramps for these vehicles will provide only 2 to 6 minutes of travel time savings per vehicle.

Bottlenecks related to incomplete HOV lanes near Northgate, Downtown Seattle, and at the King/Pierce County line on I-5 cause HOV users to join general traffic, thus increasing congestion. SR-167 again at the King Pierce County line is another bottleneck. Segments of the HOV have been completed in King County except for a small portion of 167. Pierce County HOV lanes to connect with King County segments are planned but not scheduled to start construction until 2009 on Interstate 5. The continuing expansion of the HOV system will add capacity that continues to be in demand, especially on segments that are already at capacity.

HOV overall performance of overcrowded segments and underutilized segments needs to be reviewed. HOV required three occupants (HOV-3) throughout the Puget Sound Region when it was first implemented. Later the requirement dropped to two occupants (HOV-2) — except for one segment on 520 that ends prior to the bridge over Lake Washington. HOV use increased in certain areas, but unfortunately also decreased in other underutilized areas.

The method used to implement the HOT Lane Pilot on SR-167 may be used to help balance capacity in other parts of the Region. In order to create enough HOT Lane capacity, some HOV Lanes will require a change to HOV-3.

To relieve congestion and improve the overall efficiency of the HOV system, completion of the segments through Seattle and to Tacoma should be a top priority. Interstate 5 carries more people, vehicles, and commercial traffic than any other route and added HOV would improve the overall traffic flow. Direct access points for buses and car pools should be developed but only after the completion of the missing segments. Ramps that service direct access to the HOV lanes should be a lower priority as they sometimes are used by only a few hundred vehicles per day.

WSDOT should consider converting underutilized HOV segments such as I-90-Mercer Island to general purpose lanes. Consideration should be given to using HOV-3 rules for sections that fail WSDOT's 45 mile per hour criteria. Travel advantage for HOV users would then increase however general purpose lanes would become more congested. This conversion would also provide capacity for HOT lanes.

Recommendation 22: **We recommend WSDOT:**

- **complete the core HOV network, with an emphasis on the I-5 corridor to Tacoma.**
- **consider adjusting current policy where needed in order to meet existing performance standards.**
- **critically examine expensive interchanges and direct ramp access before additional investments.**

WSDOT Response: We agree that active HOV lane management and operational policies are critical components of optimum performance. WSDOT's HOV policy is currently under review, and the agency is preparing an HOV Action Plan which analyzes modifications to operating policies. The plan will include an ongoing assessment of HOT lane opportunities. WSDOT also assesses and closely monitors HOV performance on an annual basis, and periodically evaluates the operations policy.

WSDOT agrees with the first two recommendations. WSDOT is working on completing I-5 HOV projects that will extend the system from SR-16 in Tacoma through King County to US-2 in Everett. Ten lane-miles of HOV on I-5 were extended from Federal Way to the King/Pierce County line this year. Completion of all of these HOV projects is a high priority:

- Another fifteen lane-miles of HOV opened on SR-16 in Pierce County, connecting Gig Harbor to the Fircrest area in Tacoma across the Tacoma Narrows Bridge. This section of HOV is planned to connect to I-5 by 2015.
- Work on HOV lanes on I-5 between SR 16 and the King/Pierce County line is scheduled to begin in 2009.
- HOV lanes on SR-167 were also extended south one mile to 15th NW this year, and are being extended east on SR-520 (open 2011) and north on I-5 (2008).
- Unfunded segments include: 1) a portion of the core HOV network on I-5 south from the SR-16 interchange area down to SR-512, 2) SR-16 east to Purdy, 3) SR-167 south to Puyallup, and 4) linkage of I-5 to I-405 across the SR-520 bridge.

In response to the second recommendation, the HOV Action Plan combined with on-going corridor planning work, will analyze modifications to operating policies. HOV policy will continue to seek the optimal balance between how fast vehicles travel in the lane and how many people are carried.

Through modeling analysis, WSDOT concluded that simply raising the HOV occupancy requirement (e.g., 2-3 person requirement) without policy or operational changes, such as converting to HOT lanes at the same time, would result in significantly underused HOV lanes and create more congestion on the adjacent general purpose (GP) lanes. WSDOT will likely revisit this issue after the demonstration of the SR-167 HOT lane pilot project.

WSDOT has also considered, but rejected, the idea of converting HOV lanes to GP lanes in the central Puget Sound region for a number of reasons:

- Historical data indicated that HOV volume per hour per lane has been growing at three to four times that of adjacent GP lanes.
- Converting HOV lanes to GP lanes now would make it much more difficult to implement (if not preclude) HOT lanes in the future.
- Bus Transit (especially express buses), as well as vanpools and carpools, rely heavily on HOVs to increase travel time reliability.
- WSDOT's recent HOV user survey shows nearly 20 percent of HOV users would revert back to SOV if HOV lanes were converted to GP lanes.

- If an HOV lane is converted to GP, drivers who now use other roads or modes may instead use the newly created GP because there will be initial capacity. However, that temporary capacity will likely fill quickly. The possible initial congestion reduction in the GP lanes may be offset by this increased volume in the converted lane.

In response to the third recommendation, direct access ramps on I-5 are not being built with state funding.

OFM Response: WSDOT is working to complete an HOV Action Plan for I-5 that describes where HOVs are working well and where failures are occurring. The plan will include actions that can be performed in the near term to address performance problems.

We appreciate the recognition given to the state for its leadership in implementing an extensive HOV system. We agree that completing this important corridor of HOV between Seattle and Tacoma is critical. In fact, connecting Pierce, King, and Snohomish counties along I-5 is one of the most important and highest funding priorities in the state. We have made significant headway in completing this HOV corridor. The HOV system through King County was completed in September 2007. WSDOT expects to complete construction of the HOV system between Seattle and Everett by the summer of 2008. HOV construction from the King County line to 38th Street in Tacoma is expected to be complete by 2012. Additional HOV lanes are planned from 38th Street to SR-512 in Tacoma but are currently unfunded.

<u>Action Steps and Timeframe</u>

- WSDOT's HOV Action Plan will be completed by December 2007.
- As indicated above, WSDOT will complete the funded I-5 HOV projects as identified on the 2007 project list adopted by the Legislature.

Appendix

WSDOT Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion

A-1 – Glossary of Terms

TERM	DEFINTION
95% reliable travel time	Time it takes to arrive "on time" 19 out of 20 days.
AASHTO	The American Association of State Highway and Transportation Officials is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. It represents all five transportation modes: air, highways, public transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system.
Area-wide charges	Per-mile charges on all roads within a geographic area where rates vary by level of congestion.
Arterial (Major)	A major thoroughfare used for traffic access to adjacent freeways. Arterials are characterized by high vehicular capacity in addition to the continuity of movement. In the case of this report, arterials are defined as a separate functional class from freeways and are generally not operated by WSDOT.
ATCS	Adaptive Traffic Control System
Average Peak Hour Travel Time	Travel time between two points during the most congested part of the day.
Average Volume	Average number of vehicles (vehicles per lane per hour).
Benefit-Cost Analysis	The technique of analyzing the cost effectiveness of a transportation investment by comparing benefits to transportation costs. Benefits often include reduced travel time; costs often include project construction costs among other elements.
Bottleneck	A location where the volume of traffic routinely exceeds the capacity of the roadway, resulting in a constriction of traffic flow such as dense, very dense, and stop-and-go traffic; also called Chokepoint.
Breakdown	The condition where the number of vehicles on a highway reaches a critical volume, and speeds drop dramatically; the highway "breaks down," resulting in stop-and-go traffic and/or traffic jams.
CAD	Computer Aided Dispatch, a tool used by law enforcement officers to coordinate and manage incident response
Capacity	Maximum flow (vehicles per lane per hour); the maximum number of vehicles a roadway can carry in one hour.
CBD	Central Business District
CCTV	Closed Circuit Television used to monitor traffic conditions
CFR	The Code of Federal Regulations
Chokepoint	[see Bottleneck]
CMAQ	The Congestion Mitigation and Air Quality Improvement Program
Commuter	A driver who is traveling to or from an employment location.
Congestion	Traffic condition characterized by slower speeds, longer trip times, increased queues, and reduced throughput of vehicles. When traffic demand is greater than the capacity of a road (or of the intersections along the road), congestion occurs. Extreme traffic congestion, where vehicles are fully stopped for periods of time, is commonly known as a traffic jam.
Congestion Index	The percentage of time when the ratio of travel time during congestion periods to travel time in free-flow is above a chosen threshold value. This ratio is a measure of the compactness of the traffic and also reflects congestion. TRAC defines the threshold for congestion at 19%. A travel time index of 1.4 means that travel takes 40% longer during the peak.
Congestion Pricing	Toll-based pricing that aims to shift a commuter's decision during rush-hour from highway travel to other transportation modes, to off-peak periods, and/or to not traveling at all; also called Value Pricing.

TERM	DEFINTION
Cordon Charges	Variable or fixed fees charged to commuters who drive into a city or within a congested area of a city. These fees have been implemented in London and Stockholm and are planned for New York City.
CTR	Commute Trip Reduction; a program used by WSDOT to encourage non-SOV travel.
Delay	The additional time required to complete a trip in excess of the time the trip would take under free flow speed.
Demand Management	[see Travel Demand Management]
FETSIM	Fuel Efficient Traffic Signal Management program; program that optimized traffic signal timing plans and coordinated traffic signal control.
FHWA	Federal Highway Administration, a modal administration of the USDOT
Flow	Vehicles per lane per hour
Free Flow Speed	Free flow speed is defined--for monitoring purposes--as the posted speed limit of a highway facility.
Freeway	Access-controlled, divided highway. Most freeways are at least four lanes, two lanes each direction.
FTA	Federal Transit Administration, a modal administration of the USDOT
GAO	The Government Accountability Office
GBC	Governor's Business Council (Texas)
GP Lane	General Purpose Lane; for mixed traffic, including automobiles, trucks, and motorcycles.
HAR	High Advisory Radio is a system used to advise travelers of traffic-related alerts.
HOT Lane	High Occupancy Toll Lanes are dedicated lanes for the use of vehicles meeting HOV lane requirements and SOVs that pay a toll. Typically tolls vary depending on traffic volume, as a means of regulating access to or the use of the facility, to maintain travel speed and reliability. HOT Lanes are an example of Managed Lanes.
HOV Lane	High-occupancy vehicle lanes are dedicated lanes for the use of vehicles with two or more occupants, transit vehicles, and motorcycles.
Highway	A major road for any form of motor transport.
Highway Breakdown	[see Breakdown]
Incident Management	The management of non-recurring congestion, such as spills, collisions, immobile vehicles, or any other impediment to smooth, continuous flow of traffic on freeways.
ISTEA	Intermodal Surface Transportation Efficiency Act which was passed into law in 1991. Governs how the U.S. Government spends transportation money. It sets the rules for how states and local governments can spend the federal transportation funds they receive. Superseded by TEA-21 and SAFETEA-LU.
ITS	Intelligent Transportation Systems comprise communication systems and information technologies that are designed to move automobiles and transit more effectively and to convey information to the traveling public. ITS can include devices that integrate with traffic signal systems, allow transit vehicles to have priority over other vehicles, and offer electronic fare payment for greater customer convenience.
Joint Program Office	The USDOT Joint Program Office coordinates federal policy regarding technology and transportation.
JOPS	Joint Operation Policy Statement, developed by WSDOT and WSP to encourage coordinated incident management.
Journey to Work	The U.S. Census measure that provides statistics on the modes of individual transportation to and from work.
Just-in-Time	An inventory system designed to ensure that materials or supplies arrive at a facility just when they are needed so that storage and holding costs are minimized.

TERM	DEFINTION
LOS	Level-of-Service; a measure of efficiency of the roadway segment from a user's perspective. The measure is a function of density, average travel speed, volume to capacity ratio, and the maximum service flow rate.
LRP	Long-Range Transportation Plan; mandated by SAFETEA-LU for MPOs and DOTs which requires 20 to 25-year considerations for regional/state multimodal transportation system.
Managed Lanes	One or more lanes of a highway where lanes are managed to regulate access to or the use of the facility in order to maintain travel speed and reliability; HOT lanes are an example of Managed Lanes.
Mixed traffic	Traffic which includes both passenger and freight modes.
Mode	The different kinds of transportation facilities that are often used to transport people and goods such as airplanes, trains, cars, foot, etc.
MP3	WSDOT's Mobility Prioritization Process
MPO	Metropolitan Planning Organization; regional entity responsible for the continuing, cooperative and comprehensive transportation planning process for its urbanized area. Each urbanized area in the United States with a population of 50,000 or more is required by the federal government to have a metropolitan planning organization (MPO). PSRC is the MPO for the Seattle region.
Multimodal	Characterized by several different modes of transportation, including passenger vehicle and transit.
Multimodal tradeoffs	The process by which investments are compared across all modes – highway, transit, etc. – using common measures of benefits. Funding for improvements is then allocated based on comparisons.
MVET	Motor Vehicle Excise Tax
NCHRP	The National Cooperative Highway Research Program
Nickel Funding Program	A program which identifies 158 projects to be funded over a ten-year period in Washington State (2003).
Non-Recurring Congestion	Congestion created by unplanned events such as incidents or bad weather.
Non-SOV	All modes of transportation other than the single-occupancy vehicle, including HOV, transit, and telework alternatives.
Occupancy	Percentage of time that a lane is occupied by vehicles.
Operations (transportation)	Strategies designed to improve the efficiency of the highway network without adding capacity. Can include ITS or other technologies, ramp metering, and/or incident and event management techniques.
Peak Hour	Commute travel period, usually lasting more than one hour. In the morning, 6:00 a.m. to 9:00 a.m.; in the afternoon, 3:00 p.m. to 7:00 p.m. Also known as Rush Hour.
Potential Throughput	Maximum possible throughput given particular road conditions, generally just before highway breakdown.
Practical Throughput	Average throughput given particular road conditions.
Project Prioritization	List of transportation projects in rank order to be matched with funds (programmed).
PSRC	Puget Sound Regional Council; the MPO for the Seattle region.
Ramp Metering	Operations technique that uses traffic signals to control the entry of vehicles from a ramp onto a freeway. During congested periods, ramp meters control the frequency and spacing of merging vehicles, which helps to improve the traffic flow.
RCW	The Revised Code of Washington
Recurring Congestion	Congestion created by a general imbalance between the demand for travel and the physical capacity of the roadway to deliver (demand is greater than supply).

TERM	DEFINTION
Reliability	Performance measure for reliability referred to as the 95% Reliable Travel Time--an estimated travel time with 95% certainty that you will arrive on time. The ability of the transportation network to allow for users to arrive on-time.
RTC	The Regional Transportation Commission is a group established by the State Legislature to study alternate ways to manage highway and transit programs in the Puget Sound Region.
RTID	Regional Transportation Investment District
RTPO	Regional Transportation Planning Organization
Rush Hour	[see Peak Hour]
SAFETEA-LU	The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users; authorizes the Federal surface transportation programs for highways, highway safety, and transit for the 5-year period 2005-2009.
SAO	Washington State Auditor's Office
SIP	State Implementation Plan
Sound Transit	The Central Puget Sound Regional Transit Authority; created by King, Pierce and Snohomish counties in the early 1990s to plan, build and operate a high-capacity transit system within the Puget Sound region's most heavily traveled corridors. The Sound Transit District includes the three-county area's urban centers and close to half of the state's population.
SOV	Single Occupancy Vehicle; a vehicle (more than two wheels) with one occupant.
Speed Index	The percentage of time that average speed is less than a chosen threshold value.
Speed-Flow Curve	Graph that shows the relationship between volume (flow) and average speed. Speed is shown on the vertical axis and flow is shown on the horizontal axis.
ST2	Sound Transit's proposed investment program that will be voted upon in the November 2007 ballot.
STIP	State Transportation Improvement Program
TCI	Texas Congestion Index
TDM	Transportation Demand Management; strategies that aim to shift demand from single occupancy vehicle travel during peak hours to other transportation modes, to off-peak periods, and/or to not traveling at all.
TEA-21	The Transportation Equity Act for the 21st Century; enacted June 9, 1998, as Public Law 105-178. TEA-21 authorizes the Federal surface transportation programs for highways, highway safety, and transit for the 6-year period 1998-2003. Superseded by SAFETEA-LU.
Telecommuting	Work arrangement in which employees enjoy flexibility in working locations and hours.
Teleworking	[see Telecommuting]
Texas Transportation Institute Urban Mobility Study	Study of national congestion performance measures, including travel time index comparisons, last published in 2007.
The Congestion Mitigation and Air Quality Improvement	The Congestion Mitigation and Air Quality Improvement (CMAQ) program is part of the federal highway program and provides a flexible funding source for state and local governments to fund transportation projects and programs that helps meet the requirements of the Clean Air Act (CAA).
TIP	Transportation Improvement Program; Program of transportation projects drawn from or consistent with the transportation plan and developed pursuant to Title 23, USC (United States Code) and the Federal Transit Act. This document is prepared by metropolitan planning organizations listing projects to be funded with FHWA/FTA funds for the next one- to three-year period.
TMC	Traffic Management Center
TMMP	Texas Metropolitan Mobility Plan
TPA	Transportation Partnership Account

TERM	DEFINTION
TRAC	Washington State Transportation Center; cooperative transportation research agency. Its members, the Washington State University (WSU), the University of Washington (UW), and the Washington State Department of Transportation (WSDOT), support TRAC to coordinate both state and commercial transportation research efforts and to develop research opportunities nationally and locally.
Transportation Planning	Process mandated by federal legislation for DOTs and MPOs which provides an opportunity to consider the effects of transportation enhancements as well as an opportunity for goal-setting.
Transportation programming	Process by which prioritized transportation projects are matched with funds for construction.
Travel survey	Survey of individual travel behavior. Most surveys collect information about individuals (e.g. demographics, their households (size, structure, relationships), their vehicles (age, make, model), and diaries of their journeys on a given day (their start and end locations, start and end times, modes of travel, accompaniment and purpose of travel).
Travel Time Index	Ratio of travel time during congested periods to travel time during free flow.
Trip Chaining	A single trip which combines several stops such as multiple errands.
TTI	Texas Transportation Institute
USDOT	United States Department of Transportation
Value Pricing	[see Congestion Pricing]
Variable Tolls on Entire Roadways	Tolls that vary based on congestion levels in order to provide users a predicable travel speed. These tolls are charged on roads and bridges as well as existing toll-free facilities during rush hour
VMS	Variable Message Signs
VMT	Vehicle Miles Traveled
VPLPH	Vehicles per lane per hour
WAFC	Washington Association of Fire Chiefs
WSDOT	Washington State Department of Transportation
WSP	Washington State Patrol
WSTC	Washington State Transportation Commission
WTP	Washington Transportation Plan

A-2 - Puget Sound Freeway Network — Traffic Congestion Data Analysis

Puget Sound Freeway Network - Traffic Congestion Data Analysis

OVERVIEW

To quantitatively describe congestion on Puget Sound Region's freeway network, traffic data was obtained from the Washington State Transportation Center's TRAC web site. Data is available from 415 vehicle detector stations (VDS) covering most of the I-5, I-405, I-90, SR-520, and SR-167 freeways in the Seattle metropolitan area. We also obtained more detailed data sets for these same sensors from WSDOT.

