2007-2026
Highway System Plan

High Benefit
Low Cost

December 2007
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December 21, 2007

FOREWORD

I am pleased to present the 2007-2026 Washington State Highway System Plan. The plan identifies current and forecasted state highway needs and presents strategies and performance measures to address those needs. This plan is based on the goals established by the Washington State Transportation Commission in the 2006 Washington Transportation Plan and supports the state’s transportation policy goals contained in RCW 47.01.012:

- (1) *Preservation*: to maintain, preserve and extend the life and utility of prior investments in transportation systems and services;
- (2) *Safety*: to provide for and improve the safety and security of transportation customers and the transportation system;
- (3) *Mobility*: to improve the predictable movement of goods and people throughout Washington state;
- (4) *Environment*: to enhance Washington’s quality of life through transportation investments that promote energy conservation, enhance healthy communities, and protect the environment; and
- (5) *Stewardship*: to continuously improve the quality, effectiveness, and efficiency of the transportation system.

This plan was developed over the last several years. It reflects the substantial transportation safety, preservation and traffic improvement investments underway as a result of the Nickel and Transportation Partnership programs enacted in 2003 and 2005. The plan also recognizes that we must do more to get the most productivity out of our state transportation system and to fight congestion by managing demand, operating our highways more efficiently and adding highway capacity strategically.

WSDOT intends to update the Highway System Plan every two years and use it as a guide in the development of the highway portion of the Capital Improvement and Preservation Program. Each update of the Highway System Plan builds upon previous plans, refining identified needs, strategies, and solutions; and covers emergent issues.

As we move forward, we hope that the Highway System Plan provides useful guidance for this and future budget development cycles.

Paula J. Hammond, P.E.
Secretary of Transportation
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>Preservation</strong></td>
<td>2</td>
</tr>
<tr>
<td>Pavement</td>
<td>2</td>
</tr>
<tr>
<td>Bridges and Structures</td>
<td>2</td>
</tr>
<tr>
<td>Other Highway Assets</td>
<td>2</td>
</tr>
<tr>
<td><strong>Improvement</strong></td>
<td>3</td>
</tr>
<tr>
<td>Highway Safety</td>
<td>3</td>
</tr>
<tr>
<td>Mobility</td>
<td>3</td>
</tr>
<tr>
<td>Economic Vitality</td>
<td>4</td>
</tr>
<tr>
<td>Health and the Environment</td>
<td>4</td>
</tr>
<tr>
<td><strong>I. Preservation</strong></td>
<td>5</td>
</tr>
<tr>
<td>Pavement</td>
<td>5</td>
</tr>
<tr>
<td>Description of Issue</td>
<td>5</td>
</tr>
<tr>
<td>Needs</td>
<td>7</td>
</tr>
<tr>
<td>Strategies for Preserving Highway Pavements</td>
<td>8</td>
</tr>
<tr>
<td>Performance Measures</td>
<td>11</td>
</tr>
<tr>
<td>Maintenance and Operation</td>
<td>11</td>
</tr>
<tr>
<td>Bridges and Structures</td>
<td>13</td>
</tr>
<tr>
<td>Structures Overview</td>
<td>13</td>
</tr>
<tr>
<td>Description of Issue</td>
<td>13</td>
</tr>
<tr>
<td>Bridge Preservation</td>
<td>14</td>
</tr>
<tr>
<td>Catastrophic Reduction</td>
<td>20</td>
</tr>
<tr>
<td>Performance Measures</td>
<td>27</td>
</tr>
<tr>
<td>Security</td>
<td>27</td>
</tr>
<tr>
<td>Other Highway Assets</td>
<td>29</td>
</tr>
<tr>
<td>Maintenance Strategies and Goals</td>
<td>29</td>
</tr>
<tr>
<td>Emergency Preparedness</td>
<td>29</td>
</tr>
<tr>
<td>Safety Rest Area Preservation</td>
<td>29</td>
</tr>
<tr>
<td>Major Drainage System Rehabilitation</td>
<td>32</td>
</tr>
<tr>
<td>Highway Slopes and Embankments</td>
<td>33</td>
</tr>
<tr>
<td>Major Electrical Preservation</td>
<td>37</td>
</tr>
<tr>
<td>Weigh Station Replacement and Rehabilitation</td>
<td>47</td>
</tr>
<tr>
<td><strong>II. Improvement</strong></td>
<td>51</td>
</tr>
<tr>
<td>Highway Safety</td>
<td>51</td>
</tr>
<tr>
<td>What We Have Done</td>
<td>51</td>
</tr>
<tr>
<td>What We Are Doing Now</td>
<td>51</td>
</tr>
<tr>
<td>Description of Issues</td>
<td>52</td>
</tr>
<tr>
<td>Needs</td>
<td>53</td>
</tr>
<tr>
<td>Strategies</td>
<td>54</td>
</tr>
<tr>
<td>Performance Measures</td>
<td>61</td>
</tr>
<tr>
<td>Mobility</td>
<td>63</td>
</tr>
<tr>
<td>Description of Issues</td>
<td>63</td>
</tr>
<tr>
<td>Needs</td>
<td>66</td>
</tr>
<tr>
<td>Strategies</td>
<td>67</td>
</tr>
<tr>
<td>Performance Measures</td>
<td>80</td>
</tr>
<tr>
<td>Economic Vitality</td>
<td>83</td>
</tr>
<tr>
<td>Freight Transportation Network</td>
<td>83</td>
</tr>
<tr>
<td>Description of Issues</td>
<td>84</td>
</tr>
<tr>
<td>Needs</td>
<td>88</td>
</tr>
<tr>
<td>Strategies</td>
<td>89</td>
</tr>
<tr>
<td>Performance Measurement</td>
<td>90</td>
</tr>
<tr>
<td>Health and the Environment</td>
<td>93</td>
</tr>
<tr>
<td>Fish Passage Barrier Removal</td>
<td>93</td>
</tr>
<tr>
<td>Habitat Connectivity</td>
<td>95</td>
</tr>
<tr>
<td>Fixing Chronic Environmental Deficiencies</td>
<td>97</td>
</tr>
<tr>
<td>Noise Barrier Retrofit</td>
<td>102</td>
</tr>
<tr>
<td>Bicycle Transportation, Pedestrian Walkways</td>
<td>105</td>
</tr>
<tr>
<td>and the Environment</td>
<td></td>
</tr>
</tbody>
</table>
### Appendices

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Glossary</td>
<td>A-1</td>
</tr>
<tr>
<td>B</td>
<td>Regional Transportation Planning</td>
<td>B-1</td>
</tr>
<tr>
<td>C</td>
<td>WSDOT Regions</td>
<td>C-1</td>
</tr>
<tr>
<td>D</td>
<td>National Highway System</td>
<td>D-1</td>
</tr>
<tr>
<td>E</td>
<td>Highways of Statewide Significance</td>
<td>E-1</td>
</tr>
<tr>
<td>F</td>
<td>Freight and Goods Transportation System</td>
<td>F-1</td>
</tr>
<tr>
<td>G</td>
<td>Development Impacts Assessment</td>
<td>G-1</td>
</tr>
<tr>
<td>H</td>
<td>Scoping Process Flow Diagrams</td>
<td>H-1</td>
</tr>
<tr>
<td></td>
<td>Bridge Scour</td>
<td>H-1</td>
</tr>
<tr>
<td></td>
<td>Chronic Environmental Deficiencies</td>
<td>H-5</td>
</tr>
<tr>
<td></td>
<td>Fish Passage Barrier Removal</td>
<td>H-7</td>
</tr>
<tr>
<td>I</td>
<td>Bottlenecks and Chokepoints</td>
<td>I-1</td>
</tr>
<tr>
<td>J</td>
<td>HSP Implementation Strategies</td>
<td>J-1</td>
</tr>
<tr>
<td></td>
<td>Tier I Solutions</td>
<td>J-5</td>
</tr>
<tr>
<td></td>
<td>Tier II Solutions</td>
<td>J-27</td>
</tr>
<tr>
<td></td>
<td>Tier III Solutions</td>
<td>J-49</td>
</tr>
<tr>
<td>K</td>
<td>Solutions that Require Further Analysis</td>
<td>K-1</td>
</tr>
<tr>
<td>L</td>
<td>Locations that Require Further Analysis</td>
<td>L-1</td>
</tr>
<tr>
<td>M</td>
<td>Highway/Ferry Linked Solutions</td>
<td>M-1</td>
</tr>
<tr>
<td>N</td>
<td>WTP Trucker Survey Results Map</td>
<td>N-1</td>
</tr>
<tr>
<td>O</td>
<td>HSP Funding and WTP Targets</td>
<td>O-1</td>
</tr>
<tr>
<td>P</td>
<td>Non-Interstate Corridor Reports</td>
<td></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.wsdot.wa.gov/planning/hsp">www.wsdot.wa.gov/planning/hsp</a></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>Interstate Corridor Reports</td>
<td></td>
</tr>
<tr>
<td></td>
<td><a href="http://www.wsdot.wa.gov/planning/hsp">www.wsdot.wa.gov/planning/hsp</a></td>
<td></td>
</tr>
</tbody>
</table>
Transportation affects everyone. Whether commuting to work, delivering products, taking a vacation, or running errands, our lives and livelihood depend on a safe, efficient and reliable transportation system. Washington State’s population continues to grow, as does the need to move more people and freight. The Washington State Department of Transportation (WSDOT) is dedicated to providing a safer, more efficient and reliable transportation system and is committed to being good stewards of the state’s transportation system.