The data used for this analysis was:

- Average Volume — average number of vehicles (vehicles per lane per hour - vplph).
- Average Speed — average rate of travel, i.e., distance traveled over time (miles per hour - mph).
- Lane occupancy — percentage of time that a lane is occupied by vehicles.

To analyze the data and provide a visual representation of it, a geographic information system database tool (Manifold GIS) was employed. Figure 1 is a representative display and shows VDS icons in their approximate locations. The inner icons are the mainline travel lanes and the outer smaller icons are the HOV lanes.

Color coding is dependant on the display but in general:

- Dark Green and Light Green - improving or good
- Red, Orange, Yellow - degrees of worsening or bad
- Black - missing data

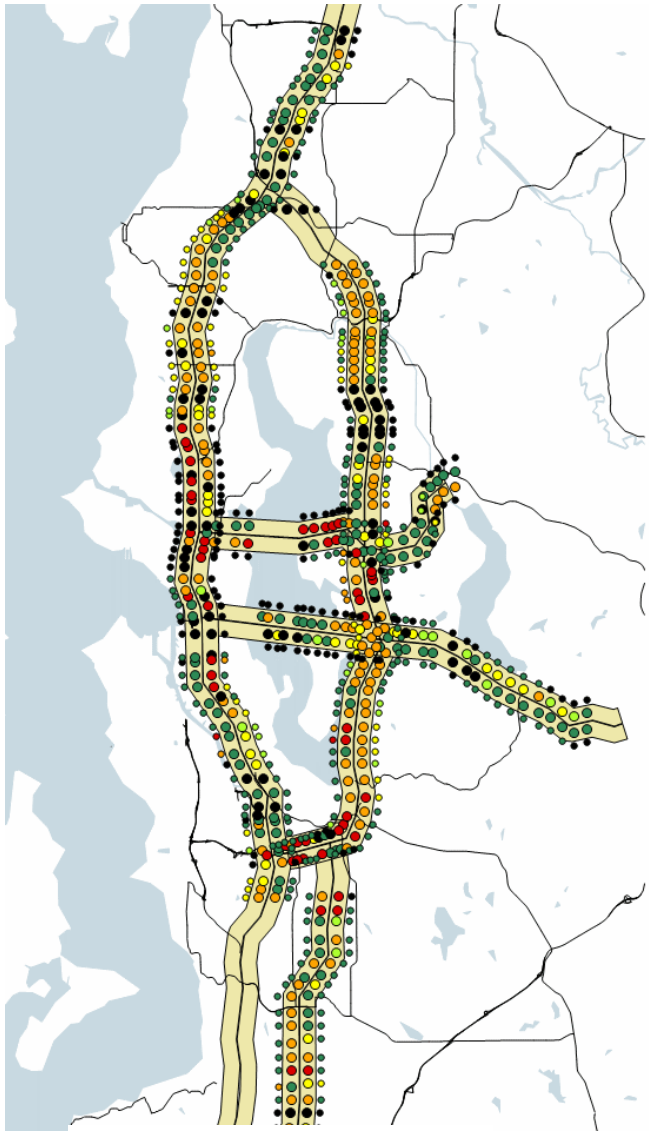


Figure 1 - GIS Map

DATA AVAILIBILITY

Data availability is a primary prerequisite to any analysis and it was found that quality was excellent for the sample years.

Figure 2 shows the VDSs and their associated availability for 2006 from 6:00 a.m. to 7:00 p.m. and is representative of all years. The coloring used is:

- Green VDS - > 90% available
- Red VDS - < 90% available
- Black - No data available

The team used data records from a particular VDS only when 90% or more of the records was available.

The TRAC website also provides average values for five-minute periods for all weekdays between 2001 and 2006. Even this reduced data set provides over 10 million records. These data records were recorded at the 415 VDSs covering most of the I-5, I-405, I-90, SR-520, and SR-167 freeways in the Seattle Metropolitan Area. Data records are not available for southwest branch of I-5, the major alternate routes (SR-99 and SR-520), and the major arterials where VDSs have not yet been installed.

For more specific analyses, the team also analyzed the raw VDS data sets provided by WSDOT.

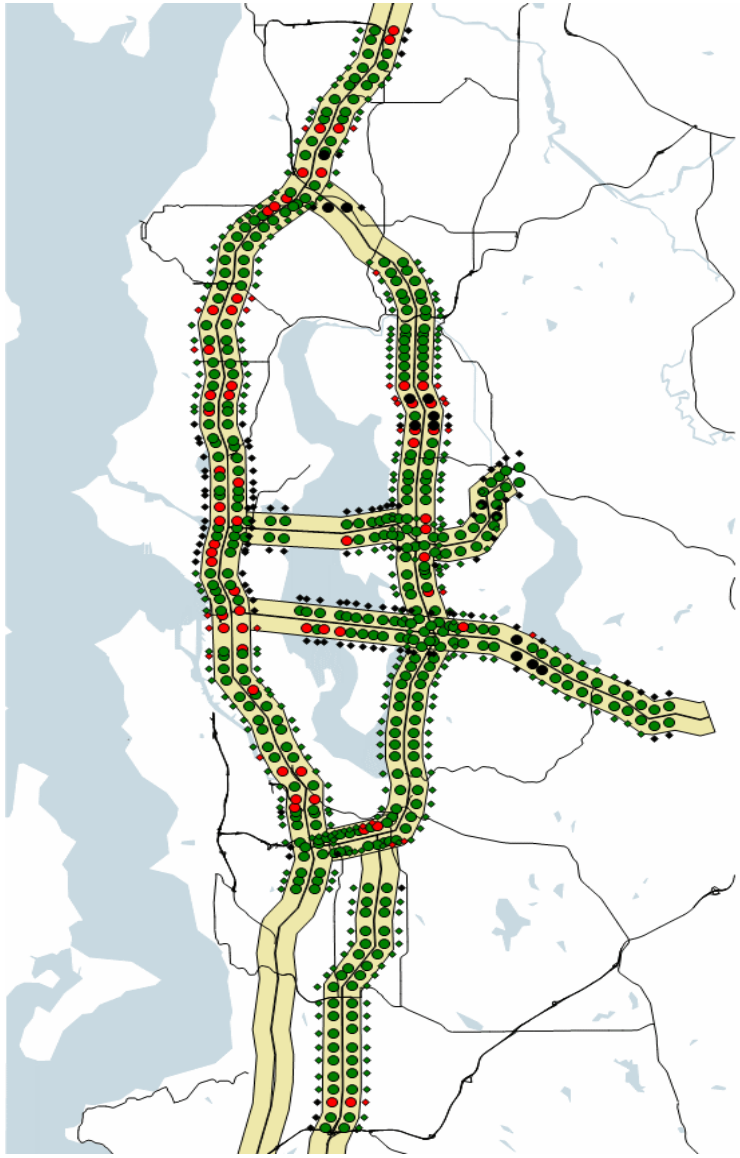


Figure 2 - VDSs

COMPUTED DATA

To analyze the vast amount of data, the Audit Team computed the following indices:

Speed Index (SI) - the percentage of time that average speed was below a chosen threshold value. Figure 3a shows the SI data for 2006 between 6:00 a.m. and 7:00 p.m. for average speeds below 45 mph. The color coding is shown in the legend. For example, a dark red VDS represents an average speed below 45 mph over 40% of the time on weekdays.

Congestion Index (CI) - represents the percentage of time when lane occupancy is above a chosen value. TRAC sets such threshold at 19%. This is a measure of the compactness of the traffic and also reflects congestion. Figure 3b shows the CI Index data for 2006 between 6:00 a.m. and 7:00 p.m. for congestion above 30 (i.e., 30% of the samples were above 19% occupancy). The color coding is shown in the legend. For example, a dark red VDS means the congestion was above 30 more than 40% of the time on weekdays.

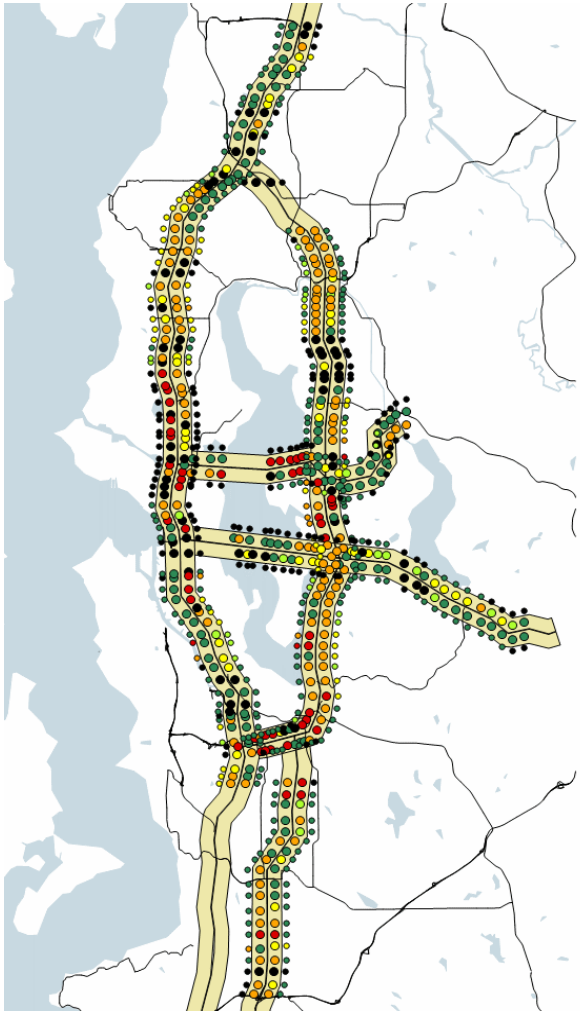


Figure 3a – Speed Index

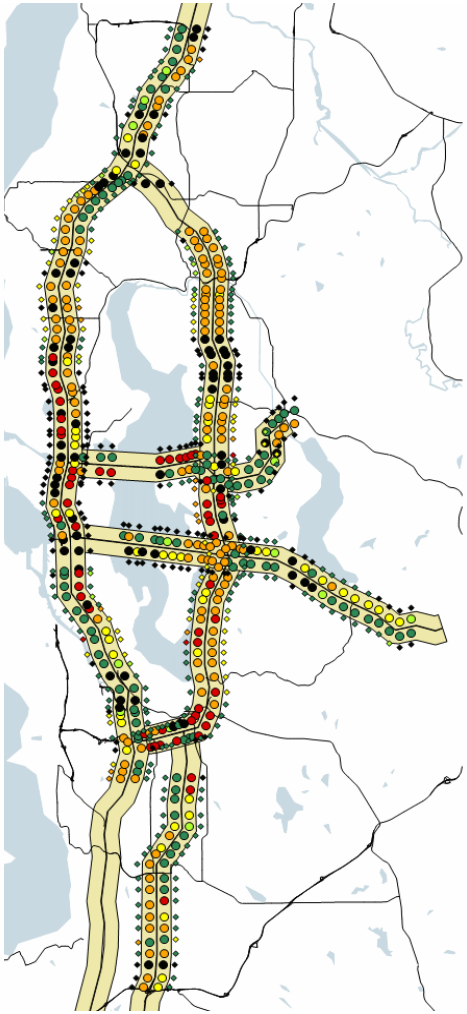


Figure 3b – Congestion Index

The analysis focused on the following:

- An overview of network-wide conditions in 2006 for the AM and PM peak periods, the 16-hour period from 5:00 a.m. to 9:00 p.m., and for the entire day (24 hours).
- A comparative assessment of change in congestion over 3- and 5-year periods (since 2003 and 2001 respectively).
- A more detailed review to summarize congestion levels along select sections of I-5, I-405, I-90, and SR-520
- A comparison of throughput performance of HOV and GP lanes.

Puget Sound Freeway Network - Traffic Congestion Data Analysis

OVERVIEW OF 2006 TRAFFIC CONDITIONS

Traffic conditions in the Puget Sound Region have deteriorated between 2001 and 2006 and the rate of deterioration is increasing. The level of congestion is higher and the length of time that the network is congested is greater.

The team analyzed 2006 average traffic condition data for the following periods of the day: 1) 24 hours; 2) 5:00 a.m. to 9:00 p.m.; 3) morning peak period (6:00 a.m. to 9:00 a.m.); and 4) afternoon peak period (4:00 p.m. to 7:00 p.m.). This analysis uses speed thresholds of 55 mph, 45 mph, and 25 mph.

A series of Speed Index displays in Figures 4a to 7c highlight the percent of time that speeds are below the 55 mph, 45 mph, and 25 mph thresholds in the respective periods. The results show that congestion percentages get higher over time and as one moves from a 24 hour average to the 16-hour period (5:00 a. m. and 9:00 p. m.), and then to the AM and PM peak periods.

Key observations here are:

- the PM Peak is a lot worse than the AM peak, with significant portions of the freeway network operating below the 45mph threshold for well over 40% of the peak period.
- consistent with the peak periods, the 16-hour period (5:00 a.m. to 9:00 p.m.) already shows the areas of the network that experience significant slowdowns throughout the day; areas of the network that stay below the 45mph threshold for close or over 40% of the time (orange and red sections in Fig. 4b) include the approaches of I-5 to downtown Seattle and its interchanges with SR-520, I-90 and I-405, large stretches of I-405 from its southerly interchange with I-5 to north of SR-520, as well as sections of SR-167 and SR-520.

The above observations are further highlighted in a series of Congestion Index displays (Figures 8a - 8d) which show how persistently “compact” is the traffic during the four periods of analysis (24 hours, 16 hours and peak periods).

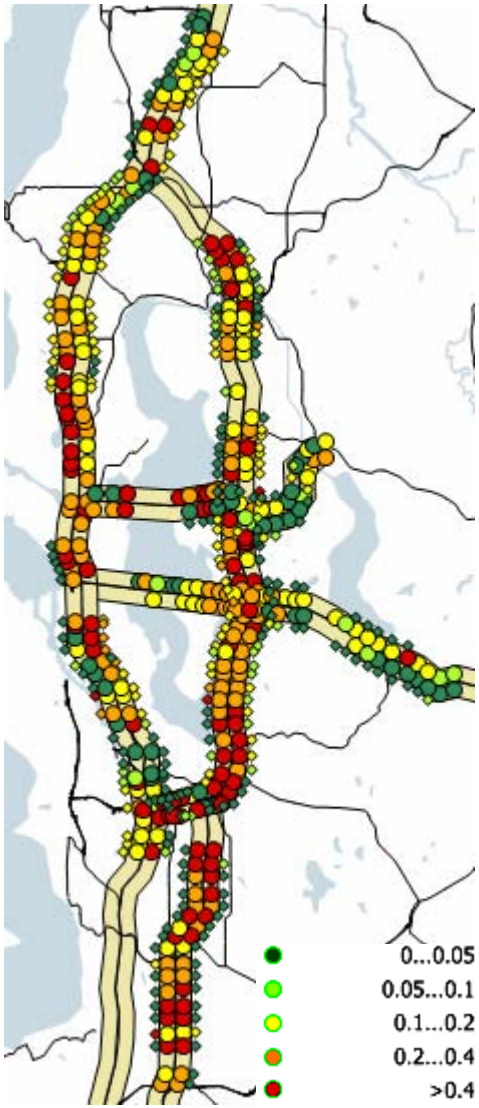


Figure 4a - percent of 24-hour period with average speed below 55mph

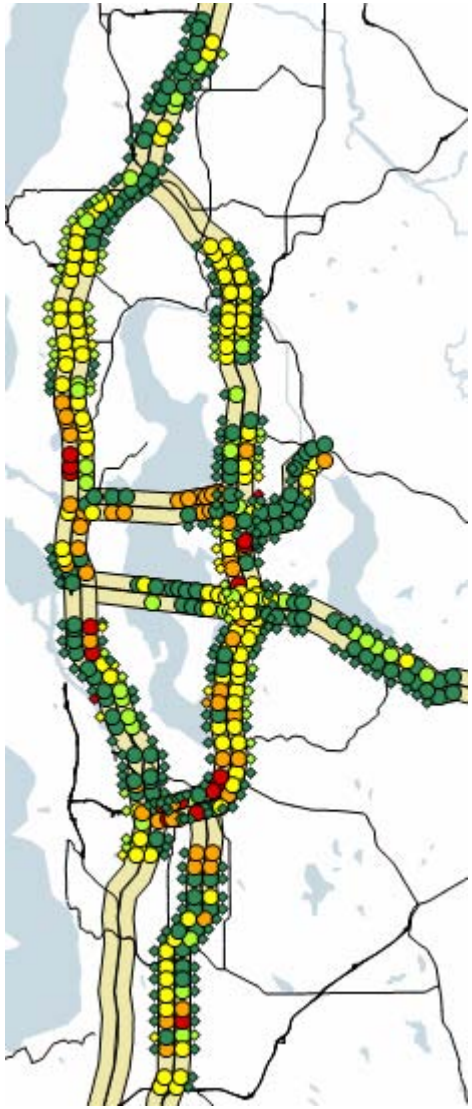


Figure 4b - percent of 24-hour period with average speed below 45mph

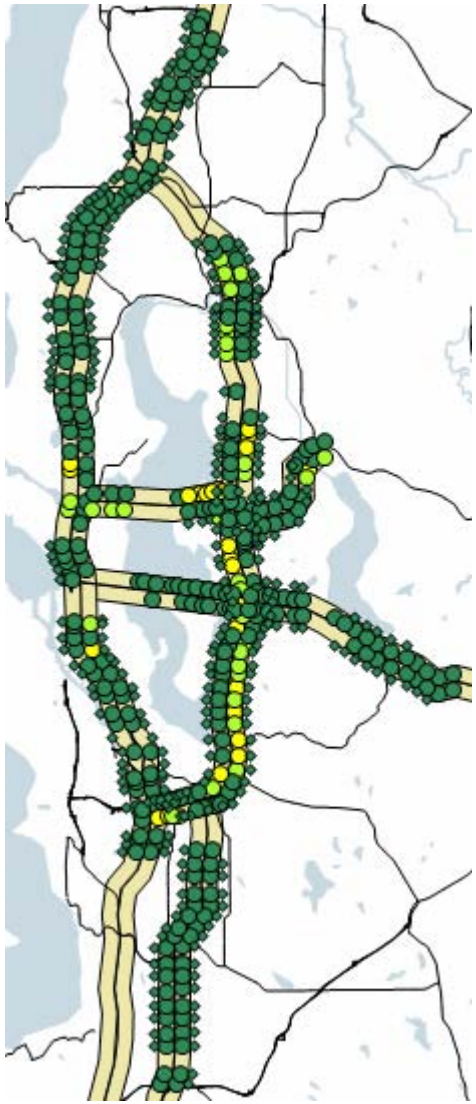


Figure 4c - percent of 24-hour period with average speed below 25mph

Puget Sound Freeway Network - Traffic Congestion Data Analysis

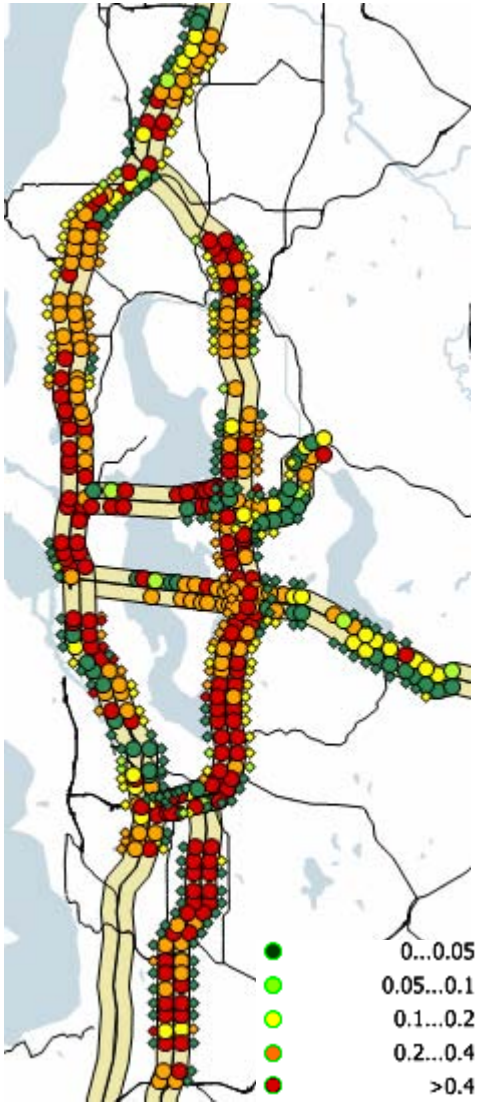


Figure 5a - percent of 5am-9pm period with average speed below 55mph

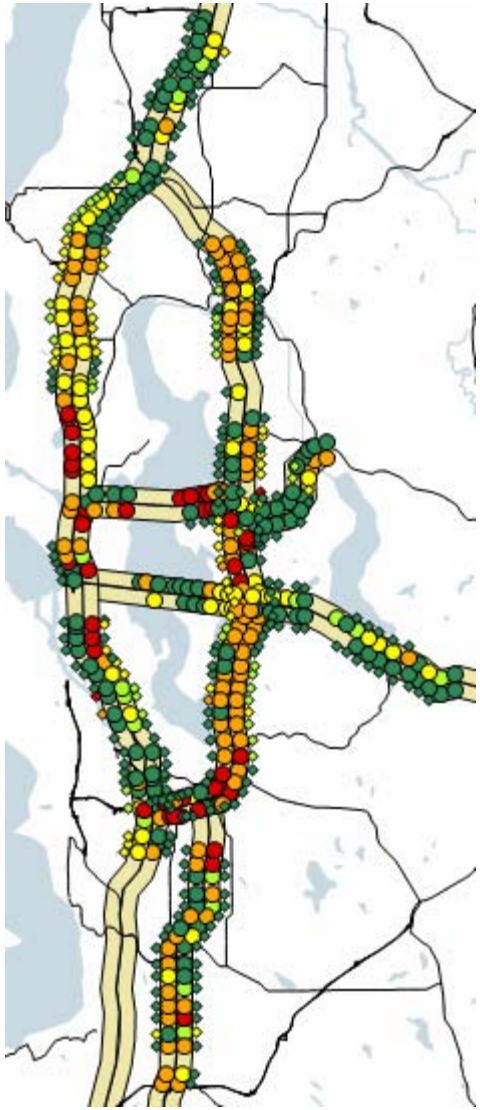


Figure 5b - percent of 5am-9pm period with average speed below 45mph

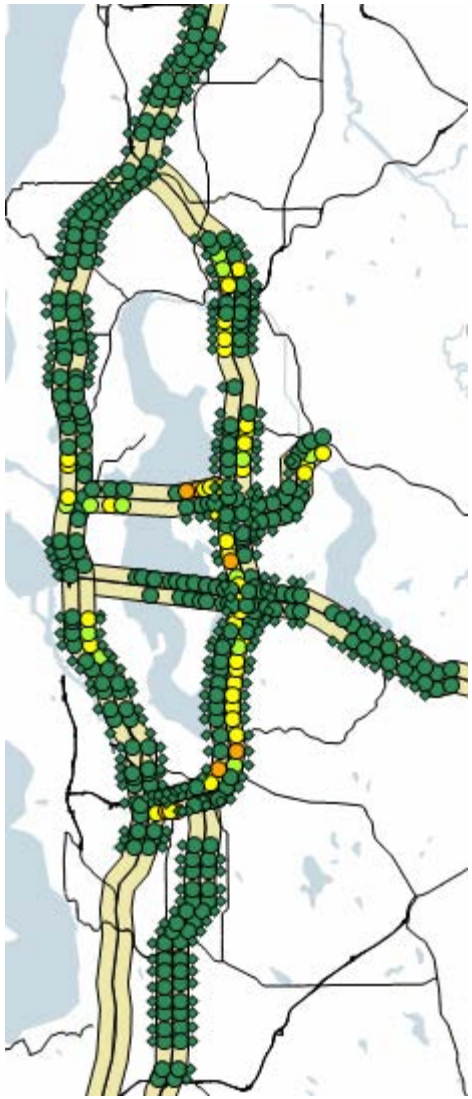


Figure 5c - percent of 5am-9pm period with average speed below 25mph

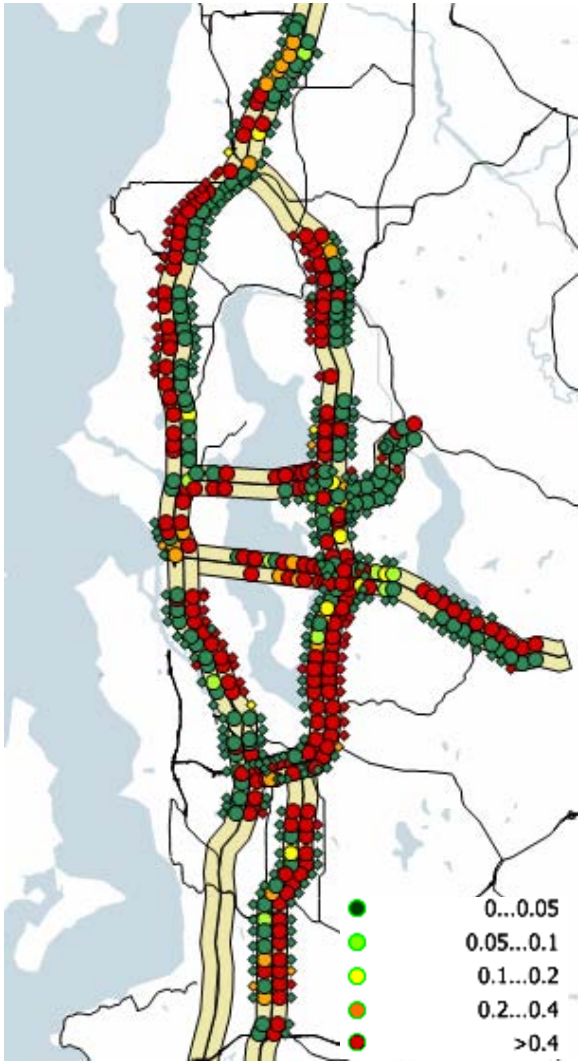


Figure 6a - percent of AM peak period with average speed below 55mph

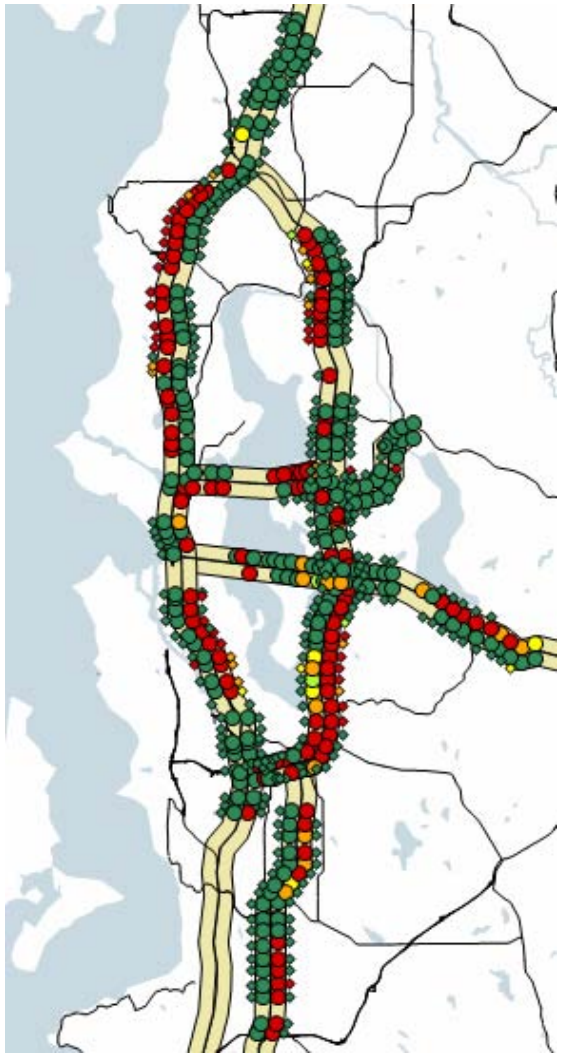


Figure 6b - percent of AM peak period with average speed below 45mph

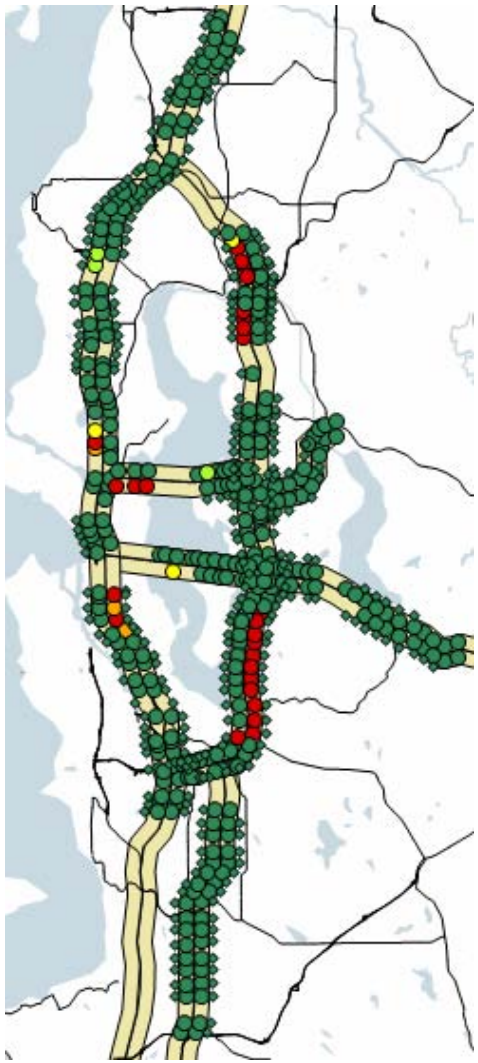


Figure 6c - percent of AM peak period with average speed below 25mph

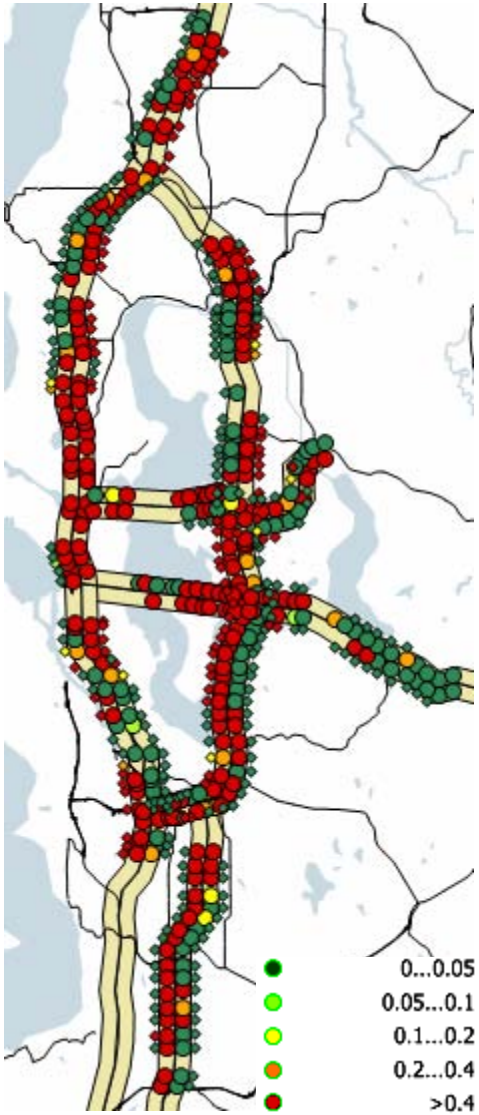


Figure 7a - percent of PM peak period with average speed below 55mph

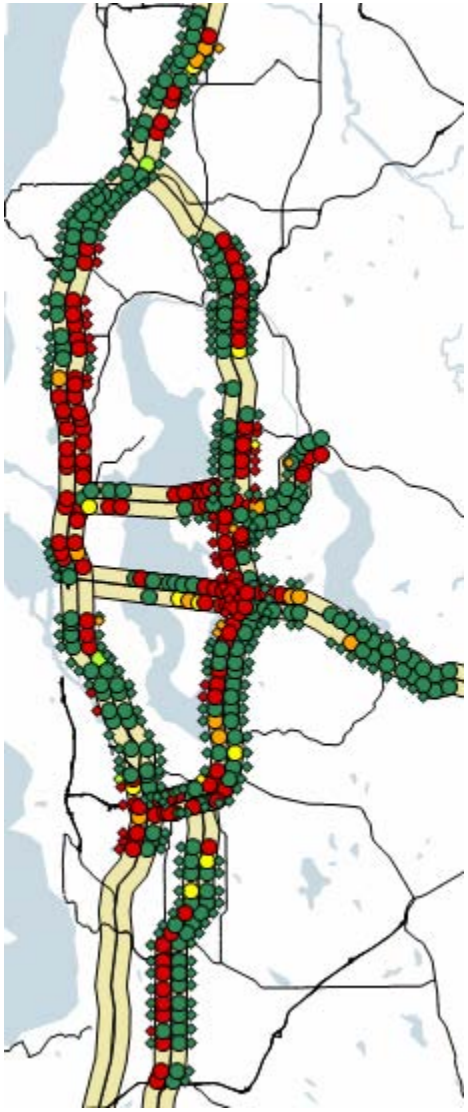


Figure 7b - percent of PM peak period with average speed below 45mph

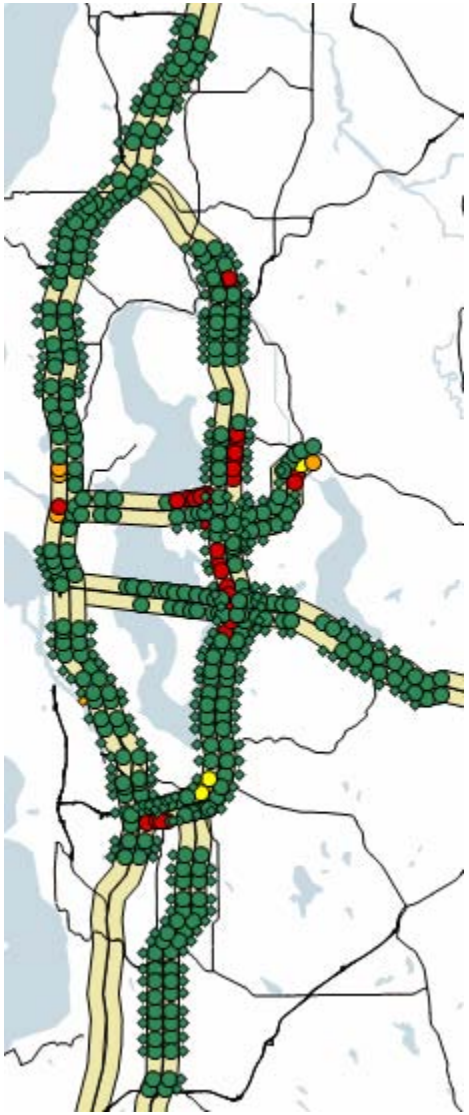


Figure 7c - percent of PM peak period with average speed below 25mph

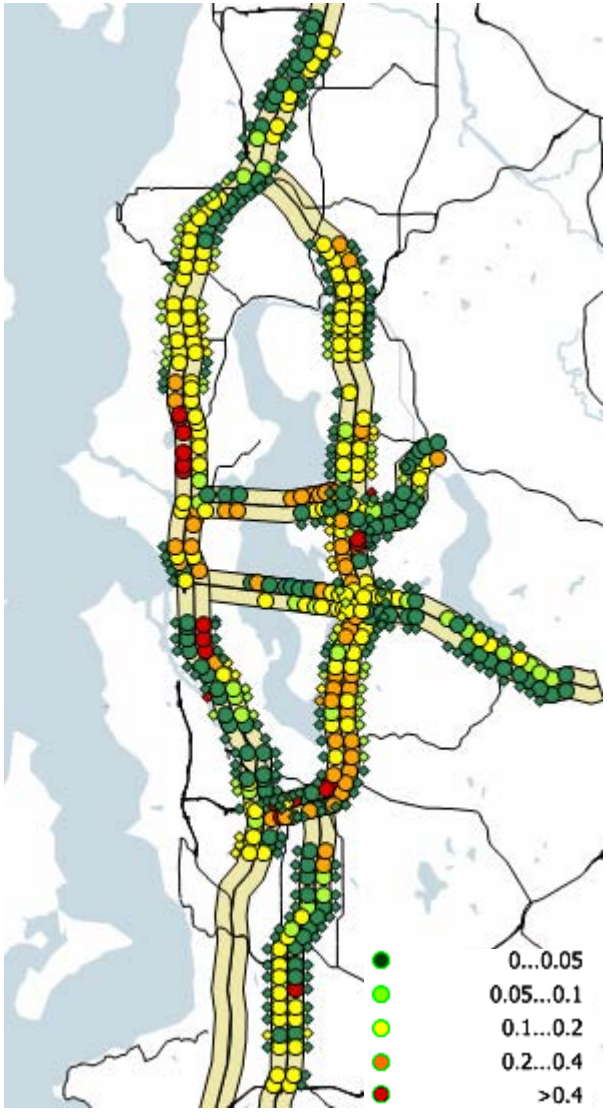


Figure 8a - percent of 24-hour period with dense traffic conditions or worse

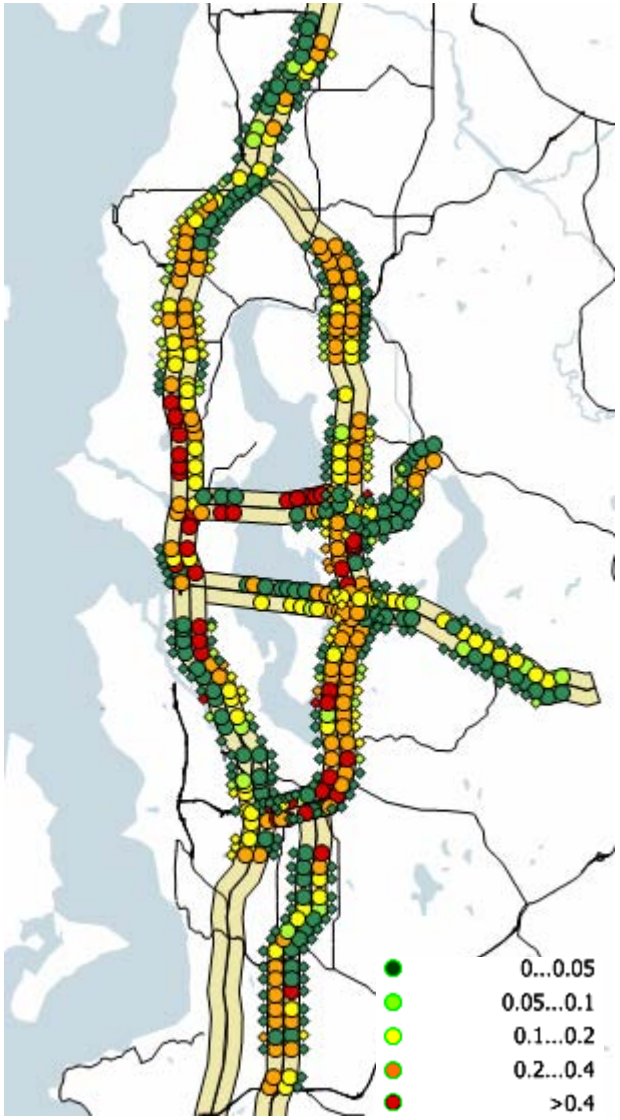


Figure 8b - percent of 5am-9pm period with dense traffic conditions or worse

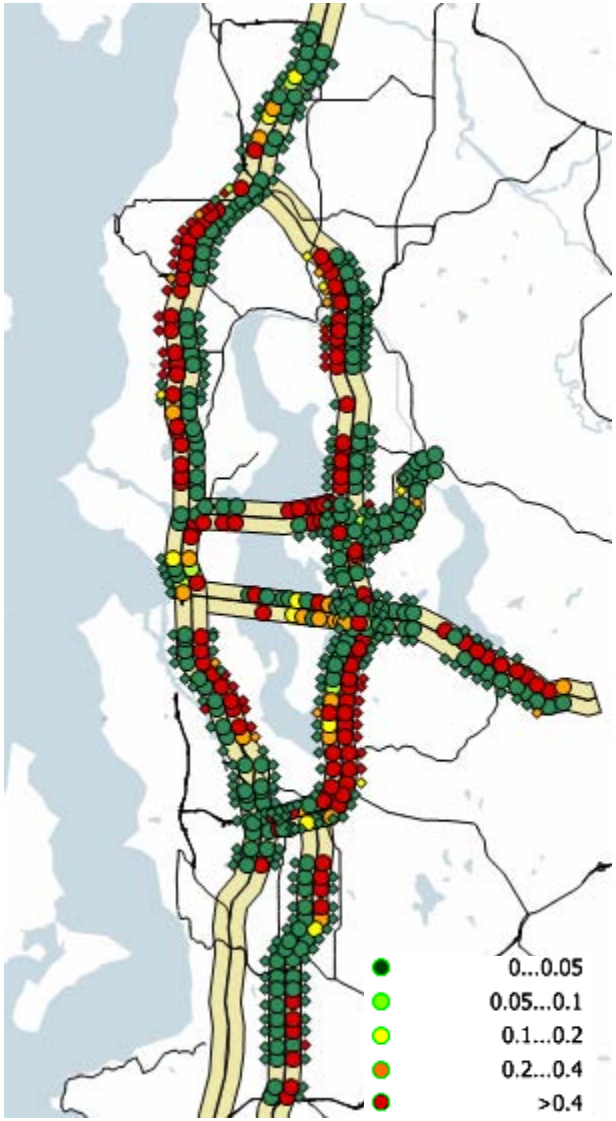


Figure 8c - percent of AM peak period with dense traffic conditions or worse

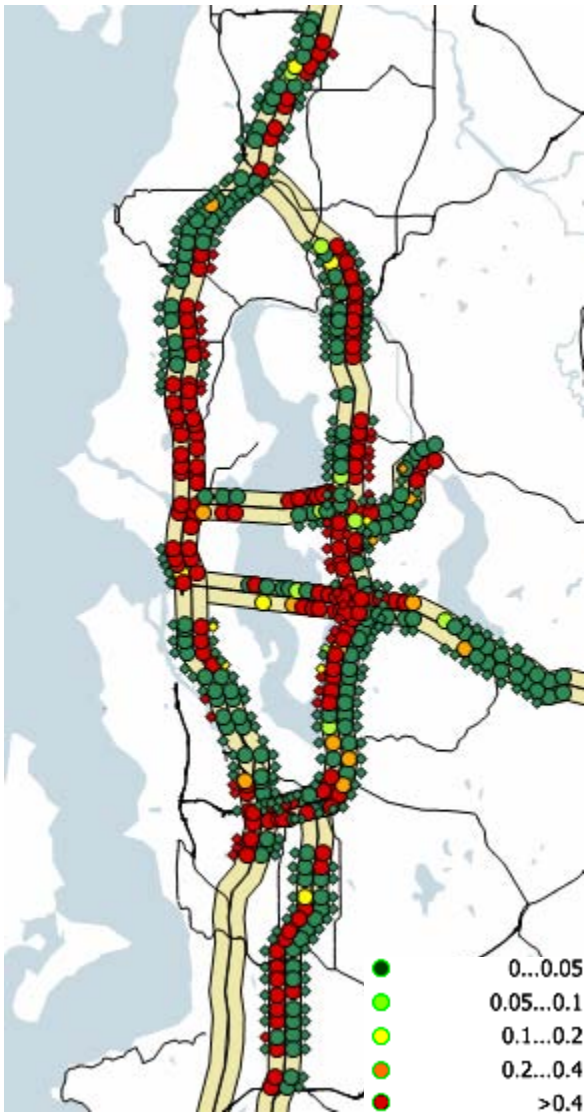


Figure 8d - percent of PM peak period with dense traffic conditions or worse

Summary of Freeway Network Performance

The Speed and Congestion Index analysis (network-wide averages in 2006) provide some insight at to how the relationship between effective capacity and demand for travel affect the performance of the freeway system. These show that significant portions of the network are "fragile," meaning that relatively small changes in demand or capacity can have a significant negative impact on congestion.

Figure 9 shows the percent of time that the freeway network operated below the 25mph and 45mph thresholds during the peak periods, the 5:00 a.m. - 9:00 p.m. period and on the full 24-hour day (average conditions in 2006).

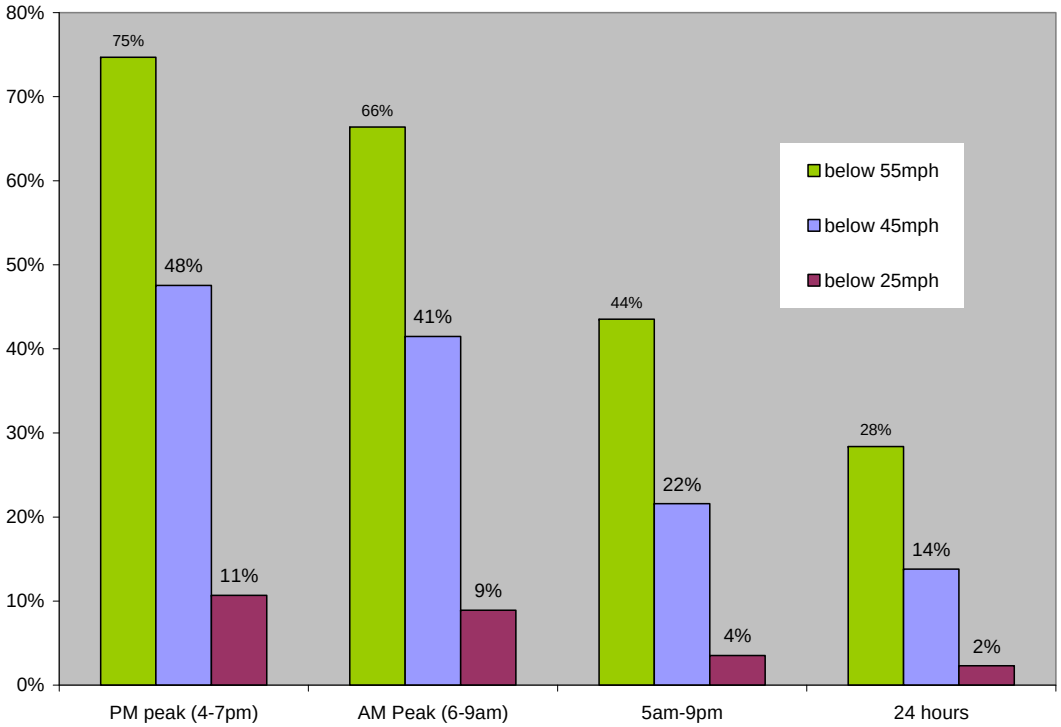


Figure 9 - Percent of Time that the Freeway Network was Below Speed Thresholds in 2006

Figure 10 shows the percent of time that the freeway network operates over congestion thresholds that could be described as "dense traffic", "very dense traffic" and "extremely dense traffic" during the same periods. For purposes of this chart, we defined

- "Dense traffic" as the condition when at least 20% of a detector's output shows an occupancy value of over 19%;
- "Very dense traffic" when at least 40% of a detector's output shows an occupancy value of over 19%;