**Washington State Law, the Washington Transportation Plan and the 2007-2026 Highway System Plan**

The 2007 Legislature revised and streamlined various existing state transportation goals, objectives and responsibilities, and the process by which these elements are measured and reported. Their Transportation Policy Goals for the planning, operation, performance of and investment in the state transportation system are described in Figure 1.

The goals established by the Washington State Transportation Commission in the 2006 Washington Transportation Plan (WTP) are consistent with the direction provided (see Figure 1) by the Legislature in Senate Substitute Bill 5412.

The Washington State Highway System Plan (HSP) is the element of WTP that addresses current and forecasted state highway needs based on the investment options identified in the WTP. These long-range planning documents assess current and future transportation needs through a collaborative planning process with local governments, regional planning agencies, and private transportation providers to ensure that the state’s transportation network functions safely, efficiently, reliably and cost effectively. The HSP identifies all needs consistent with the policies set by the Legislature. The WTP constrains the HSP by policy, not by available or forecasted revenue.

The HSP is updated every two years, and guides WSDOT in the development and prioritization of the Capital Improvement and Preservation Program (CIPP). Each future update of the HSP, beginning with this one, builds upon the previous plan, refining identified needs, strategies and solutions; and will expand to cover emergent issues and additional locations previously unidentified. Each update also includes a “snapshot” of the most recent findings of WSDOT’s continuous system-wide analysis, performance measurement and monitoring programs.

**Figure 1. Transportation Policy Goals**

- **Preservation:** To maintain, preserve and extend the life and utility of prior investments in transportation systems and services;
- **Safety:** To provide for and improve the safety and security of transportation customers and the transportation system;
- **Mobility:** To improve the predictable movement of goods and people throughout Washington State;
- **Environment:** To enhance Washington’s quality of life through transportation investments that promotes energy conservation, enhance healthy communities and protect the environment;
- **Stewardship:** To continuously improve the quality, effectiveness and efficiency of the transportation system.

*Source: RCW 47.04.280*
Overview

The rest of the overview will briefly touch on each of these Legislative and WTP priorities, their respective needs, and WSDOT strategies for addressing these needs (see Figure 2). In addition, the 2007-2026 HSP update document includes constrained lists of identified congested segment needs, specific prioritized strategies for addressing them, and performance measurements to determine the effectiveness of these strategies.

**Figure 2. WTP Priorities**

The Highway System Plan (HSP) will address each of the Washington Transportation Plan (WTP) priorities as follows:

- Definition of the issue
- Needs and criteria used
- Strategy to address the needs
- Performance measures
- Maintenance – where applicable
- Emergency Plan – where applicable

Preservation

Use of the State highway system continues to grow while the system ages. Periodic rehabilitation is necessary in order to ensure reliable movement of people and goods essential for a vibrant economy. The challenge facing state decision makers is to strike a balance between system improvement and rehabilitation.

Pavement

WSDOT maintains approximately 7,000 miles of highway. Pavement preservation requires periodic rehabilitation to keep the driving surface smooth and prevent failure of the underlying sub-structure. WSDOT policy is to resurface specific highway segments when it is most economical to do so using either flexible or rigid pavement types.

Washington uses several methods to evaluate state pavement conditions and develop a cost effective rehabilitation schedule. These methods are incorporated into a pavement management system, which is used to develop a list of locations that are due for rehabilitation by year. Field investigations confirm these assessments.

**Bridges and Structures**

WSDOT owns 3,596 structures statewide. A table in the Structures section shows these structures by type. WSDOT policy is to maintain 95 percent of its bridges at a structural condition of at least fair, meaning all primary structural elements are sound.

This HSP update will include investment levels and strategies to address the bridge preservation needs in each of the following categories:

- Replacement or major rehabilitation of structurally deficient or functionally obsolete bridges
- Improving seismic strength of bridges
- Painting steel bridges
- Preserving bridge decks
- Protecting against scour
- Special bridge repair

**Other Highway Assets**

This section includes the following elements:

- **Slope Stabilization** – Roadside slopes that pose a risk to motorists due to falling rocks or slope failure are evaluated based on the degree of risk.
- **Rest Areas** – Rest areas are inspected every two years to determine the condition of water, sewer, buildings and site conditions. Water quality and sewage disposal have the highest priority. Buildings and site work come next.
- **Weigh Stations** – WSDOT works with the Washington State Patrol identifying facilities needed in order to weigh and inspect trucks to minimize wear and tear of Washington’s pavements and bridges, improve safety and freight movement.
- **Major Drainage and Electrical Rehabilitation** – WSDOT inspects these systems as warranted. WSDOT is in the process of establishing its inventory system. These updates will enable WSDOT to be more effective at managing assets, determining long-term needs and prioritization.
Improvement

Highway Safety
Collisions cause approximately 600 fatalities each year on state, county, and city roads. Approximately 270 of those fatalities occur on the state highway system. Despite recent progress to improve safety conditions on our highways, the number of fatalities is still unacceptable and we continue to look for ways to achieve further reductions.

Fatalities and injuries on all Washington’s roadways costs $5.3 billion annually. Sharply reducing fatalities and severe injuries will require more than improved vehicle and road engineering. Increased enforcement and a focus on public education are necessary to combat the greatest contributors to the problem: speeding and impaired driving. These two factors combined cause 60 percent of all traffic fatalities. Eliminating these human behaviors is essential to reach the goal of zero fatalities by 2030 as indicated in Washington State Strategic Highway Safety Plan – Target Zero.

The objective of the Safety program is reducing and preventing fatalities, decreasing the frequency and severity of disabling injuries, and minimizing the societal costs of accidents on the state highway system. Implementing these collision prevention and reduction measures not only focuses on motor vehicle drivers and passengers, but also on pedestrians and bicyclists.

Special safety initiatives are proving to be a low cost/high benefit way to make the statewide highway system safer for the traveling public. Statewide accident reduction and prevention measures, using low cost fixes include:

Crossover Accidents
- Centerline rumble strips to alert motorists
- Cable median barrier to prevent crossover accidents on multilane highways with divided medians
- Passing lanes on two way rural highways

Run-Off-the-Road Collisions
- Fixed object – remove or protect vehicles from sudden stops
- Upgrade non-standard guardrail and bridge rail
- Guardrail infill
- Shoulder rumble strips

The WTP and this HSP update have a safety and investment target of approximately $3 billion over 20 years. These funds will be expended using an incremental approach for prioritizing safety projects that target risk, interstate standards, behavioral programs, pedestrian and bicycle facilities, and rural two lane roads.

Mobility

Major Factors Contributing to Congestion
The growth in travel demand, especially during peak hours, has caused many of the urban and suburban highways in Washington State to operate less efficiently. The major factors that contribute to congestion are as follows:

- Bottlenecks
- Traffic Incidents
- Weather
- Work Zones
- Signal Timing
- Special Events
- Land Use
- Ferry Traffic
- Fluctuations in Normal Traffic

To identify highway congestion for this update the forecasted peak-hour travel speed for 2030 had to fall below 70 percent of the posted speed limit.

Mobility needs were addressed by separating strategies into three investment tiers that build upon previous work to maximize every dollar invested.

Strategies to address congestion primarily target low cost solutions that improve highway system efficiency and reduce the number of bottlenecks and chokepoints. Low cost strategies range from active traffic management, to transportation demand management, to congestion pricing.
Economic Vitality

Freight Transportation Network
The goal of freight integration in the Transportation Network Systems Plan is to provide lowest-cost freight system project proposals that support the state’s economic output and associated supply chains.

Freight Transportation Network investments are intended to generate overall economic prosperity and wealth for Washington’s citizens. They are focused on improving the performance of the freight system for the users and customers of the system. These improvements are necessary to support Washington’s role as a global gateway, our state’s manufacturers and agricultural growers, and our retail and wholesale distribution system.

Washington State’s strategic investment plan in the freight transportation network is supported by the Washington Transportation Plan Freight Report, which was presented to decision-makers in 2005 and 2006. It is organized in three chapters that explain Washington’s role as a gateway state, how freight transport supports Washington’s regional economies, and the role of the local distribution system.

Health and the Environment

Investing in our transportation system can help address citizens’ goals for a healthy environment. Environmental elements are considered part of every project’s design, construction, operation and maintenance.

Highway construction projects address such environmental issues such as treating stormwater, protecting groundwater, controlling erosion, providing for fish passage, reducing noise, replacing or improving wetlands, habitat connectivity, and bicycle/pedestrian facilities.

Health and the Environment projects are stand-alone work, and include fish passage barrier removal, habitat connectivity, stormwater retrofit, chronic environmental retrofit, noise barrier retrofit, and bicycle/pedestrian facilities.

WSDOT works with Department of Fish and Wildlife (WDFW) to inventory, identify, and prioritize fish passage barriers that should be removed along the state highway system. The agencies have found 1,600 fish passage barriers among more than 6,000 stream crossings on the state-owned highways.

To date, WSDOT has removed 205 of these barriers and gained over 480 miles of stream habitat for fish use. The effort to fix barriers continues and is a high priority in the HSP.
I. Preservation

Pavement

WSDOT owns and maintains approximately 7,000 miles of highway, including mainline, spurs, couplets, reversible, alternate, grade-separated, ramps, collectors, and special use lanes (slow vehicle, two-way turn, chain up, transit, climbing, bike, holding, weaving/speed change, and HOV lanes).

Basically, all hard surfaced pavement types can be categorized into two groups: flexible and rigid.

Description of the Issue

Flexible Pavements

Flexible pavements are roads that are surfaced with bituminous (or asphalt) materials (Figure 3). These can be either in the form of a chip seal, which is generally found on lower traffic-volume roads, or hot mix asphalt pavements which are typically used on medium to high volume roadways.

**Bituminous Surface Treatment (BST) or Chip Seal**

Chip seal are generally used on lower volume local roadways (Figure 3) and has an expected life of six to eight years (Photo 1).

**Hot Mix Asphalt (HMA)**

Hot mix asphalt pavement is typically designed for 20 to 50 years of life with routine overlays every 10 to 15 years (Figure 3). An average statewide pavement life cycle is 15 years (Photo 2).
Rigid Pavements

Rigid pavements are roads that have a surface of Portland Cement Concrete (Figure 3). Portland Cement Concrete Pavement (PCCP) generally lasts 30 to 50 years with minimal maintenance (Photo 3).

WSDOT selects a pavement type based on pavement design criteria (materials, traffic, etc.), life cycle cost analysis and engineering evaluation.

Currently, the state highway pavement network is composed of approximately 87 percent flexible pavements and 13 percent rigid pavements (Table 1, Figures 4 and 5).

Roadways require periodic rehabilitation to keep the driving surface smooth and safe and to prevent failure of the underlying substructure. Identifying the optimal time for rehabilitation is crucial to efficient pavement management. If rehabilitation is done too early, pavement life is wasted. Rehabilitation that is done too late requires additional costly repair work and increases the risk of subsurface structural failure.

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Lane Miles</th>
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<th>Traveled Miles Annually</th>
<th>Traveled Miles Annually (Percent)</th>
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</thead>
<tbody>
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<td>Chip Seal (Flexible)</td>
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<td>21.6</td>
<td>1.1</td>
<td>3.5</td>
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<tr>
<td>Hot Mix Asphalt (Flexible)</td>
<td>13,214</td>
<td>65.8</td>
<td>21.7</td>
<td>68.7</td>
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<tr>
<td>Portland Cement Concrete (Rigid)</td>
<td>2,537</td>
<td>12.6</td>
<td>8.8</td>
<td>27.8</td>
</tr>
</tbody>
</table>

Table 1. Annual Vehicle Miles in 2005 (in Billions)

Figure 4. Statewide Pavement Inventory
Needs

There is no more fundamental transportation capital investment than system preservation—keeping the existing infrastructure in good condition. As transportation facilities age and are used, a regular schedule of maintenance, rehabilitation, reconstruction, and replacement is needed to keep the system usable. Timing is important: if preservation investment is deferred, costs increase dramatically, leading to the saying “pay me now, or pay me more—lots more—later” (Figure 6).

WSDOT’s objective is to preserve roadways at the lowest cost per year of pavement life. Heavy traffic, studded tires, and extreme weather create wear and tear on pavement surfaces leading to its deterioration. Regular roadway preservation benefits motorists’ safety by reducing the risk of hydroplaning in wet weather, minimizing rough drive, and increasing resistance to skipping and skidding. Roadway preservation includes restoring worn-out safety features such as signs, striping, and guardrails.

The Department uses a process to identify needs to preserve the existing state highway system, which gives considerations to lowest life cycle costing (RCW 47.05.051).
The legislature placed additional emphasis on preservation of asphalt pavements using lowest life cycle cost principles by inserting the following language in recent budget bills:

“The department of transportation shall continue to implement the lowest life cycle cost planning approach to pavement management throughout the state to encourage the most effective and efficient use of pavement preservation funds. Emphasis should be placed on increasing the number of roads addressed on time and reducing the number of roads past due.”

WSDOT’s Pavements Management Division uses three types of measures (see below) to evaluate pavement condition for rehabilitation scheduling. These include surface distresses (cracking, patching etc.), rut depth and roughness (Photo 4) as characterized by international roughness index (IRI). A specialized vehicle is used to measure pavement condition while traveling at highway speeds. It collects high-resolution digital images (for subsequent distress rating), profile (for roughness) and rutting data annually on all state highways. Trained technicians play back the digital images on special workstations at slow speeds and identify surface distresses. Quality assurance and control processes are applied throughout the rating process to verify and validate the accuracy of the distress data.

Washington uses a lowest life cycle methodology to carefully evaluate the state highways surfaced with flexible pavements, and to develop a roadway rehabilitation schedule. WSDOT incorporates this methodology into the pavement management system to develop a list of roadways that are due for rehabilitation, or will be due at some point in the future. Field investigations confirm these assessments. This methodology is not as accurate for predicting PCCP rehabilitation cycles.

Strategies for Preserving Highway Pavements

WSDOT places emphasis on preserving highway pavements by maintaining, and extending the life of existing system — accomplishing one of the essential transportation system policy goals established by the legislature. The department also continues to improve the quality, effectiveness, and efficiency of the pavement system preservation, achieving another important policy goal of stewardship. The strategies for preserving highway pavements described in this sub-chapter are instrumental to fulfilling our commitment to these policies.

Photo 4

The Washington State Pavement Management System (WSPMS) plays a pivotal role in identification and prioritization of roadway preservation needs and projects. As part of this process, annually WSDOT collects, rates and analyzes pavement surface condition data for the entire state highway system. The three types of condition measures used for evaluation are shown below.

**Pavement Structural Condition (PSC).** This measure is based on cracking, patching, etc. A roadway should be considered for rehabilitation when PSC is between 40 and 60.