- "Extremely dense traffic" when at least 80% of a detector's output shows an occupancy value of over 19%.

Some quick observations:

- Figures 9 and 10 show that afternoon peak is significantly worse than morning peak;
- Almost half of the time during the 3-hour afternoon peak, traffic is moving at below the 45 mph speed threshold for maximum throughput, using the threshold generally referenced by WSDOT in its performance reporting;
- Over 50% of the time during the 3-hour afternoon peak period and over 40% in the morning peak period, traffic is in dense, very dense or extremely dense conditions (Fig. 10);
- For almost a quarter (23%) of the day and evening hours (5:00 a. m. - 9:00 p.m.), traffic is in dense or very dense or extremely dense conditions.

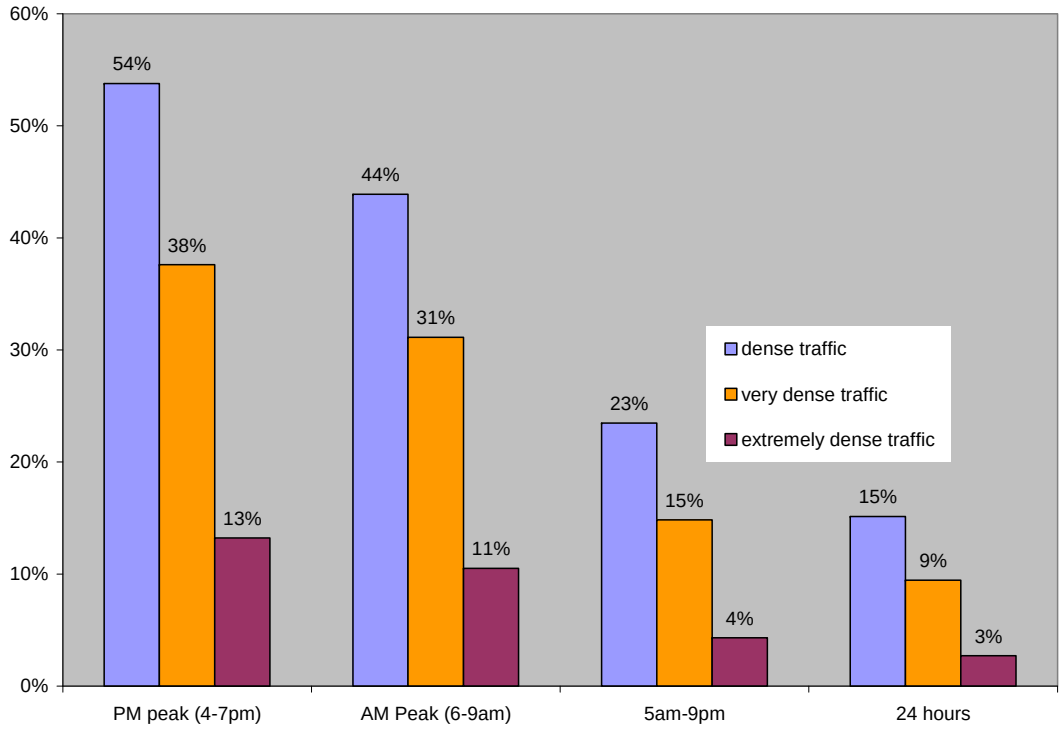


Figure 10 - Percent of Time that the Freeway Network was in Congested Conditions in 2006

Average and Maximum Flow Comparisons for Morning & Afternoon Peak Periods in 2006

Figures 11a-c and 12a-c show the average flow (left), maximum flow (middle) and the difference between maximum and average flows (right) during the average 2006 morning (6:00 a.m. - 9:00 a.m.) and afternoon (4:00 p.m. - 7:00 p. m.) peak periods expressed in vehicles per lane per hour (vplph) and color-coded as shown in the legend.

Figures 11a and 12a show that throughput on the majority of freeway sections is below 1,800 vplph (yellow) and likely closer to 1,500 vplph (green). These results are generally consistent with reports from TRAC for 2005 that show an average morning peak throughput of 1,567 vehicles per lane per hour and 1,507 for the afternoon peak.

Figures 11b and 12b show the maximum throughput recorded at each location during the same period, probably just before "breakdown" conditions. It should be noted that the capacity of a lane is not fixed; instead, capacity varies with change in road conditions (e.g. substrate, weather), etc. The team used maximum peak throughput as a measure of potential capacity and average peak throughput as effective capacity.

[Note: if we were to consider the same screen of maximum flow for the 16- or 24-hour period, we would probably get a value closer to the actual maximum capacity for the respective locations.]

Figures 11c and 12c show the difference between average and maximum throughput which can be regarded as the potential capacity increase at each location under prevailing conditions i.e., without considering physical improvements. I.e., if every possible breakdown trigger were removed (e.g. weaving), throughput would increase to levels closer to the potential capacity at the respective location, (as shown in the middle figures), traffic would gain some speed (as the local speed-flow curve may suggest), and this would also improve reliability (if traffic were able to stay at the upper part of the curve).

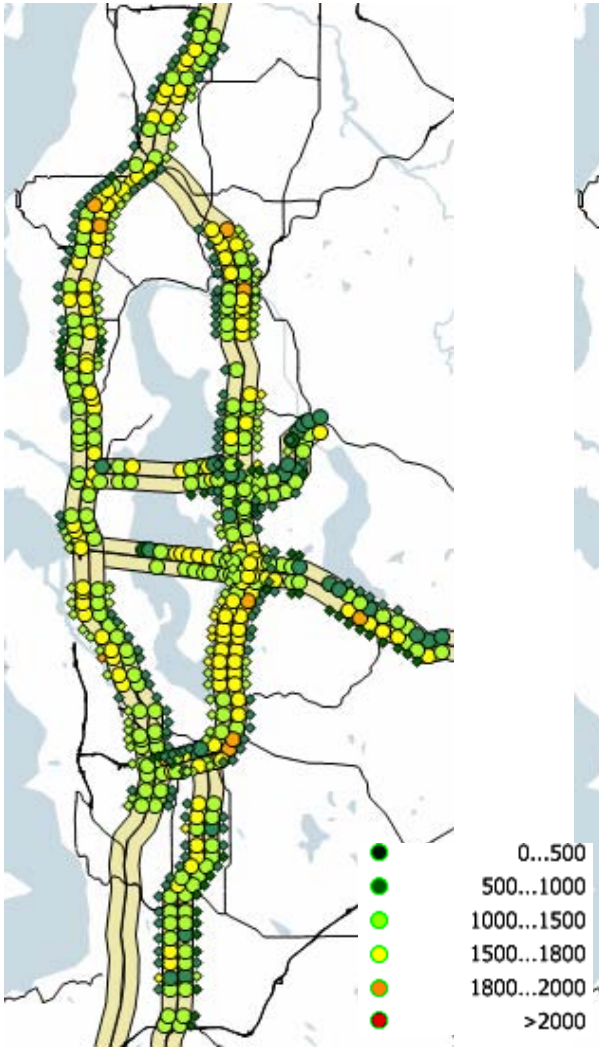


Figure 11a – Average flows recorded in the PM peak period (2006 average)

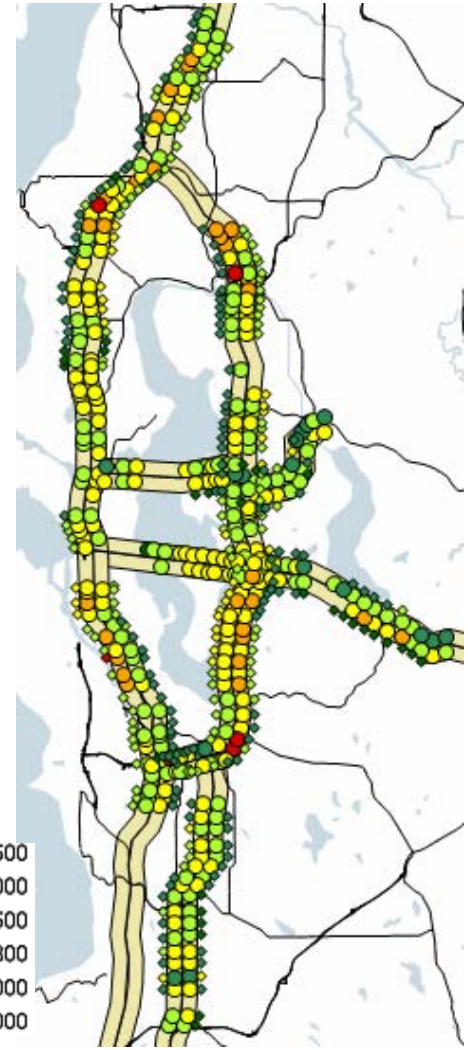


Figure 11b – Maximum flows recorded in the PM peak period (2006 average)