**Rutting** is caused by heavy traffic or studded tire use. Ruts greater than 1/3 inch deep require rehabilitation.

**Roughness** is characterized by international roughness index (IRI). A roadway should be rehabilitated when IRI is between 170 and 220 inches per mile.
Each segment of state highway is assigned a year where the projected cost will be at the lowest cost for rehabilitation. This is known as the “due year.” If the highway segment is not rehabilitated during its due year it becomes “past due.” The Department uses the WSPMS information to determine when the roadway pavement sections have reached the “due” year and need to be rehabilitated to prevent additional deterioration which may result in either increased maintenance costs or added rehabilitation costs. Some roadway segments may actually be in the “past due” category for a few years without accruing significantly higher rehabilitation costs, but other segments may experience higher costs within one to two years, depending on climate and traffic volumes.

**Chip seal pavements** are maintained at the lowest life cycle cost in the pavement preservation program. These pavements generally require rehabilitation every six to eight years and provide a very durable surface for low volume roadways (typically less than 4,000 vehicles per day with less than 15 percent truck traffic) where adequate sub-base exists.

For **hot mix asphalt pavements**, a range in pavement life of eight to 18 years is typical in Washington State. On average, western Washington HMA pavement life is 16.5 years, whereas eastern Washington’s pavement life is 11.3 years, and the statewide average is 14.7 years. The range in pavement life between eastern and western Washington is primarily due to the severe winter cold and extreme summer heat experienced in eastern Washington. HMA pavement is susceptible to aging, cracking and rutting caused by temperature extremes.

High volume intersections with stop and go traffic provide a different challenge. Typically stop and go conditions, extreme weather, heavy traffic, and downhill grade cause severe damage to the hot mix asphalt pavements on those intersections. Using **PCCP at high volume intersections** has shown to be cost effective over the pavement’s life, as well as eliminating the need for periodic overlays.

Ramps and auxiliary lanes are similar to the HMA intersections but these have longer life.

There is an enormous task at hand with PCCP. Originally, PCCP was designed for only a 20-year life. To date, approximately 80 percent of the concrete pavement in Washington State is more than 20 years old (Figure 7 and Table 2). In addition, PCCP carries two to five times more traffic than engineers’ anticipated in the original design.

Over the last 40 or more years, a number of PCCP design and performance issues have been evaluated. WSDOT believes that with today’s technology it is possible to construct a PCCP that will perform for 50 or more years with minimal rehabilitation. WSDOT

---

**Table 2. Statewide PCCP Age***

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Total Lane Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>87.51</td>
</tr>
<tr>
<td>11-20</td>
<td>318.91</td>
</tr>
<tr>
<td>21-30</td>
<td>541.19</td>
</tr>
<tr>
<td>31-40</td>
<td>540.37</td>
</tr>
<tr>
<td>41-50</td>
<td>375.91</td>
</tr>
<tr>
<td>51-60</td>
<td>12.35</td>
</tr>
<tr>
<td>61 or more</td>
<td>36.07</td>
</tr>
<tr>
<td>Not identified</td>
<td>65.39</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,977.69</strong></td>
</tr>
</tbody>
</table>

*Note: The PCCP lane miles total does not include special use, grade-separated HOV, PCCP intersections, or ramps.*
envision that future rehabilitation will be required to repair the damage caused by studded tires. Banning studded tires would not only lengthen pavement life, improve pavement ride, and reduce pavement noise, but would also reduce costs and future traffic disruptions due to pavement rehabilitation.

The majority of PCCP is on the more heavily traveled areas of the interstate highway system. Pavement rehabilitation work inconveniences the traveling public and creates high traffic management costs while construction is underway. A PCCP that is faulted, but not cracked, can usually be rehabilitated by dowel bar retrofit and diamond grinding.

Due to the high cost for the rehabilitation of concrete pavement, selective panel replacement combined with overlay will be required due to limited funds. Additionally, for PCCP rehabilitation projects, WSDOT policy is not to include retrofitting of existing environmental needs such as fish passages, storm water, or noise. Replacing or rehabilitating these features may not make a big change in performance. Funding is better spent on targeted environmental investments (see the Health and the Environmental section). Until recently, WSDOT has not needed to rehabilitate major sections of PCCP over the last 20 to 30 years. Unfortunately, that luxury no longer exists. Concrete pavement that is severely cracked may be beyond rehabilitation and may require complete reconstruction. It will take time and a considerable dedicated funding source to bring the PCCP to the same level of service that WSDOT strives to obtain for our other roadways.

Over the past three years an improved pavement management methodology was implemented. It is more efficient, cost-effective and consistent with Washington law, passed by the 2003 Legislature that emphasized the lowest life cycle cost principles. Pavement Management has been supported by years of experience and research, as well as collaboration with national and international professional technical organizations such as the University of Washington, AASHTO, World Bank, and FHWA. The strategies discussed in the following pages of this section came about as a result of this intensive coordination and collaboration. Two key goals emerged as a result of this work for new flexible pavement methodology:

- Reducing the annualized cost of a pavement by optimizing the pavement design.
- Applying BST on some roadways traditionally paved with HMA by alternating cycles of chip seals followed by HMA surfacing. This does not affect WSDOT’s policy regarding paving within city/town limits as city and town streets will continue to be paved with the HMA.

A few critical areas requiring further research include:

- Refining the selection criteria for cost-effective methodologies using BST and HMA in alternating paving cycles.
- Predicting the life of concrete pavement including the development/refinement of the concrete performance curve will enable WSDOT to estimate the number of miles of concrete pavement needing replacement in the next 20 years.

Prioritization

As funds become tighter, WSDOT continues to search for and analyze better, more cost-effective pavement management methodologies consistent with current legislation.

If there are not enough funds to rehabilitate all the pavements according to the lowest life cycle cost averages, rehabilitation needs are ranked in the following order to minimize additional deterioration and potential future cost increases:

- Construction in progress
- Chip seal
- Emergent concrete (based on HQ WSDOT Materials Lab approval)
- Due HMA
- Pave due HMA miles with chip seal on identified sections. Apply savings to:
  - Past due HMA
  - Ramps and/or concrete (based in HQ WSDOT Materials Lab approval)
  - Intersections
- Concrete (non emergent) replacement/rehabilitation
Chip seals are prioritized first because of their low cost-per-mile to pave when “due,” compared to a rehabilitation project when “past due.” The additive cost of deferring chip seal “past due” pavement can be very high as it may exceed 10 times the cost of the project when it is due.

There is an emerging need for rehabilitation/reconstruction of PCCP – these pavements are disproportionately represented in future “poor condition” pavement miles. The funding approved by the Legislature has been adequate to cover asphalt and chip seal repaving needs, but fall far short of funding PCCP rehabilitation/reconstruction needs.

Therefore, it is WSDOT’s intent to evaluate each heavily traveled intersection and determine the appropriateness and life cycle cost to reconstruct these intersections with concrete. WSDOT has estimated that approximately 130 intersections may be appropriate for PCCP at an estimated cost of $500,000 per intersection.

**Performance Measures**

In the next 20 years, the WSDOT Pavement Strategies will be focused on three main categories, i.e.:

- Asphalt pavement preservation
- Pavement strengthening
- PCCP rehabilitation

It will include the following performance measures:

- Elimination of the backlog of past-due asphalt pavements.
- Maintaining a lowest life-cycle cost schedule for those pavements.
- Maintaining chip seal pavements at lowest life-cycle cost.
- Pavement structure strength will be maintained to adequately handle traffic volumes and truck loads on highways and intersections.

- The rehabilitation of high priority interstate PCCP sections.
- The rehabilitation of high priority non-interstate highway PCCP

In the long term, the annualized costs of pavement preservation in the state will be reduced and the traveling public will benefit from smoother rides and shorter travel times as there will be less closures due to maintenance.

**Maintenance and Operation**

As inventory of paved miles, ramps, and other paved surfaces are added to the highway system through the construction program, they will need to be maintained in order to keep them in good, working condition. This typically includes patching potholes, digging out and patching area of distressed pavement, and sealing pavement cracks.

Certain maintenance treatments on pavements will help hold the road together between preservation treatments and reconstruction projects. Some maintenance treatments will be more focused on immediate traveler safety (i.e., patching potholes) while others focus on extension of the pavement life (i.e., crack sealing). Through improved information management and decision making, the selection and timing of maintenance treatments is becoming better coordinated with the pavement preservation program.
Bridges and Structures

Structures Overview

Preservation is a statewide goal to keep transportation facilities in sound operational condition. The objective is to achieve the best long-term financial investment for a transportation facility and prevent failure of the existing system. In addition, the bridge preservation program aims to “perform the right work on the right bridge at the right time.”