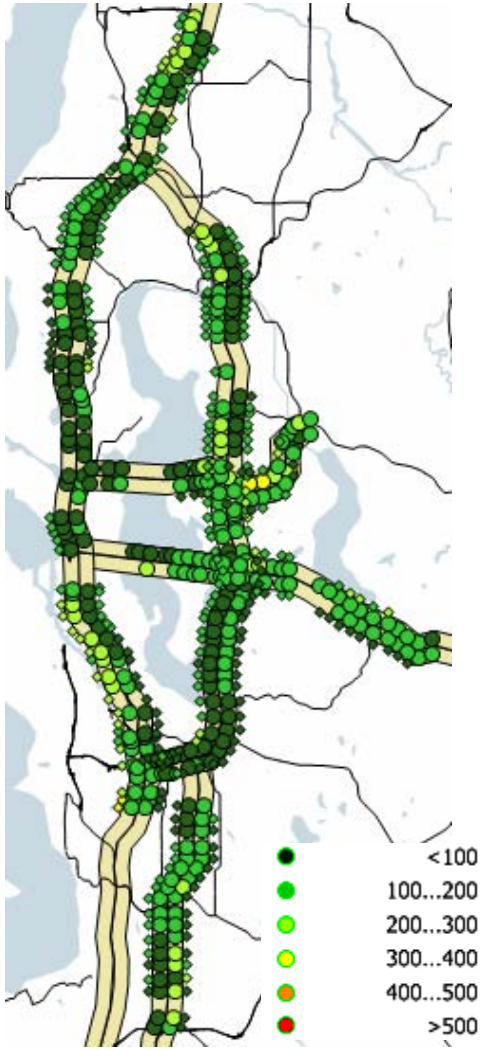


Figure 11c – Difference between Average and Maximum flows in the PM peak period

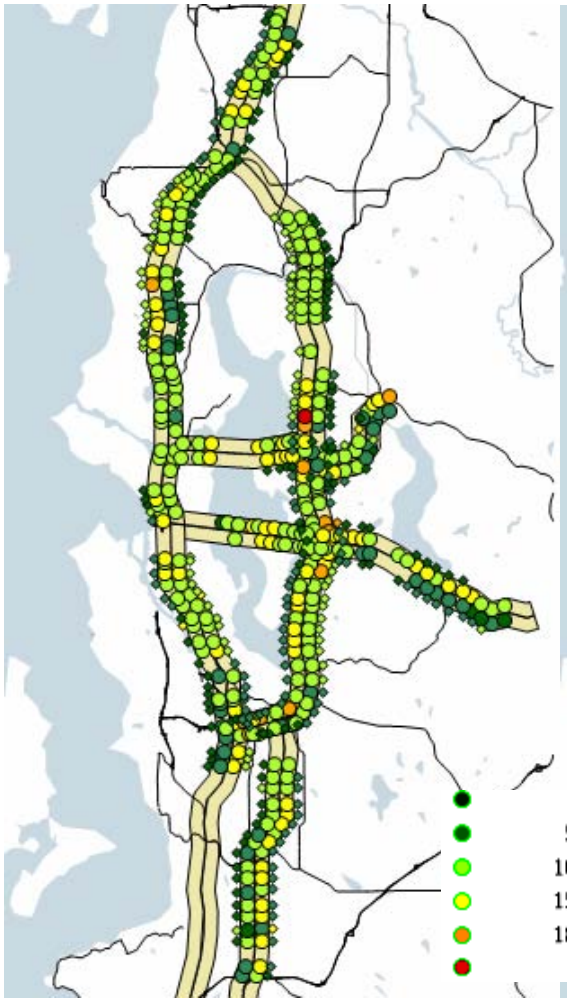


Figure 12a – Average flows recorded in the A peak period (2006 average)

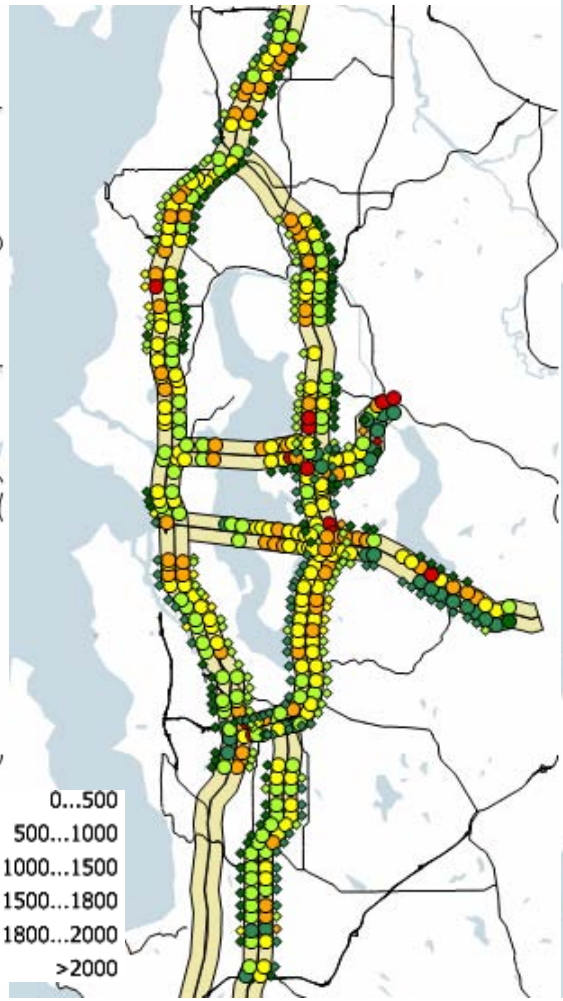


Figure 12b – Maximum flows recorded in the AM peak period (2006 average)

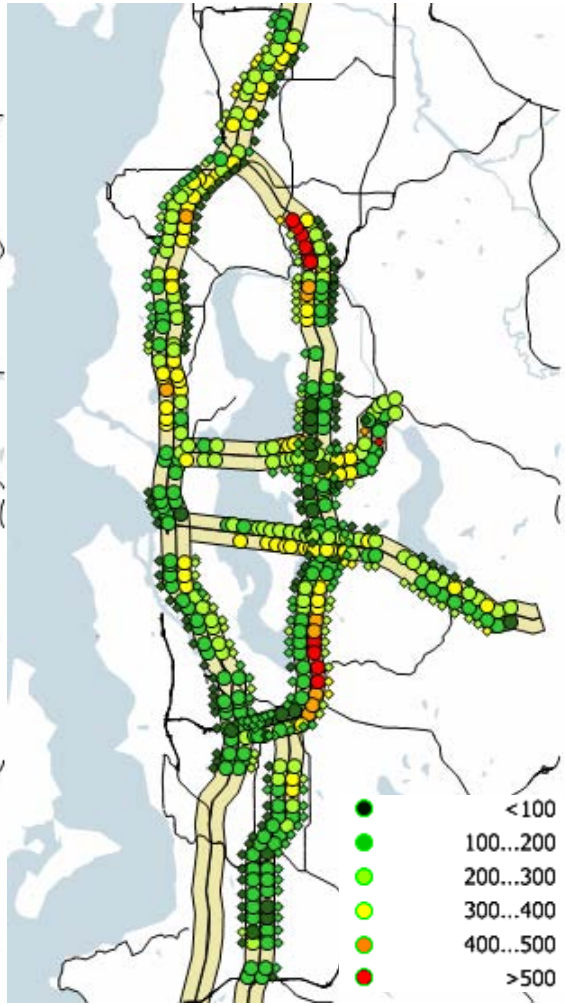


Figure 12c – Difference between Average and Maximum flows in the AM peak period

COMPARATIVE REVIEW

To illustrate congestion growth, the Audit Team compared 2001 data to 2006 data.

Figure 13 shows the Speed Index data for 2001 and 2006 between 6:00 a.m. and 7:00 p.m., as well as the percentage change between the years. Note that on the percent change graphic that the red VDS represent a 99% or greater increase in congestion.

Observations: Significant increases in congestion throughout the region are apparent with many areas showing more than a 99% increase in the number of time periods where speed drops below 45 mph.

To further investigate the percent change, the Audit Team divided data into three periods;

- Morning peak (6:00 a.m. to 9:00 a.m.)
- Afternoon peak (3:00 p.m. to 7:00 p.m.)
- Off peak (9:00 a.m. to 3:00 p.m.).

This data is shown in the next three sections.

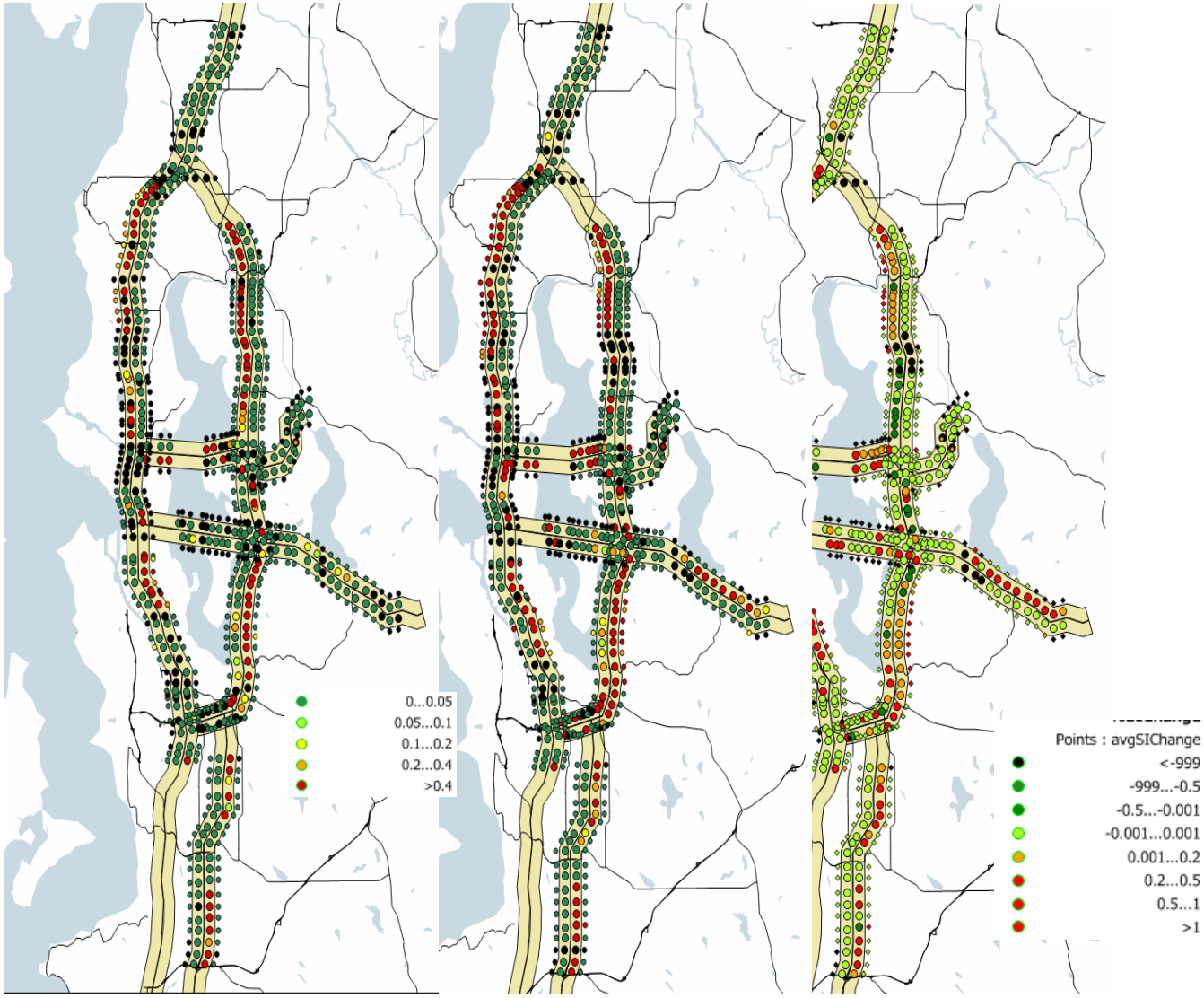


Figure 13 **2001** **2006** **Change**

MORNING PEAK DATA
2001 - 2006

Figure 14 represents the Speed Index data for years 2001 and 2006 as well as the relative change. Data are for average weekdays from 6:00 a.m. to 9:00 a.m. and represent the percentage of time the speed was below 45 mph per the legend. The third graphic represents an overview as a net change. Note the red VDSs indicate that congestion values have more than doubled in the number of periods less than 45 MPH.

Observations: Significant increases in congestion throughout the region are apparent with many areas showing over a 50% increase in the number of time periods where speed drops below 45 mph.

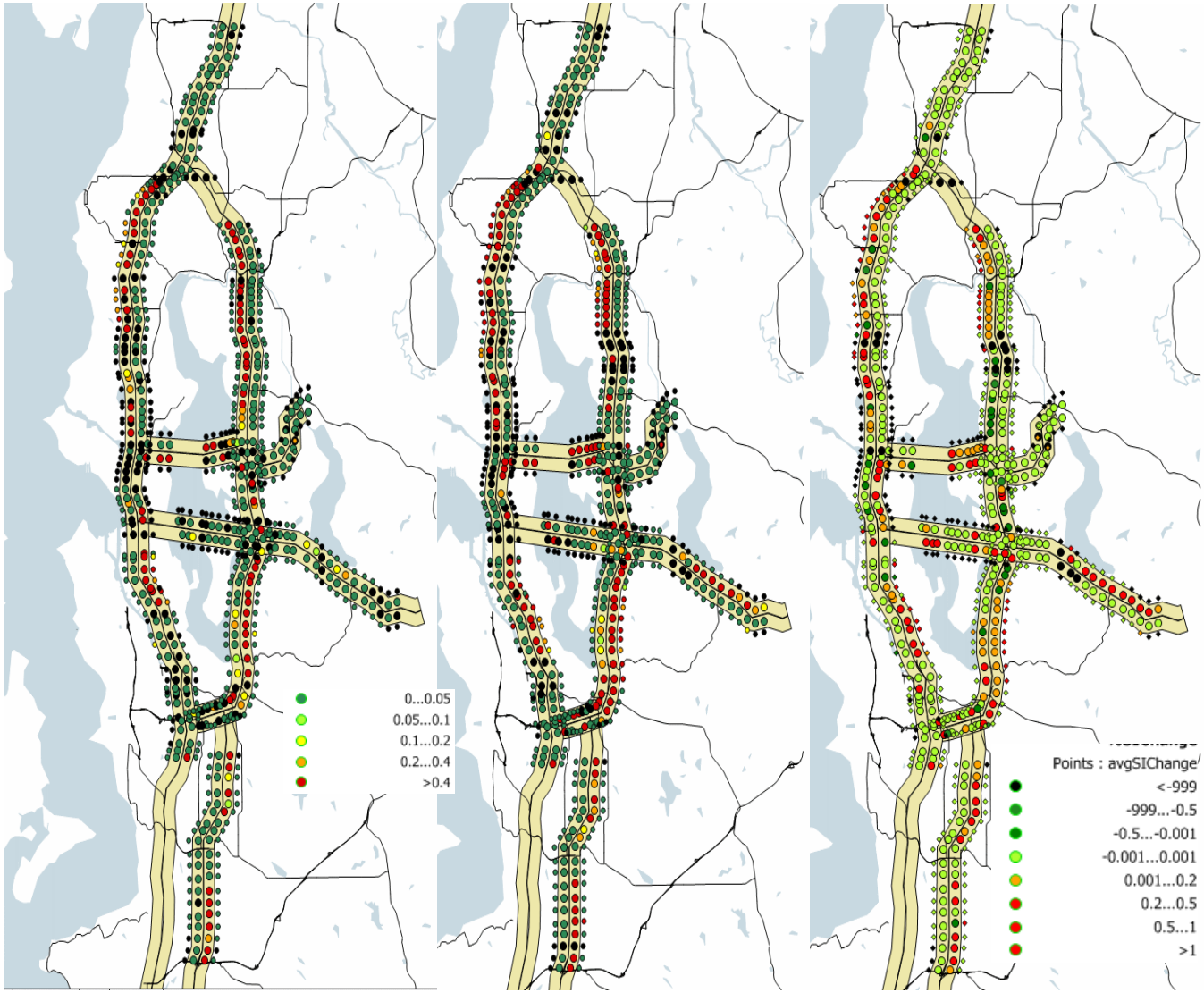


Figure 14 **2001** **2006** **Change**

AFTERNOON PEAK DATA
2001 – 2006

Figure 15 represents the Speed Index data for 2001 and 2006 as well as the percentage change. Data are for average weekdays from 4:00 p.m. to 7:00 p.m. and represent the percentage of time the speed was below 45 mph per the legend. The third graphic represents an overview as a net change. Note the red VDSs indicate that congestion values have increased over 99%.

Observations: Significant increases in congestion throughout the region are apparent with many areas showing over 50% increases in the number of time period where speed drops below 45 mph.

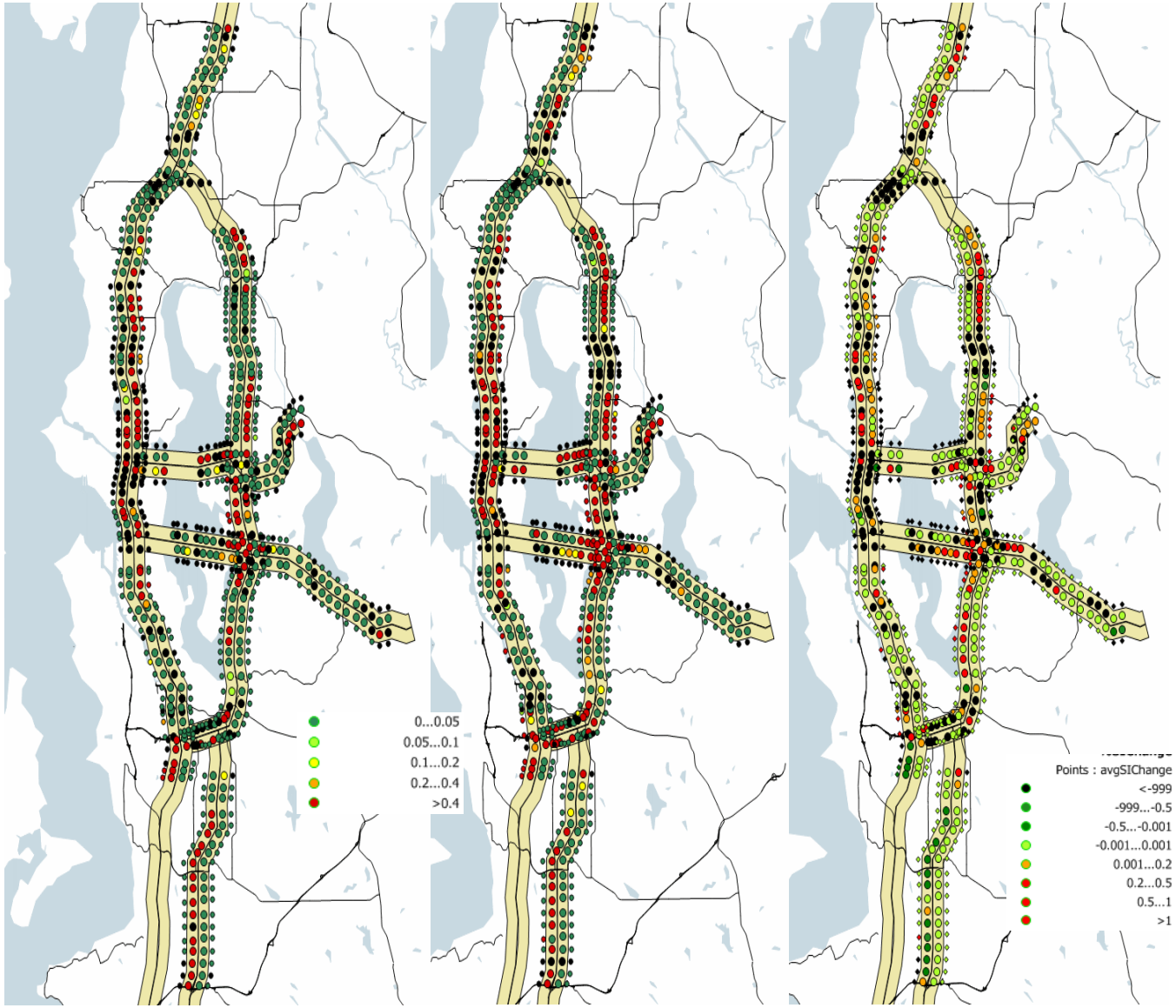


Figure 15 **2001** **2006** **Change**

OFF PEAK DATA
2001-2006

Figure 16 represents the Speed Index data for 2001 and 2006 as well as the percentage change. Data are for average weekdays from 9:00 a.m. to 4:00 p.m. and represent the percentage of time the speed was below 45 mph per the legend. The third graphic represents an overview as a net change. Note the red VDSs indicate that congestion values have increased over 99%.

Observations: Significant increases in congestion throughout the region are apparent with many areas showing over 50% increases in the number of time periods where speed drops below 45 mph. This is indicative of the growth of congestion beyond the traditional 6:00 - 9:00 a.m. and 4:00 - 7:00 p.m. peak periods.

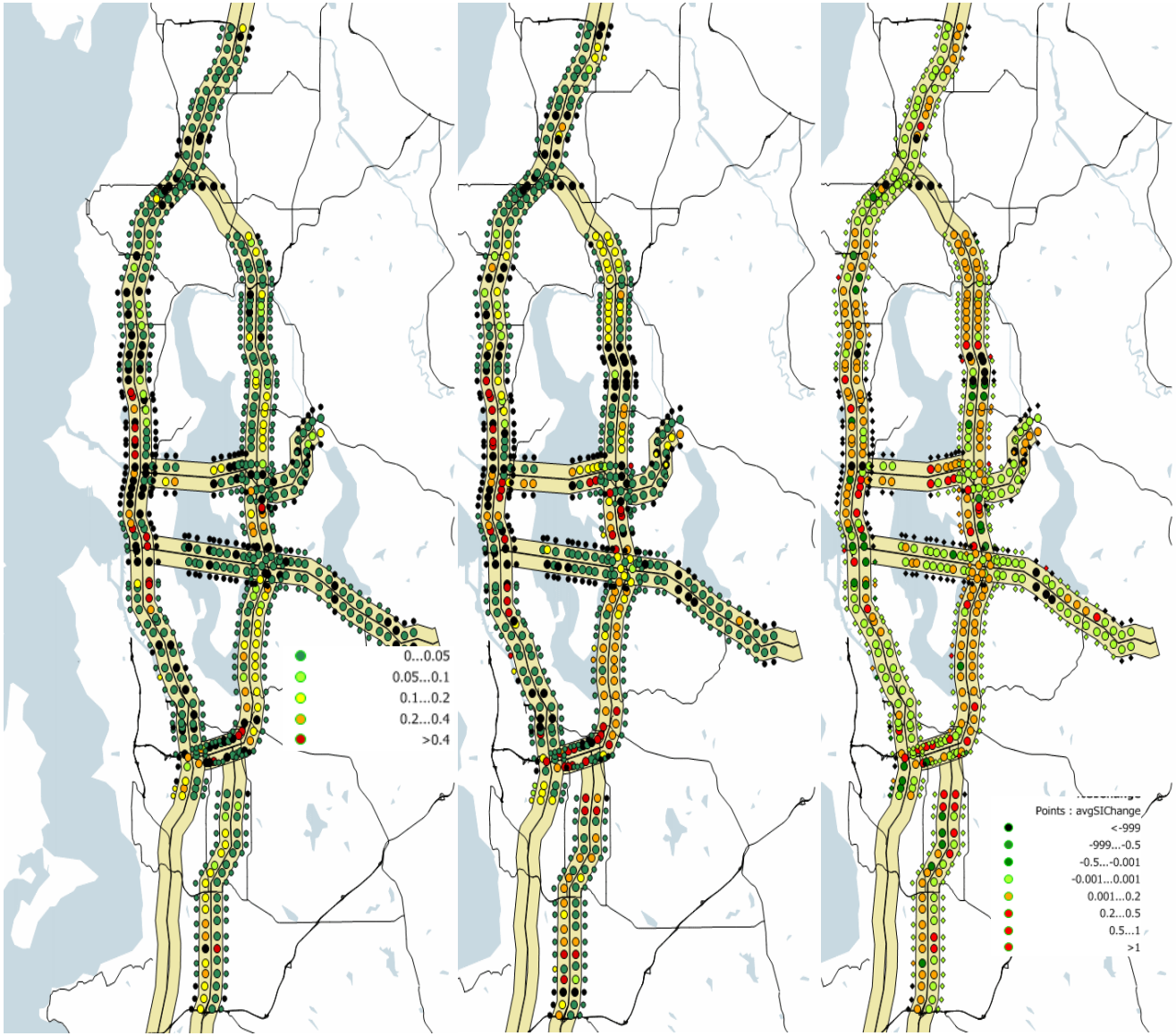


Figure 16 **2001** **2006** **Change**

Puget Sound Freeway Network - Traffic Congestion Data Analysis

Peak Hour Characteristics:

An analysis of raw data from WSDOT's vehicle detector system for the subject freeway network allowed us to identify the average start of the peak one hour in the morning and evening peak periods based on network-wide averages of the maximum volume or minimum speed that was recorded at each detector station. The following table summarizes some of the findings regarding the start of the peak hour in morning and afternoon based on volume peak and speed 'trough' in 2003 and 2006.

	Morning Peak (one) Hour				Afternoon Peak (one) Hour			
	Volume-based		Speed-based		Volume-based		Speed-based	
	start	avg vol vplph	start	avg spd mph	start	avg vol vplph	start	avg spd mph
2003	7:00	1459	7:45	51	15:51	1514	15:55	52
2006	6:53	1424	7:45	51	15.49	1428	16:00	50

As expected, the speed-trough happens after the volume peak. However, the lag is significantly shorter in the afternoon than in the morning (and consistent for both years), which indicates that the afternoon peak is by far more "inelastic" than the morning - just one more indication that the afternoon is much worse than the morning. It is quite interesting that our expectation for this lag was the middle of the range (i.e., 15-20 minutes), but it turned out that it is much shorter in the afternoon (no more than 5 min) and much longer in the morning (almost 45 min). This is another sign about the 'quality' of peak period traffic conditions - the system can sustain relatively higher volumes for longer time in the morning before breaking down, but in the afternoon it becomes very "fragile" and even little volume excess is followed by speed drops quite immediately. Once again, quite consistent with the fact that traffic patterns in the morning are more regular and "smoother" than in the afternoon. Also, noteworthy in this regard, volume/speed drop in the morning from 2003 to 2006 is not that large (just 35 vplph and a few tenths mph), but much larger/more than double in the afternoon (86 vplph and 2 mph).

Puget Sound Freeway Network - Traffic Congestion Data Analysis

Network-wide Free Flow & 85th Percentile Speed:

The 24-hour 85th percentile of speeds (based on WSDOT's vehicle detector raw data) were as follows:

- 2003: average 62.70mph, median 62.02mph
- 2006: average 61.41mph, median 61.48mph

Free flow speeds (based on speed-flow analysis of WSDOT's vehicle detector raw data) were as follows:

- 2003: average 63.78mph, median 62.50mph
- 2006: average 63.86mph, median 62.10mph

Puget Sound Freeway Network - Traffic Congestion Data Analysis

Peak Period Spreading

For a sample of increasing congestion and an indication of broadening of the peak period data for I-405 SB SE of 8th the STAT was analyzed in more detail.

The data is for the number of 5 minute periods when the speed was <= 45 MPH

The results were as follows:

Year	Number of Congestion Periods	Approx Start of Cong	Approx End of Cong	Minimum Speed
2001	60	13:40	18:35	19.6
2002	58	13:45	18:40	19.9
2003	66	13:20	18:45	16.8
2004	94	11:10	18:55	14.0
2005	102	10:35	19:00	12.5
2006	109	10:20	19:15	12.5

For this station the number of congested periods nearly doubles and the congested period widens starting over 3 hours earlier and finishing 45 minutes later.

Puget Sound Freeway Network - Traffic Congestion Data Analysis

Summary of Freeway Network Performance Comparisons

The Speed and Congestion Index comparisons (network-wide averages) for the years 2001, 2005 and 2006 provide significant insights about congestion growth over the period from 2003 to 2006, but also about the change in the most recent one-year period from 2005 to 2006 relative to that in the previous one-year periods.

Figure 17 show the percentage of time that the freeway network operated below the 25mph, 45mph and 55mph thresholds during the peak periods, the 5:00 a.m. - 9:00 p.m. period and on the full 24-hour day (average conditions in 2001, 2005 and 2006).

Figure 18 show the percentage of time that the freeway network operated over congestion thresholds that could be described as “dense traffic”, “very dense traffic” and “extremely dense traffic” during the same periods.

Lastly, Figure 19 shows changes in average throughput per lane and average speeds for the morning and afternoon peak periods since 2003.

Some observations include the following:

- The results confirm that traffic conditions are worse in the afternoon peak than in the morning, but the morning peak is now deteriorating almost as fast: the percentage of time with speeds below 55mph in the peak periods has grown a little since 2003; yet, the percentage of time for the 45 mph and 25 mph thresholds has been growing steadily and, in fact, has almost quadrupled since 2003.

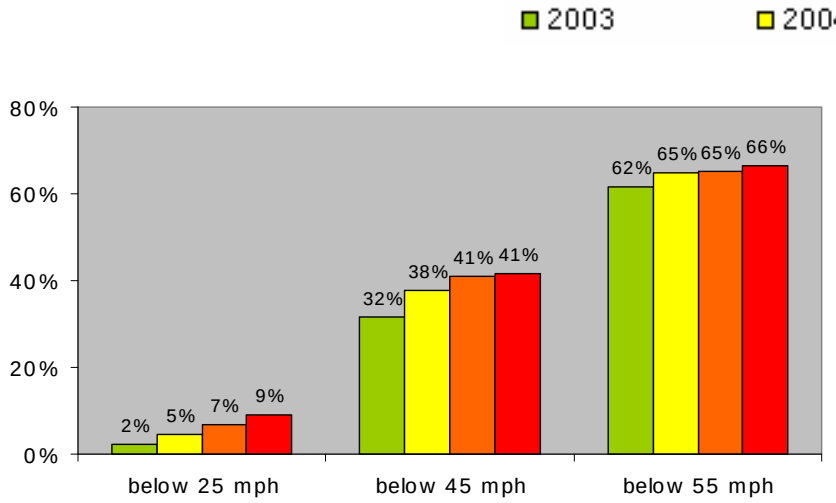
- It is also important to note that the percentage of time below the 25mph threshold has almost doubled and quadrupled for the 24- and 16-hour periods respectively since 2003.

- Changes in the Congestion Index thresholds (dense, very dense, extremely dense) confirm the deterioration in traffic conditions since 2003:
  - although the overall amount of time in ‘dense’ or worse conditions has not changed more than 4-6 percentage points since 2003, the amount of time in “stop & go” conditions for the 16- and 24-hour periods has doubled and tripled respectively since 2003.
  - the change in ‘extremely dense’ conditions during the morning and afternoon peak periods has also doubled.

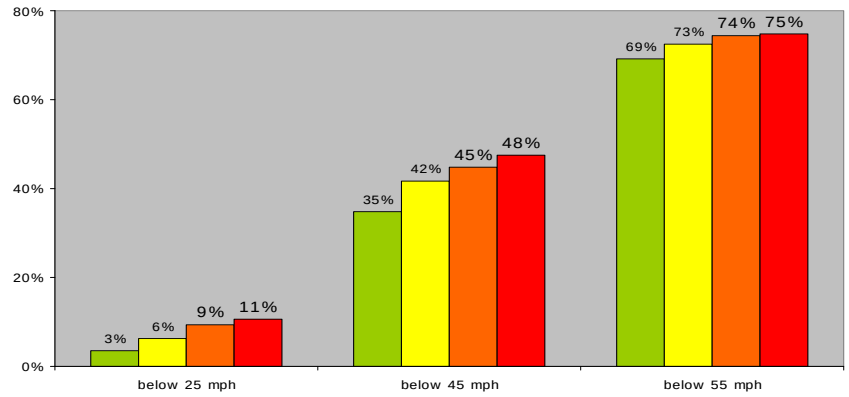
- Changes in average throughput per lane and average speeds for the morning and afternoon peak periods suggest that throughput has decreased by about 100 vplph since 2003 and average speeds are dropping by about a mile per hour every year.

In conclusion, while overall time in “dense” and “below 55 mph” traffic conditions has not changed significantly since 2003, the change in “extremely dense”/”below 25 mph” has been quite dramatic (has doubled and almost quadrupled in some cases). The acceleration of change indicates that traffic conditions are deteriorating more rapidly - traffic is compromised for longer periods of the day and not recovering as quickly.

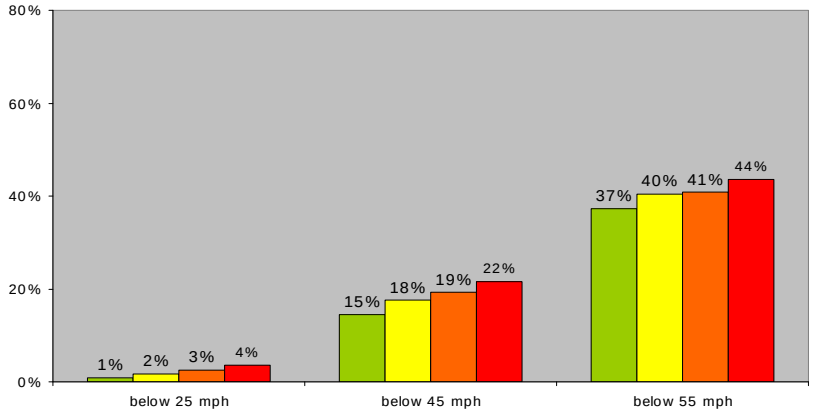
Figure 17 - Percent of Time that the Freeway Network was Below Speed Thresholds for the Period 2003-2006



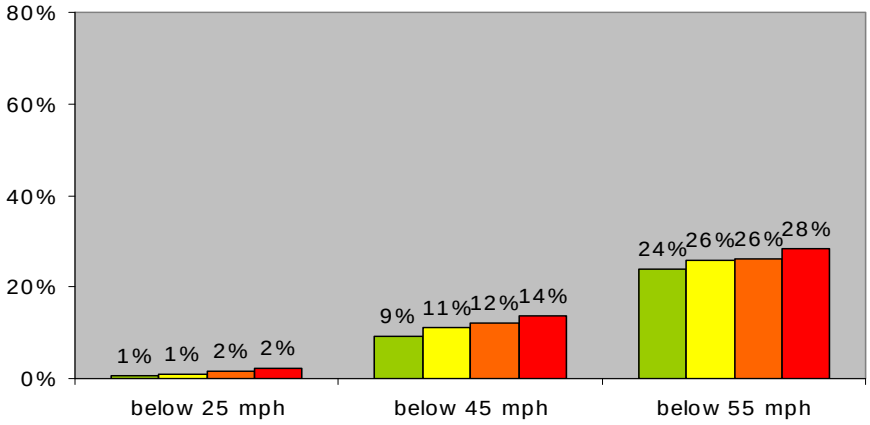
AM Peak Period (6:00 a.m. – 9:00 a.m.)



PM Peak Period (4:00 p.m. – 7:00 p.m.)

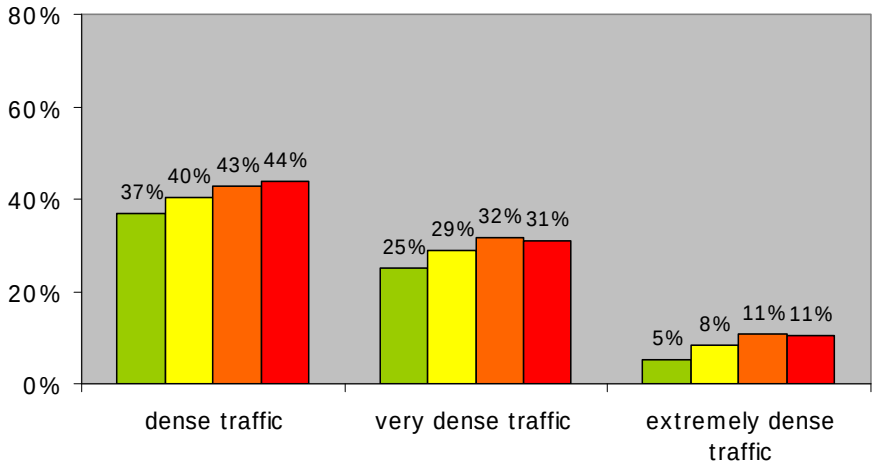


16-hour Period (5:00 a.m. – 9:00 p.m.)