WSDOT is responsible for managing an inventory of nearly 3,500 bridges and structures. These structures (see Figure 8 and Table 3) carry vehicle and pedestrian traffic over or under other roadways or natural features.

Description of the Issue

WSDOT manages all state-owned bridges using the Washington State Bridge Inventory System (WSBIS). It is WSDOT policy that structural condition of 95 percent of its bridges rate fair or better, meaning that all primary structural elements are sound. The condition rating is based on the structural sufficiency standards established in the FHWA “Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation’s Bridges” (NBIS). This rating relates to the evaluation of bridge superstructure, deck, substructure, structural adequacy and waterway adequacy.

When a bridge is built, it is given a design life of 75 years. The average age of state-owned vehicular bridges is now 40 years. WSDOT built a significant number of bridges during the Interstate Program in the 1950s and 1960s and many of these bridges are now over 50 years old. Most of these bridges are in good to fair condition which is a testimony to sound engineering practices and durable materials; however, age alone is not an indicator of overall bridge condition.

Bridge inspections provide the information needed to determine the condition of a bridge and if any repairs are necessary. The frequency of the inspection and the information gathered during the inspection is defined by the Federal Highway Administration (FHWA) in the NBIS guide.

Most bridges are inspected every two years. Some bridges are inspected every year due to their condition and design type. A few structures require a more frequent inspection cycle, such as the Alaskan Way Viaduct which is inspected every six months. Inspections include all vehicle-carrying bridges, ferry terminals, cables on floating bridges, sign bridges and any structure that has been damaged by a vehicle or vessel. If a repair is deemed necessary, then engineers review the repair options and put together a scope of work. If the

Table 3. State Owned Structures Inventory

<table>
<thead>
<tr>
<th>Structure</th>
<th>No. of Bridges</th>
<th>Square Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicular Bridges (over 20 ft. long)</td>
<td>2,978</td>
<td>43,564,680</td>
</tr>
<tr>
<td>Structures less than 20 ft long</td>
<td>263</td>
<td>n/a</td>
</tr>
<tr>
<td>Border Bridges (maintained by border state)*</td>
<td>6</td>
<td>n/a</td>
</tr>
<tr>
<td>Culverts greater than 20 ft in length</td>
<td>90</td>
<td>n/a</td>
</tr>
<tr>
<td>Pedestrian Structures</td>
<td>57</td>
<td>249,730</td>
</tr>
<tr>
<td>Tunnels and Lids</td>
<td>38</td>
<td>739,381</td>
</tr>
<tr>
<td>Ferry Terminal Structures</td>
<td>45</td>
<td>248,443</td>
</tr>
<tr>
<td>Railroad Bridges</td>
<td>5</td>
<td>n/a</td>
</tr>
<tr>
<td>Buildings (I-5 Convention Center)</td>
<td>1</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,483</strong></td>
<td><strong>44,802,234</strong></td>
</tr>
</tbody>
</table>

Maintenance and preservation costs are shared by the states

Source: WSDOT Bridge and Structures Office - October 2006

![Figure 8. Number of Bridges by Year Built](image-url)
repair is within the parameters of maintenance activities, then the maintenance program will repair the damage. For each bridge, the preservation need is prioritized and ranked against all bridge needs statewide according to degree of risk and damage. This prioritization process occurs every two years.

WSDOT’s Bridge and Structure Preservation Program is addressed in three distinct categories: Bridge Preservation, Catastrophic Reduction, and Bridge Replacement and Major Rehabilitation. Bridge Preservation is further divided into more refined sub-categories: Special Repair, Bridge Deck, Scour, Painting, and Miscellaneous Structures. All categories consist of implementing cost-effective investments that extend the service life of the structure.

**Bridge Preservation**

**Special Bridge Repair/Major Repair/Movable Bridge Repair**

Our goal is to address major bridge repair needs that are beyond routine maintenance in a timely manner to ensure public safety and avoid costly future rehabilitation (see Figure 9 and Photo 5). Maintenance repairs will maintain the operating integrity of a bridge between preservation treatments and reconstruction jobs. Through information sharing and decision making, maintenance treatments are coordinated with the bridge preservation program.

**Special Bridge Repair/Major Repair/Movable Bridge Repair Needs**

This work differs from rehabilitation in that major repair projects are not intended to address all the deficiencies of a bridge. Major bridge repairs address (see Figure 10) specific bridge elements such as deteriorated concrete columns, replacing rusty anchor cables on floating bridges, and repairing or replacing expansion joints. This category also includes any work performed on moveable bridges.
Special Bridge Repair/Major Repair/Movable Bridge Repair Strategies

These types of repairs are prioritized based on engineering analysis and evaluation performed by WSDOT bridge engineers. They consider a multitude of criteria to assist in their decisions for which bridges are to be repaired. They consider safety to the public, continued maintenance costs, life expectancy of the bridge and replacement costs if the bridge is to be replaced earlier than anticipated.

The state owns and maintains 17 movable span bridges (see Figure 11 and Photo 6) and shares the funding responsibility for three additional bridges with Oregon and Idaho. Most of these structures are over 50 years old and have obsolete mechanical and electrical systems. Over the past 10 years, we have been upgrading these bridges to ensure that the lift spans do not fail and impede either roadway or waterway traffic. Sixteen movable bridges have been overhauled with one remaining.

Moveable bridges receive a comprehensive inspection on a five-year cycle. These inspections are performed by a consultant that specializes in these types of bridges. The findings and recommendations are then reviewed by bridge engineers dedicated to movable bridges.
I. Preservation > Bridges and Structures

A plan is developed for each structure to determine the short term (maintenance) and long term rehabilitation needs. A key element in determining whether a bridge is to receive funding for repairs is the reliability and user needs of the bridge. As part of determining a solution for these unique bridges, a replacement alternative for high-level fixed span bridges may be considered. This cannot be a viable solution at all the locations due to topographic constraints and funding restraints. Since it is not feasible to replace all of these bridges, it becomes imperative to extend the service life of the bridge and to minimize the frequency of roadway closures due to mechanical or electrical malfunctions. The goal is to keep the electrical and mechanical components of these bridges in sound operational condition. From this effort all but one bridge has been overhauled. The remaining bridge in this category that has not been overhauled is US 101 Hoquiam River at Riverside.

**Steel Bridge Painting**

Protective paint coatings on steel bridge elements are essential to prevent corrosion and loss of structural load carrying capacity needed for freight movement. Our goal is to preserve the load carrying capacity of steel bridges by maintaining properly functioning paint systems that provide protection against corrosion.
**Steel Bridge Painting Needs**

A three part paint system is used to overcoat the existing paint on steel (see Figure 12 and Photo 7). Some other states, like Oregon, prefer to remove all the existing paint before adding a new paint system. This process tends to be two or three times more expensive than WSDOT's overcoating method.

**Steel Bridge Painting Strategies**

Our policy is to repaint steel bridges when approximately two to five percent of the existing steel surface area is exposed. The amount of time it takes a bridge to reach this condition depends on the type of paint, bridge type, and geographic location of the bridge. Generally a paint system will last 15 to 20 years before repainting is required. Since 1991 new steel bridges have been painted with a three part zinc-moisture cured polyurethane paint system that will last longer than previously used paint systems.

WSDOT maintains 282 painted steel bridges on the state highway system. There are also four steel bridges that are owned by Oregon and cross over the Columbia River. These bridges are classified as “Border Bridges” since they cross a state border. The cost to repaint Border Bridges is shared equally between Oregon and Washington.

The department has 19 unpainted weathering steel bridges. Weathering steel bridges were originally designed to resist corrosion and not require painting. Some of these bridges have experienced unacceptable levels of corrosion and will need to be addressed in the next 20 years. A single coat of clear rust penetrating sealer is used to prevent further corrosion. A sealer has been applied to four of the weathering steel bridges to date.

WSDOT uses environmentally sound practices to contain debris generated from the bridge painting process. WSDOT has an agreement with the Washington Department of Ecology and Department of Fish and Wildlife to use a filter fabric tarp during pressure washing of a bridge. This process is used on a majority of bridges depending on the amount of water flow in the river. Bridges over lakes and low water flow require full containment and off site disposal of all wash water.

WSDOT also ensures worker safety on bridge painting jobs by following new regulations and using new procedures to protect bridge workers from excessive lead paint exposure.

**Bridge Deck Preservation**

WSDOT’s goal is to ensure safe, long-lasting roadway surfaces on all reinforced concrete bridge decks by timely repair and application of durable protective bridge deck overlays. This will enable movement of freight by maintaining the load carrying capacity of bridges.

**Bridge Deck Preservation Needs**

For years, concrete bridge deck deterioration has been the single largest bridge-related problem in the country. Using salt in winter deicing practices has caused premature deterioration of many of the state’s concrete bridge decks (see Figure 13 and Photo 8). WSDOT has been working since the early
I. Preservation > Bridges and Structures

1980s on a systematic program aimed at preventing concrete deterioration. This is done by using epoxy-coated rebar in new bridges, and by repairing deteriorated and traffic-related damaged rebar with durable protective overlays on bridge decks. Repairing and overlaying deteriorated bridge decks is very cost effective compared to total deck replacements.

Bridge deck testing has been completed on all of our concrete bridge decks. This testing has determined the amount of chlorides, the location and size of any delaminations, and the concrete cover over the reinforcing steel. Deck repair and a protective overlay are required if any of the following deck testing results is found:
Bridge Deck Preservation Strategies
A modified (latex, micro silica, or fly ash) concrete overlay is the preferred protection system for bridges that meet the requirements for protective overlay. An alternative three-quarter inch thick polyester or one and one-half inch thick rapid set latex modified concrete overlay may be used if rapid construction is needed. These alternatives can cure in four hours compared to 42 hours for a modified concrete overlay. We have overlaid 552 bridges with a modified concrete overlay.

The timing for replacing a concrete deck is related to the amount and condition of previous deck repairs and the amount and nature of the traffic. Failure in previous repaired areas can eventually cause debonding (reinforcing steel separates from the concrete causing cracking), cracking, and potholes in the concrete overlay.

Miscellaneous Structures
This is the smallest category within the bridge preservation category. These projects (see Figure 14) are usually dependant on larger projects for funding. They receive stand alone funding if they become a hazard to the public.

Miscellaneous Structures Needs
Miscellaneous structures include sign support structures; high mast lights; standard and special design retaining walls; bridges less than 20 feet long (mainly culverts) and tunnels.

Miscellaneous Structures Strategies
Bridges under 20 feet and tunnels will be given precedence over all other miscellaneous structures when determining prioritization.

Sign structures are prioritized by groups based on their physical condition. Bridge engineers consider complete replacement when there is a loss of load...
bearing capacity in the main support members. Other considerations are given for fatigue cracking, foundation instability and inadequate design capacity.

**Catastrophic Reduction**

**Seismic Retrofits**

A study performed by the Federal Emergency Management Agency in 2001 found that Washington has the second highest risk for economic loss in the nation due to earthquakes. California has the highest risk. Washington has several geological faults that influence the western part of the state. The largest earthquakes in recent history occurred in 1949, 1965 and 2001 and killed 15 people. The most recent Nisqually earthquake killed one, injured 320 and caused over $2 billion dollars worth of damage.

The objectives of the seismic retrofit program are to:

- Minimize the risks of complete bridge collapse
- Minimize loss of life and disruption of commerce
- Accept moderate damage

**Seismic Retrofits Needs**

The seismic program prioritizes bridge projects based on essential lifelines that need to remain in service following a seismic event, and where the bridges are located in the seismic risk zones (see Figures 15 and 16 and Table 4). All bridges within the highest risk zone and those on Interstates in the moderate risk zone will have a higher priority and will be retrofitted first. Those bridges with single columns located in the low-moderate range will also be retrofitted after the higher risk areas have been completed.

**Seismic Retrofits Strategies**

WSDOT’s Bridge and Structures Office has changed the prioritization philosophy for identifying seismic needs. In the past, major bridges along with the superstructure of certain bridges were the first to receive retrofits, followed by bridges with single columns. Multiple column bridges and bridge foundations were the last to receive retrofits. This plan to retrofit bridges for seismic movement has reached a point where a newer strategy was needed. Therefore, more emphasis is now placed on bridge location with respect to seismic zones and design. The highest risk zone and the moderate risk zones were the first to be targeted with the Transportation Partnership Act (TPA) funds in 2005. The highest risk zone is located in central Puget Sound. All bridges that are not part of another funded project will receive funding in this high risk zone along with bridges that are in moderate risk zone on major routes. Those routes are I-405, I-90 and I-5. In addition to the bridges located in these two zones, there are approximately 20 bridges that have single columns that could sustain significant damage during an earthquake. They will remain on the priority list for retrofit until they are completed.

Our goal is to finish those bridges identified for seismic retrofit work in the high risk zone and the moderate zone on major routes first. Then the selection of bridges will begin to radiate outward from the high risk zone. The remaining bridges in the moderate risk zone with multiple columns will come next and will be based on average daily traffic (ADT). The higher the ADT, the higher the bridge will rank in priority. The last targeted zone is for bridges in the low to moderate risk zone. Bridges on I-5 in the low-moderate risk zone may have a higher priority than some smaller routes in a higher risk zone. The intent is to make key routes strong enough to withstand an earthquake so that access is maintained for emergency responders and supplies, and to evacuate people.

In the case of a major earthquake with a magnitude of 9.0 or greater, WSDOT has accepted that there will be damage. WSDOT designs to the most current standards for seismic strengthening on new bridges and retrofits its older bridges; however, it is unknown how bridges will perform in a very large earthquake.
**Scour Protection**

Scour is defined as the removal of streambed materials by high water flows. Scour can cause a bridge foundation to become unstable if an excessive amount of material under the foundation is removed.

Scour has been the cause of over one-half of the bridge failures in Washington since 1923 (see Photo 9). Of the 70 documented failures, 43 of these are a direct result of foundation scour due to flooding. In 1995, WSDOT began to identify and repair scour damaged foundations.

**Scour Protection Needs**

The amount of scour can be estimated by calculating how deep the waterway channel could become based on high water flows and channel conditions. A bridge is classified as “scour critical” when the calculated depth of the potential scour is below the bridge foundation (see Figure 17).

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**Photo 9. Bridge Scour**

SR 101 – Humptulips Bridge, Scour Repair, prior to the November 2006 storm
SR 101 – Humptulips River – Day 1 of the November 2006 storm
SR 101 – Humptulips River – Day 2 of the November 2006 storm
SR 101 – Humptulips River – Water receding after the November 2006 storm

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**Figure 17. Bridge Scour Retrofit Needs**
Scour Protection Strategies

The Scour program has been successful in finding a way to preserve the integrity of bridges during large storm events and is sensitive to the environmental concerns around the bridge. WSDOT evaluates the bridges identified as scour critical on a biennial basis. Bridge engineers in collaboration with hydraulic engineers determine the risk associated with each bridge by calculating the critical depth of scour using FHWA guidelines and the software, “HYRISK.” If a bridge is found to be at considerable risk for a catastrophic failure during a large storm event, the bridge is programmed for repair. On occasion a bridge becomes critical between the evaluation periods. If this happens, then the bridge may receive emergency funds to repair or partially repair the scour damage. When the emergency repair is a partial repair, the Department returns the following summer during the “fish window” to finish the work. A fish window is a period when work in the water is least likely to impact fish.

To assist in delivering scour projects on time and on budget, a new approach to scoping scour projects was developed with input from all internal participating support offices. This process was presented to WSDOT executives and was approved in 2005. This process calls for scour specialists to perform more up front work in order to present a defendable and permitable project to the resource agencies. This also gives clear guidance to the regional offices on the scope of work and decreases the amount of time it takes to deliver a quality project. Project costs have been difficult to estimate in the past because of increasing environmental regulations and a misunderstanding regarding compensatory mitigation. This process establishes a baseline estimate that correlates to the collaborative efforts of the scour team.