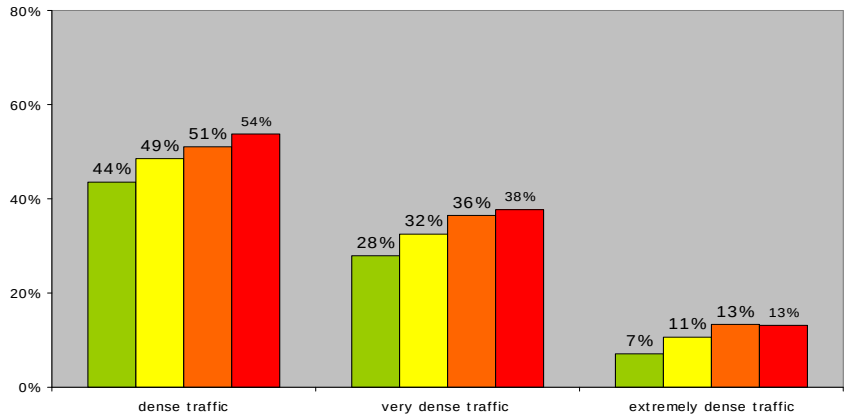


24-hour Period

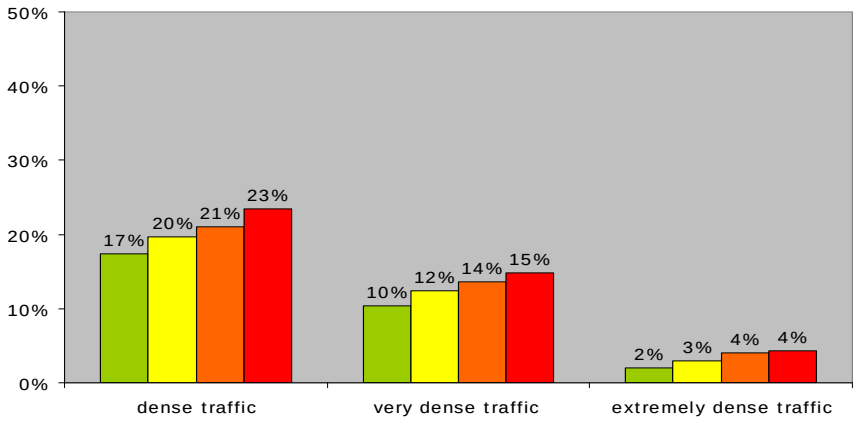
Figure 18 - Percent of Time that the Freeway Network was in Congested Conditions for the Period 2003-2006



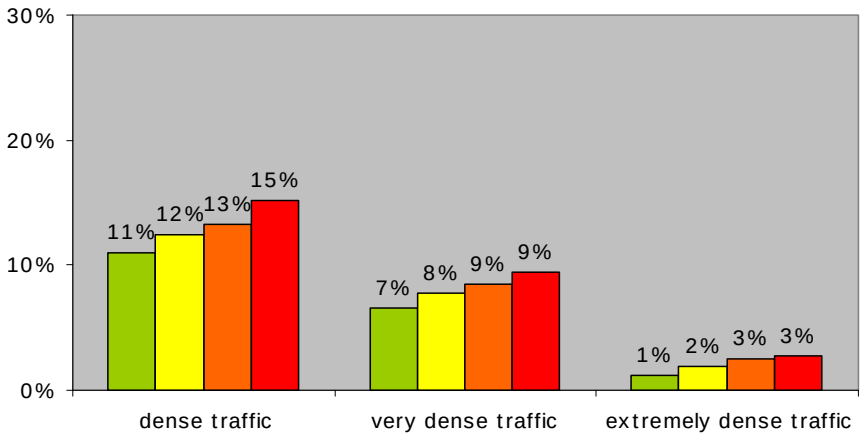
AM Peak Period (6:00 a.m. – 9:00 a.m.)



PM Peak Period (4:00 p.m. – 7:00 p.m.)

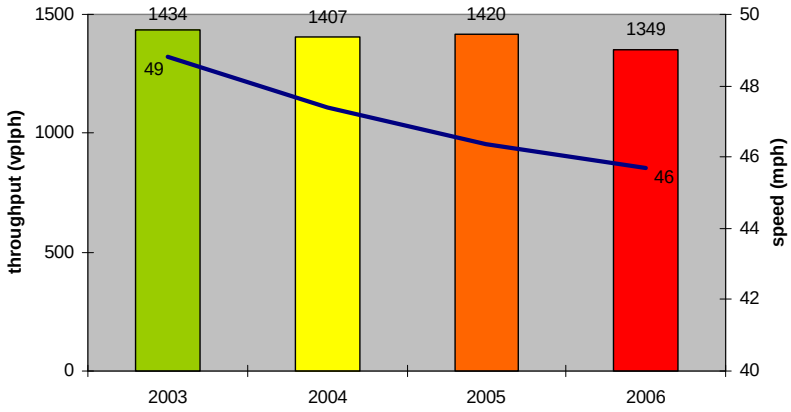


16-hour Period (5:00 a.m. – 9:00 p.m.)

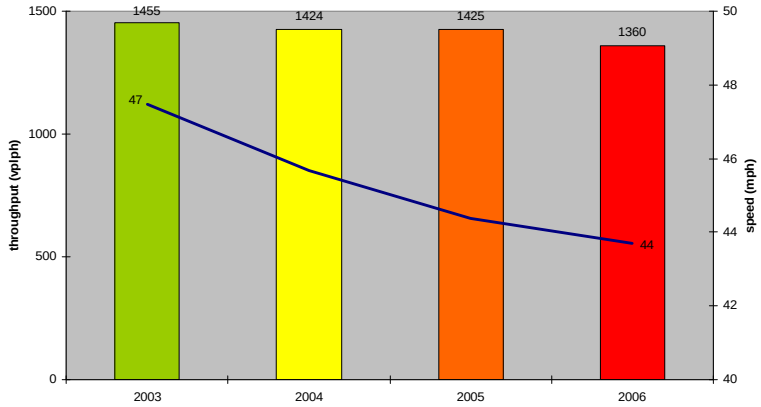


24-hour Period

Figure 19 - Average Throughput and Average Speed for the Period 2003-2006



AM Peak Period (6:00 a.m. - 9:00 a.m.)



PM Peak Period (4:00 p.m. - 7:00 p.m.)

Average Throughput **Average Speed**

Puget Sound Freeway Network - Traffic Congestion Data Analysis

Fraction of Peak Period Time that is Spent Below 35 MPH

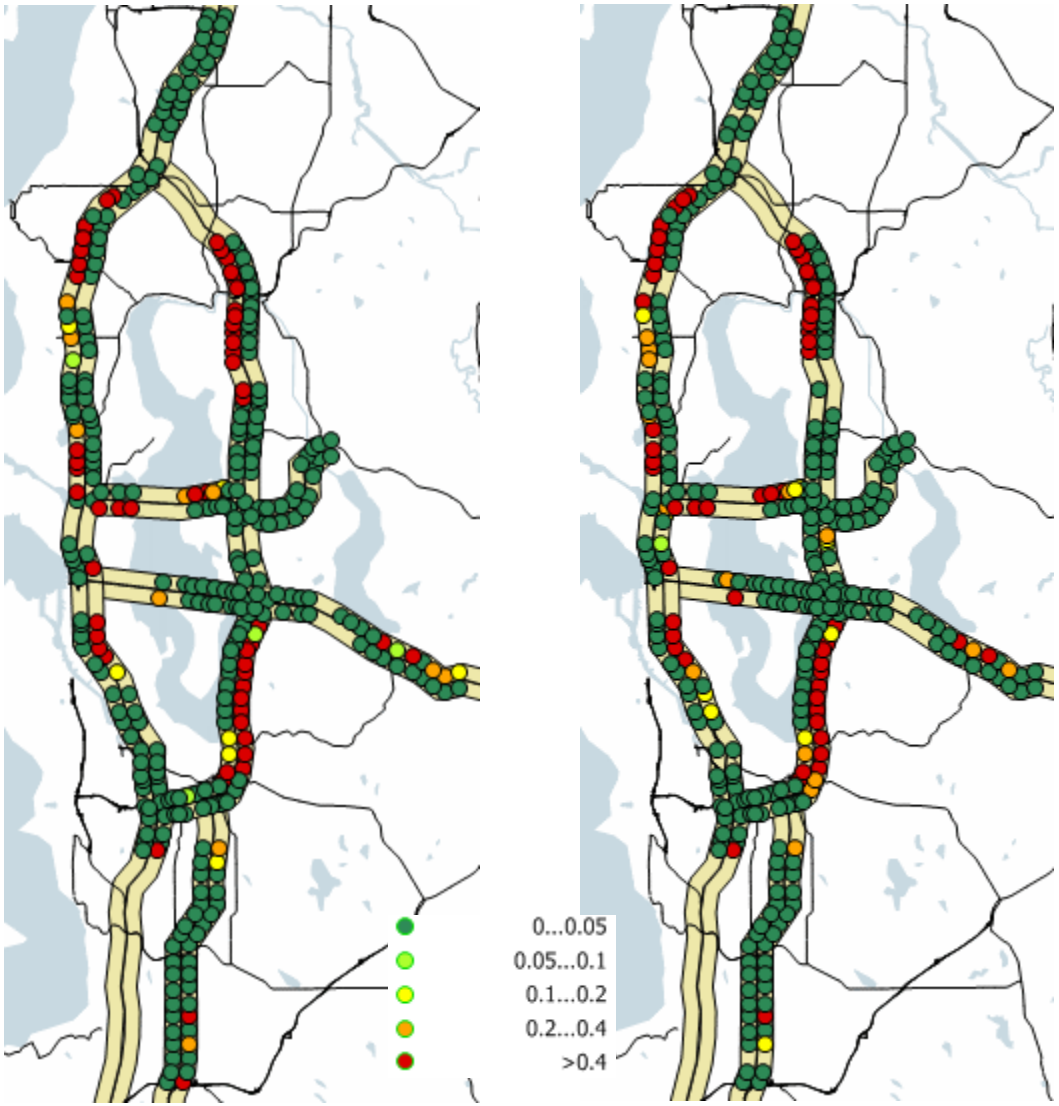
<u>Morning Peak Period 6:00 - 9:00 a.m.</u>

On the average, the network was below the 35mph threshold as follows:

2005 11% of time
(network average speed: 52mph)

2006 12% of time
(network average speed: 51mph)

2005 **2006**



Puget Sound Freeway Network - Traffic Congestion Data Analysis

Afternoon Peak Period 4:00 - 7:00 p.m.

On the average, the network was below the 35mph threshold as follows:

2005 14% of time
(network average speed: 50mph)

2006 15% of time
(network average speed: 49mph)

2005 **2006**

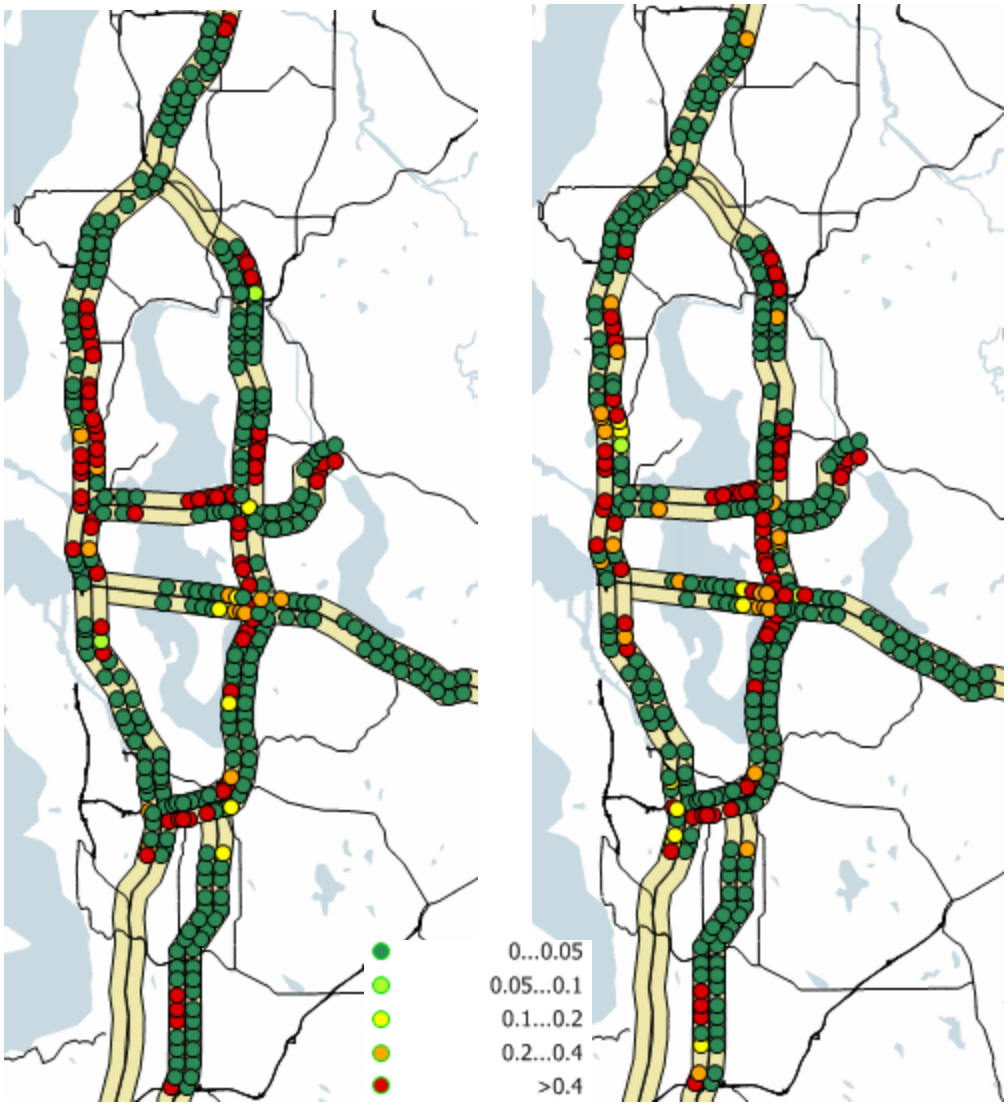
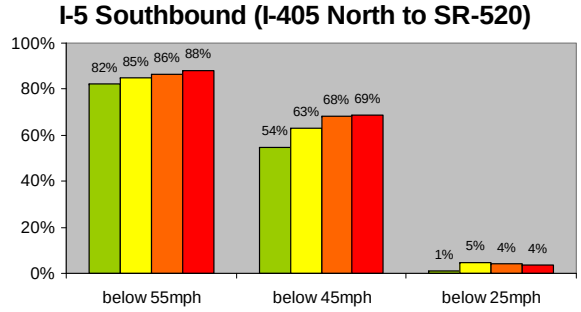
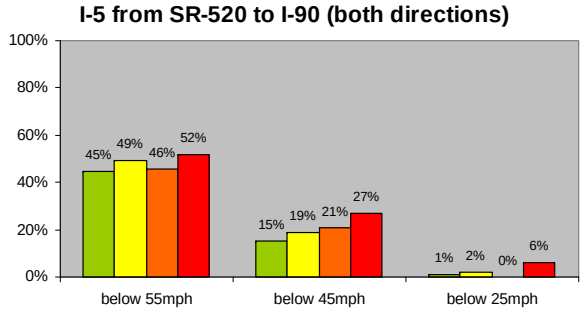


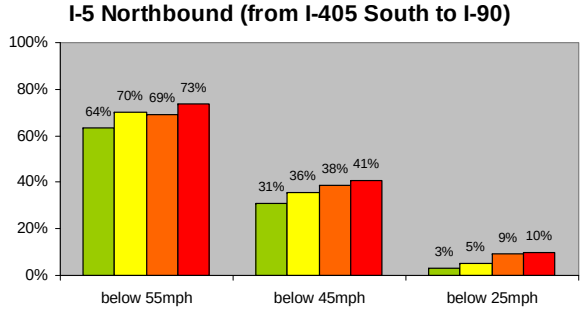
Figure 20 - Percentage of Time that sections of I-5 were Below Speed Thresholds in the Period 2003-2006

2003 2004 2005 2006

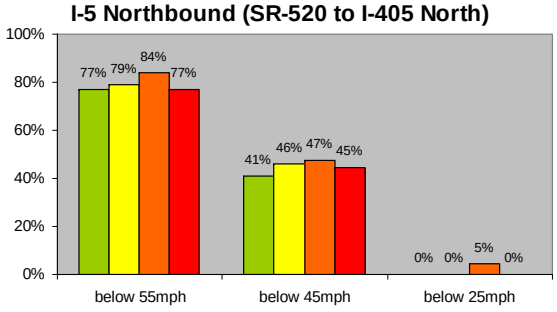
Morning Peak Period (6am-9am)

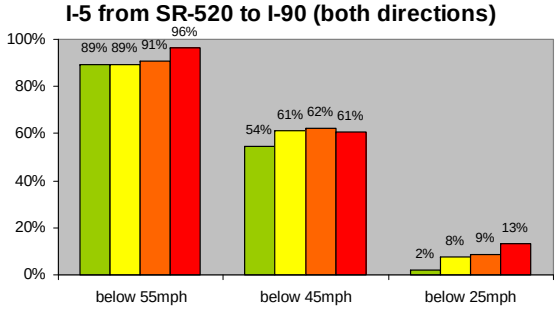






Evening Peak Period (4pm-7pm)





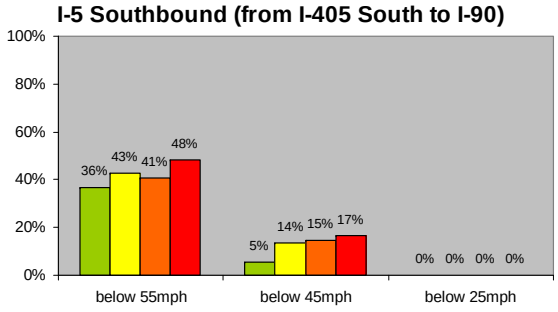
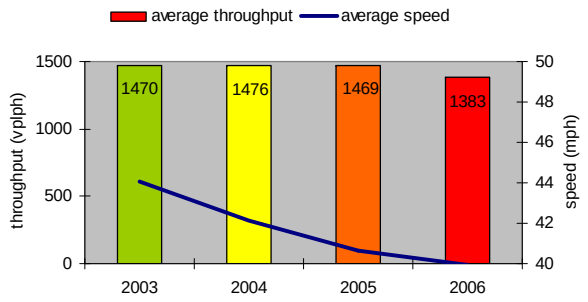


Figure 21 - Average throughput and speed on sections of I-5 in the Period 2003-2006

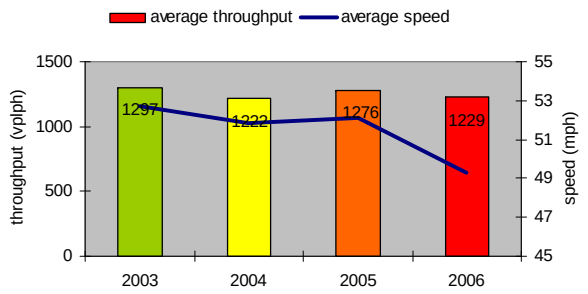
2003 2004 2005 2006

Morning Peak Period (6am-9am)