Bridge Replacement/Major Rehabilitation

The objective of the bridge replacement and major rehabilitation program is to perform necessary work when continued maintenance and preservation strategies are no longer cost effective to provide safe, continuous movement of people and goods. WSDOT has developed three strategies to prioritize bridges that require replacement or major rehabilitation. Those three strategies are structurally deficient bridges, weight restricted bridges, and narrow bridges. When looking at replacement or rehabilitation, bridges generally have a sufficiency rating of 50 or less (compared to a rating of 100 when new) and be classified as structurally deficient or functionally obsolete in order to qualify for federal bridge replacement funds (see Figures 18 and 19 and Table 5).

Bridge Replacement/Major Rehabilitation Needs

Many bridges are reaching the end of their functional lifespan. Many were not designed for the heavy loads, high traffic volumes or speeds that exist today. Bridges are replaced when continued maintenance and preservation strategies are no longer cost effective to provide safe, continuous movement of people and goods. In order to qualify for Federal Bridge replacement funds, a bridge must meet the following four criteria.

» Bridge must be on the National Bridge Inventory (NBI) list
I. Preservation > Bridges and Structures

### Table 5. Rating Bridges

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficiency Rating.</td>
<td>This is a qualitative value that measures the bridges relative capability to serve its intended purpose. The value is generated from a formula that uses inspection data required by the NBIS program. A sufficiency rating will vary from 0 to 100, with a smaller value indicating a lower sufficiency and therefore a higher need of either repair or replacement.</td>
</tr>
<tr>
<td>Structurally Deficient.</td>
<td>The bridge is in a deteriorated condition and does not adequately carry its intended traffic loads. Structurally deficient bridges have a deck or substructure code of “4” or less meaning it is in “poor” condition or a waterway adequacy code of “2” or less.</td>
</tr>
<tr>
<td>Functionally Obsolete.</td>
<td>The bridge does not have adequate approach alignment, geometry or clearance to meet the intended traffic needs and is below accepted design standards. Functionally obsolete bridges have an inspection code of “3” or less for the alignments, geometry, or clearances.</td>
</tr>
</tbody>
</table>

- Have a sufficiency rating of less than 50 to be eligible for replacement or less than 80 for major rehabilitation
- Must be structurally deficient or functionally obsolete
- Bridge cannot have been worked on in the past 10 years for either rehabilitation or replacement (new bridge) regardless of funding source.

Bridge condition can be assessed by many factors, one of which is the designation of structurally deficient or being functionally obsolete. WSDOT also use the bridge inspection report as another tool to determine the condition of the bridge. These reports are prepared every two years unless conditions make it necessary for more or less frequent inspections.

### Structurally Deficient Bridges

Bridges that are targeted for replacement or rehabilitation are not chosen on their sufficiency rating alone. There are several factors that are considered when choosing to perform the right work on the right bridge at the right time. Bridges that are structurally deficient (see Figure 20, Photo 10, and Tables 6 and 7) and have a combination of the following: on a key route, on a significant freight route, and of community significance, are placed on a potential replacement list. This list is then prioritized based on bridge condition, accident history, and when the repair should be made to gain the highest potential of the investment. As structurally deficient bridges continue to deteriorate they will eventually become posted with weight limits.

The aging of our timber bridges that are structurally deficient is an emerging trend that is of special concern. There are a total of 30 state-owned timber bridges built with all timber components, or a combination of steel, concrete and timber, that are structurally deficient. These timber bridges are deteriorating and will need rehabilitation or replacement in the future. Of the 78 bridges that are designated as structurally deficient, 30 (38 percent) of them are timber or have timber elements.

WSDOT does not replace a timber bridge just because it is timber; instead we analyze additional elements to determine priorities for rehabilitation or replacement. These elements include the approach geometrics to the bridge, width of the bridge, weight

### Table 6. Structurally Deficient Bridges by State

<table>
<thead>
<tr>
<th>Rank</th>
<th>State</th>
<th>State Owned Bridges</th>
<th>Total Struct. Def. Br</th>
<th>% SD Bridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arizona</td>
<td>4,469</td>
<td>32</td>
<td>1%</td>
</tr>
<tr>
<td>2</td>
<td>Florida</td>
<td>5,295</td>
<td>56</td>
<td>1%</td>
</tr>
<tr>
<td>3</td>
<td>Texas</td>
<td>32,086</td>
<td>554</td>
<td>2%</td>
</tr>
<tr>
<td>10</td>
<td>Washington</td>
<td>3,080</td>
<td>106</td>
<td>3%</td>
</tr>
<tr>
<td>15</td>
<td>Arkansas</td>
<td>7,084</td>
<td>322</td>
<td>5%</td>
</tr>
<tr>
<td>20</td>
<td>Iowa</td>
<td>3,972</td>
<td>212</td>
<td>5%</td>
</tr>
<tr>
<td>25</td>
<td>Mississippi</td>
<td>5,537</td>
<td>379</td>
<td>7%</td>
</tr>
<tr>
<td>30</td>
<td>New Hampshire</td>
<td>1,285</td>
<td>110</td>
<td>9%</td>
</tr>
<tr>
<td>35</td>
<td>Hawaii</td>
<td>704</td>
<td>69</td>
<td>10%</td>
</tr>
<tr>
<td>40</td>
<td>Puerto Rico</td>
<td>1,812</td>
<td>208</td>
<td>11%</td>
</tr>
<tr>
<td>42</td>
<td>Oregon</td>
<td>2,661</td>
<td>314</td>
<td>12%</td>
</tr>
<tr>
<td>45</td>
<td>North Carolina</td>
<td>16,531</td>
<td>2,204</td>
<td>13%</td>
</tr>
<tr>
<td>50</td>
<td>Vermont</td>
<td>1,077</td>
<td>193</td>
<td>18%</td>
</tr>
</tbody>
</table>

Source: 2005 FHWA National Bridge Inventory
Figure 20. Bridge Replacement/Major Repair Needs

Table 7. Bridge Structural Condition Ratings

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>A range from no problems to some minor deterioration of structural elements.</td>
<td>84%</td>
<td>85%</td>
<td>87%</td>
<td>86%</td>
<td>87%</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>Fair</td>
<td>All primary structural elements are sound but may have deficiencies such as minor section loss, deterioration, cracking, spalling, or scour.</td>
<td>11%</td>
<td>11%</td>
<td>10%</td>
<td>11%</td>
<td>10%</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Poor</td>
<td>Advanced deficiencies such as section loss, deterioration, cracking, spalling, scour, or seriously affected primary structural components. Bridges rated in poor condition may be posted with truck weight restrictions.</td>
<td>5%</td>
<td>4%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>2%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Source: Gray Notebook, June 30, 2006
restrictions if applicable, and other preservation needs, such as scour, paint or any other strategy. The more items that are deficient with a timber bridge, the higher the ranking on the replacement/rehabilitation list.

**Weight Restricted Bridges**

There are 155 bridges that have a weight restriction. Weight restricted bridges (see Figure 21) make it difficult for freight and goods to move about the state. The main criteria for identifying which bridges to replace in this category are route importance and community connectivity. Bridges that are on a major freight route are moved to the top of the priority list. If there are weight restricted bridges that hinder goods movement into or out of a community and there is no other feasible route to take, then these bridges are also placed on the list for replacement.

**Narrow Bridges**

Bridges targeted for replacement in the narrow bridge category are those that are 24-feet wide or less (see Photo 11), have poor approach geometrics, poor stopping sight distance, of a safety concern, and have community importance. Narrow bridges usually fall into the functionally obsolete category. These bridges are no longer performing as they were intended and designed because of changing traffic patterns. A majority of the functionally obsolete bridges have narrow lanes, narrow or no shoulders, poor sight distance and do not accommodate pedestrian or bicycle traffic. These bridges are usually older and built in the 1930s and 1940s using past design standards. There are 22 narrow bridges that should be replaced in the next 20 years.

The currently programmed Chehalis River Bridge is a very good example of the types of narrow bridges that would receive funding for replacement. The bridge was built in 1925 and is 20 feet wide. As the picture shows, the bridge is so narrow that some people are reluctant to be on the bridge when a truck is crossing the bridge in the opposite direction. This particular bridge received TPA funding for replacement and will be replaced in 2009.
Performance Measures

WSDOT reports the condition of its bridges to both the Federal Highway Administration (FHWA) and the State Office of Financial Management (OFM). The report follows the standards set forth by the Governmental Accounting Standards Board (GASB) and the bridge ratings follow the criteria set forth by the FHWA. WSDOT has established a goal to maintain 95 percent of its bridges at a structural condition of “Good” or “Fair.” The 2006 assessment of bridges are within these parameters. Bridges rated as “poor” may have structural deficiencies that restrict the weight and type of truck traffic allowed. The 2006 assessment found 2.5 percent of all bridges (rounded to three percent) received a rating of “Poor.” No bridge that is currently rated “poor” is unsafe for public use. Any bridge that is determined to be unsafe for public use is simply closed to all traffic.