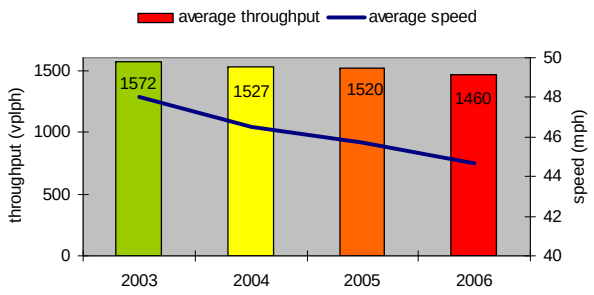
I-5 Southbound (I-405 North to SR-520)



I-5 from SR-520 to I-90 (both directions)

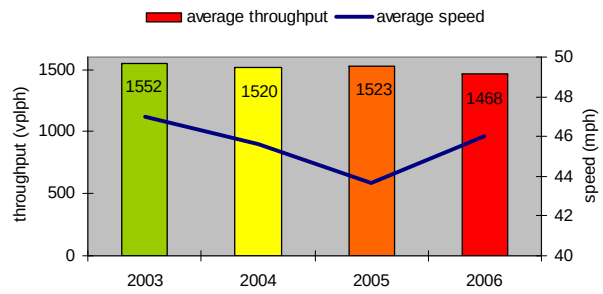


I-5 Northbound (from I-405 South to I-90)

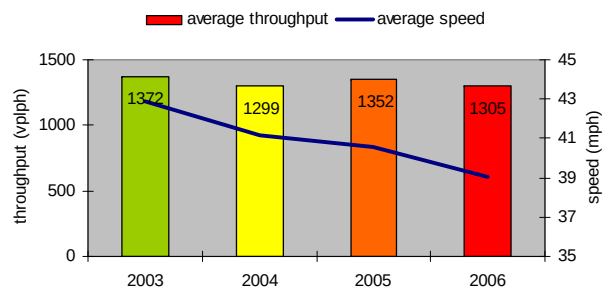


Evening Peak Period (4pm-7pm)

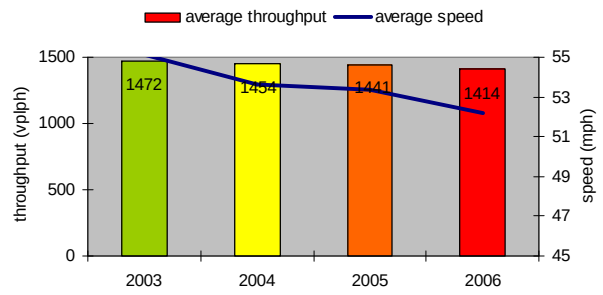
I-5 Northbound (SR-520 to I-405 North)



I-5 from SR-520 to I-90 (both directions)



I-5 Southbound (from I-405 South to I-90)



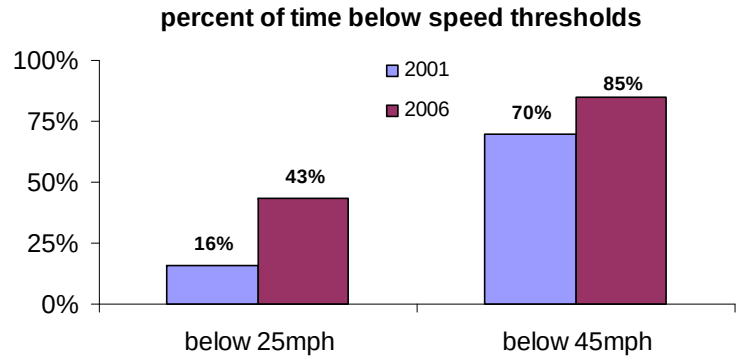
I-405 Northbound between SR-167 and I-90

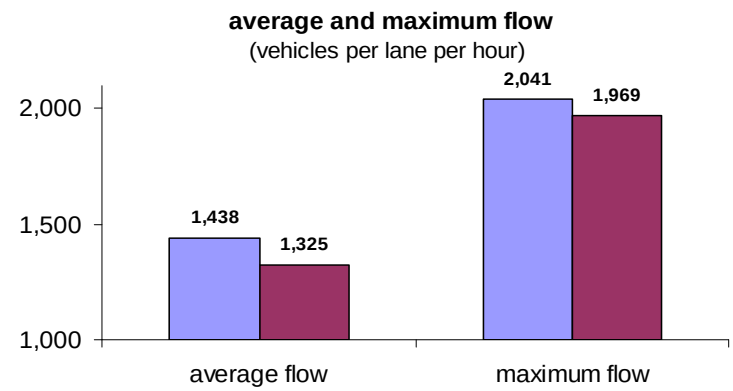
The Graphs on the right shows a comparison of morning peak period Congestion Index and Speed Index between 2001 and 2006 for the northbound section of I-405 between SR-167 and I-90.

The worsening of conditions since 2001 is quite obvious. Most alarming is the jump in the percentage of time that this section operates at less than 25 mph in the morning peak period, which has almost doubled (from 16% to 43%) since 2001. Some of this change may be due to construction activity.

What is also quite interesting is the drop in average and maximum flows on I-405: from about 1440 vplph in 2001 to 1330 vplph in 2006; while maximum flow also dropped from 2040 to 1970. The latter values could be considered some sort of practical capacity for the subject section/locations, since they were probably recorded just before breakdown conditions in the morning peak period (when usually maximum throughput conditions occur).

Performance of I-405 NB (SR-167 to I-90) in 2001 & 2006 Morning Peak Period





Comparison of Throughput Performance of HOV and GP Lanes.

The 3 displays in each of Figures 22 and 23 show average speed, vehicle throughput and person throughput for HOV and GP lanes for the 2006 morning and afternoon peak periods based on WSDOT loop detector data.

The outside dots in the displays represent data for HOV lanes while median / inside dots represent data for GPL.

The first display is a depiction of the Speed Index, where color coding highlights the percent of time that speed drops below a set threshold (in this case 45mph) during the 3-hour PM peak. E.g., red dots indicate that speed at those locations is below 45mph for over 40% of the peak period. Accordingly, highway sections where HOV lanes do not meet the criterion of operating at over 45mph for at least 90% of the time include primarily

- northbound I-5 north of Northgate,
- southbound I-5 in the vicinity of I-90
- southbound I-405 south of SR-520 and continuing for some stretches south of I-90
- northbound I-405 north of SR-520

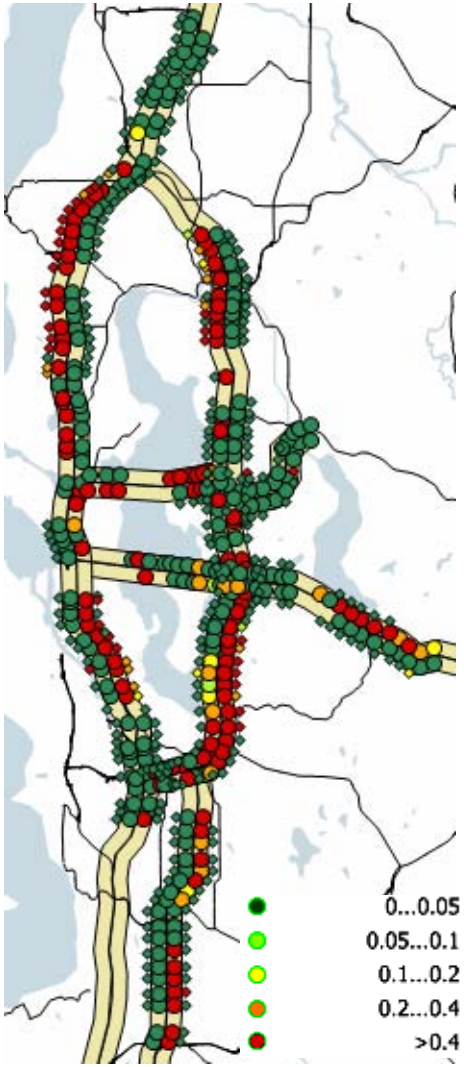
The color coding on the second display highlights average vehicle volumes in vehicles per lane per hour. Consistent with the previous display, the relative high HOV volumes (e.g., over 1,500 vplph) are observed in almost exactly the same locations where the HOV slowdowns occur.

Lastly, the third display shows the average person throughput in persons per lane per hour. It shows that HOV lane person throughput is almost consistently higher than the GPL person throughput in the peak direction of travel. This display in combination with the previous one highlights the efficiency of the HOV vs the GP lane in terms of vehicle vs person throughput comparisons.

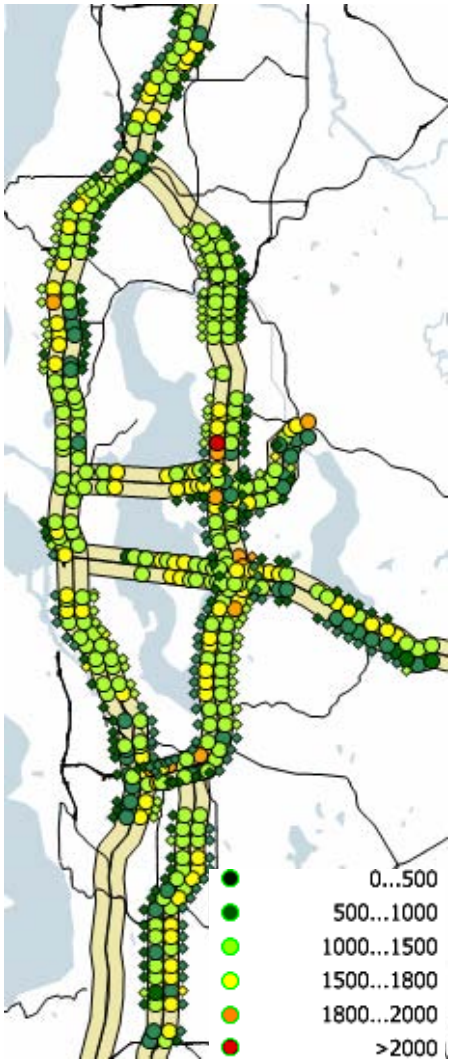
[Note that for the analysis in the last display, we used an average occupancy of 2.3 persons per vehicle for the HOVs and 1.3 for the SOVs, which is probably a conservative assessment (as the SOV average occupancy could be well below 1.2, and the HOV well over 2.4).]

Figure 22: Comparison of HOV and General Purpose Lane Performance for the 2006 AM peak period (6-9am)

Percent of time that speeds were below 45 mph



Average vehicle throughput (vehicles per lane per hour)



Average person throughput (persons per lane per hour)

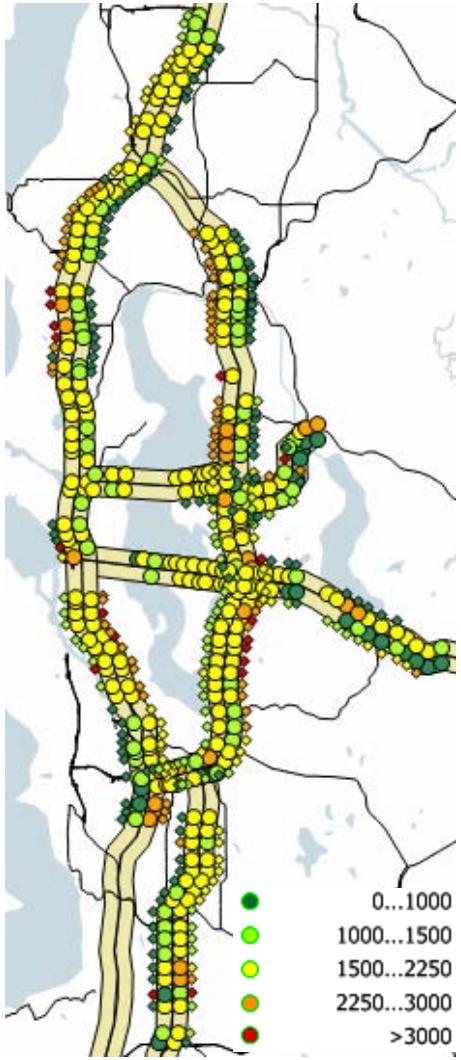
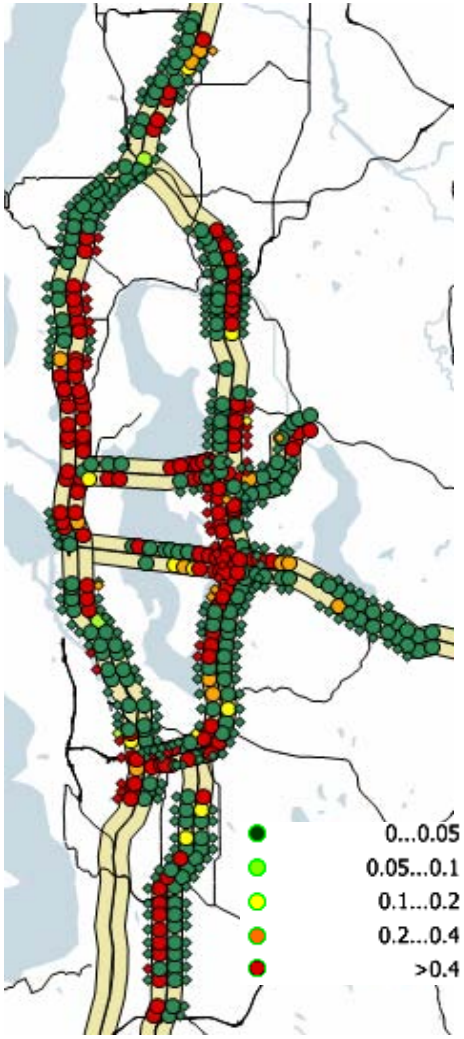
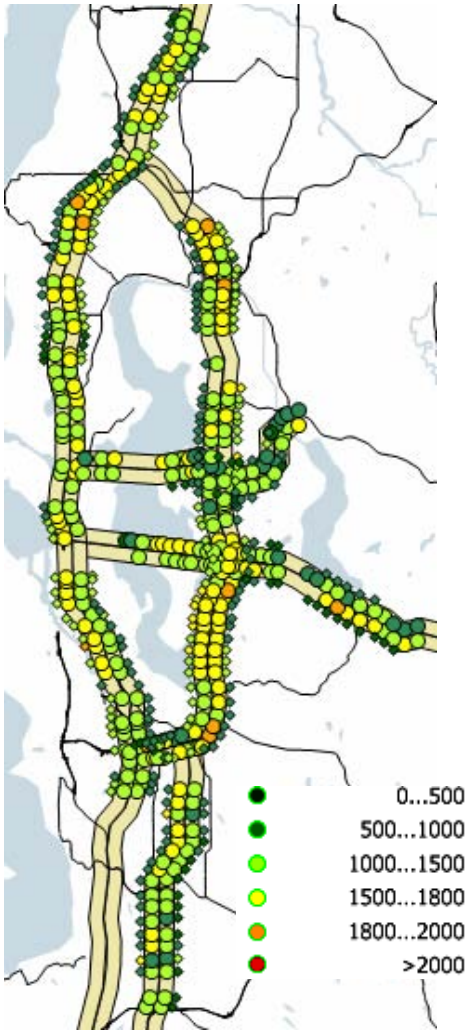


Figure 23: Comparison of HOV and General Purpose Lane Performance for the 2006 PM peak period (4:00 – 7:00 p.m.)

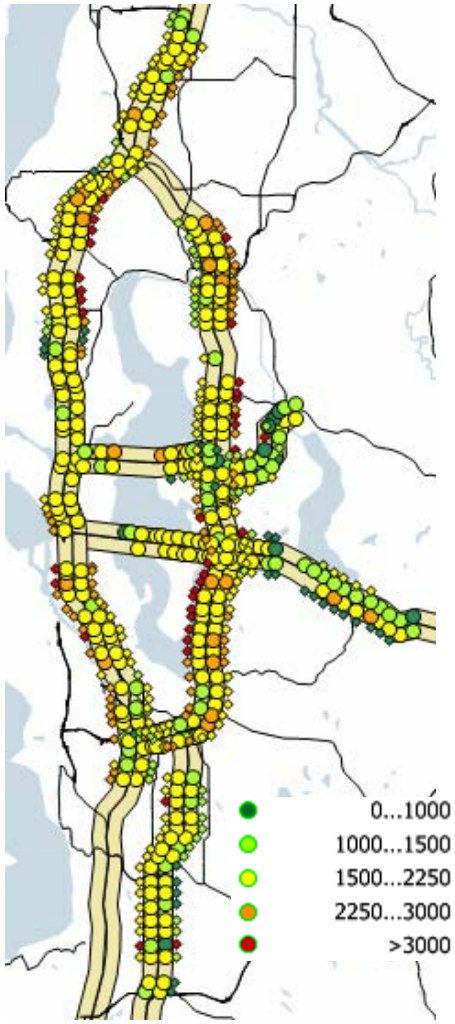
Percent of time that speeds were below 45 mph



Average vehicle throughput (vehicles per lane per hour)



Average person throughput (persons per lane per hour)



B-1 — I-900 Elements

WSDOT Management and Improvement to the State Highway System for Maximum Throughput and Minimal Congestion

I-900 Element	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Identification of cost savings. (1)																						
2. Identification of services that can be reduced or eliminated. (2)																						
3. Identification of programs or services that can be transferred to the private sector.																				X		
4. Analysis of gaps or overlaps in programs or services and recommendations to correct them.	X		X			X	X		X				X	X	X		X		X		X	X
5. Feasibility of pooling the entity's information technology systems.																		X				
6. Analysis of the roles and functions of the entity and recommendations to change or eliminate roles or functions.	X	X		X					X	X												

7. Recommendations for statutory or regulatory changes that may be necessary for the entity to properly carry out its functions.	**X**										**X**	**X**								**X**		
8. Analysis of the entity's performance data, performance measures and self-assessment systems.			**X**		**X**	**X**	**X**	**X**								**X**						
9. Identification of best practices.		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**					**X**	**X**	**X**	**X**	**X**	**X**			
I-900 Element	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**

(1) Because of the scope of this audit, recommendations do not identify opportunities for direct cost savings. Instead, recommendations focus on the potential to "slow down" the cost resulting from congestion.

(2) Based on our review of WSDOT's approach to managing congestion and its current practices, we found no opportunities for recommendations related to this element.

B-2 — Legislative Action

The following recommendation provided in this report requires legislative action in support of implementation.

Legislative Action

Recommendation 1a: **We recommend the Washington State Legislature choose/identify projects based on congestion reduction rather than other agendas.**

Recommendation 11: **We recommend the Washington State Legislature implement new legislation to facilitate the expansion of road pricing should WSDOT's HOT lane pilot be successful.**

Recommendation 12: **We recommend the Washington State Legislature empower a single body — either WSDOT or a new regional transportation entity for the Puget Sound Region — to allow for a more integrated approach to planning for congestion reduction.**

Recommendation 20: **We recommend the Washington State Legislature review whether new legislation is required for public private partnerships for transportation infrastructure and implement any necessary changes.**