Security

WSDOT is involved in discussions with state emergency officials to determine what, if any, measures might be needed to ensure our transportation system functions during a statewide emergency.
**Coordination and Involvement**

Coordination is ongoing with the Bridge Management office to gain knowledge and information about the bridge preservation program for inclusion into various presentations, papers and folio’s.
Other Highway Assets

This section contains several different categories of projects. Each is unique and is treated differently for planning and budgeting.

These categories are:

» Safety Rest Area Preservation
» Major Drainage System Rehabilitation
» Highway Slopes and Embankments
» Major Electrical System Rehabilitation
» Weigh Station Replacement and Preservation

In each section that follows, we will define the issues, identify the need, describe strategies to address the needs, and discuss performance measures used to evaluate the effectiveness of the strategies.

Maintenance Strategies and Goals

Our overall goal of maintenance is to “retain the highway system in a condition as near as possible to the condition of its initial construction or subsequent improvement.” In addition, the February 2002 Washington State Patrol/WSDOT “Joint Operations Policy Statement” was developed to stress the importance of the agencies’ responsibility to do whatever is reasonable to reduce delays associated with incidents.

With these goals and the policy in mind, WSDOT’s Maintenance will:

» Clear roadways of rocks or other debris
» Build up embankments
» Maintain rest area facilities until they reach the point of failure
» Temporarily patch pavement over failing culverts
» Replace electrical parts
» Patch weigh station pavements

These activities are done in an ongoing effort to reduce delay to the traveling public until a permanent fix can be applied.

Emergency Preparedness

Emergency preparedness and response are important elements in the operation of the highway system. A key element of this is planning for traffic movement in the event that highways are damaged and unusable. For immediate response purposes, the designation of alternate routes and the development of evacuation plans are important issues. For long-term planning, any substandard structures on evacuation routes should be identified and targeted for improvements. Mitigation measures defined through the vulnerability assessment process should also be implemented to protect critical infrastructure across the highway system. For all of these issues, communication systems and equipment are critical.

Safety Rest Area Preservation

Washington’s safety rest areas are conveniently (see Photo 12) located. They provide the opportunity for traveler’s to rest and take a much-needed break to increase alertness and safety during long trips.

WSDOT prioritizes planned facilities based on locations where collisions due to fatigue are occurring, and where no nearby rest facilities (public or otherwise) are present. Sleepy driving and inattentive driving are among the leading causes for vehicle collisions in Washington State. Together they account for 20 percent of all fatal accidents from 1993 to 2001. Unfocused drivers are a danger to themselves, their passengers, and other drivers.
Safety rest areas offer an opportunity for sleepy and inattentive drivers to get off the road and rest along highways that otherwise have no good stopping points such as all-night restaurants.

Over 20 million travelers stop at Washington’s 42 safety rest areas annually. All safety rest areas are handicapped accessible and provide a wide range of motorist services with most providing car, truck, and recreational vehicle parking; clean rest rooms; drinking water; traveler information; picnic areas; vending machines; and pet exercise areas.

Twenty-six of Washington’s safety rest areas offer travelers a unique welcome service called the Free Coffee Program which allows non-profit organizations to provide travelers with coffee and light refreshments at no charge.

The Washington State Legislature established the Recreational Vehicle (RV) Program in 1980. This program annually collects $3.00 per recreational vehicle (camper, travel trailer, and motor home) licensed in the state of Washington. Funds are deposited into a dedicated account that supports construction, maintenance, and operation of RV sanitary disposal systems at safety rest areas. WSDOT administers the RV Program and works with the RV Citizen’s Advisory Committee to define and prioritize recreational vehicle owners’ needs.

The RV Dump Program provides the traveling public with an environmentally safe repository for RV waste and potable drinking water in WSDOT safety rest areas. WSDOT owns, operates and maintains 19 RV Dump Stations within the 42 safety rest areas statewide (see Figure 22).

**Needs**

*Inventory of Safety Rest Areas*

WSDOT is responsible for 42 safety rest areas; 27 of which are located on the Interstate system. These facilities contain a total of 555 acres, 83 buildings, 29 on-site public drinking water systems, 36 on-site sewage treatment/pretreatment systems and 19 RV dump stations.
With the exception of Blue Lake on SR 17 at milepost 89 in Grant County which requires winter closures, all are open 24/7.

WSDOT performs a building and site condition assessment biennially to identify functional component deficiencies. WSDOT places a numerical rating based on guideline criteria on each functional component (such as the roof, wall tiles, etc.), and gives critical functional components a weighted multiplier in the overall evaluation. The combined total building and site ratings are used to define each facility’s overall condition and helps with strategic planning and program prioritization.

**Strategies**

**Approaches to Rest Area Preservation**

Washington’s safety rest area program began in 1967, with most of the construction completed by 1978. Many of these facilities are approaching 30 years of life. Some need to be updated for compliance with current sewer and water standards (see Photo 13). Others need replacement because of high maintenance costs due to age and high usage.

We maintain rest areas between preservation treatments and reconstruction projects. As much as possible, our maintenance activities are conducted to maximize the lifespan of rest area facilities. As rest areas are added to the highway system through the Highway Construction Program, they will need to be maintained in order to keep them in good, working condition. This typically includes minor building repair, plumbing and electrical system maintenance, and janitorial and grounds-keeping activities.

Preservation of a safety rest area consists of the following:

1. Utilities include replacing, refurbishing or rehabilitating sewer, water and electrical systems to meet regulatory requirements or reduce maintenance costs.
2. Building consists of replacing, refurbishing or rehabilitating building components (roof, doors, surfaces, and fixtures) to meet regulatory requirements or to extend service life.
3. Site (parking, lighting, landscaping) includes replacing, rehabilitating or refurbishing site components and systems to meet regulatory requirements, meet demand, improve security and safety or minimize maintenance costs.

**Prioritization Process**

The safety rest area program has three primary deficiency groups. Emphasis is placed on utility (sewer, water, and electrical) needs first with building second and site work last.

In addition, maintenance and operational costs and the number of visitors are factors in the prioritization process.
Performance Measurement
WSDOT has maintained Interstate safety rest areas at a rating of “good condition” since 1999. A safety rest area is considered in good condition if all features (such as soap dispensers or RV dump stations) are in working order, landscaping is trimmed, with only a small amount of litter, weeds, or minor defects in sidewalks or parking areas.

Safety rest areas close for varying reasons, some are seasonal. From December 1, 2005 through November 30, 2006, rest area closures occurred about 3.5 percent of the time. Normal seasonal closures accounted for 3 percent. The remaining 0.5 percent of closures were due to various problems with water and sewer systems in the older facilities, and scheduled maintenance shutdowns of the Gee Creek and Toutle River rest areas.

Major Drainage System Rehabilitation
A drainage control system is a complex system which may include:
- Culverts or other drainage structures
- Connected streams in the watershed
- Wetlands
- Ditches
- Manmade detention or retention basins
- Pervious and impervious surfaces
- Other means of controlling and mitigating stormwater runoff and impurities from roadway surfaces.

A drainage system as defined by this discussion is that portion of the overall system that lies within the roadway embankment.

Needs
Inventory of Drainage Systems at Risk of Failure
WSDOT is early in the process of developing a statewide inventory of drainage system conditions. This information will enable WSDOT to more effectively manage drainage system preservation.

Approaches to Preventing Drainage System Failure
WSDOT inspects drainage systems (see Figures 23 and 24) at least once a year and we may perform additional inspections during heavy storms and periods of high runoff in order to determine the effectiveness of the system. During an inspection, WSDOT examines the inlet and outlet condition, as well as the culvert interior. Recently WSDOT purchased new camera equipment (see Photo 14) specifically for culvert inspection which will make the process more efficient.

WSDOT routinely inspects the condition of pavements for signs of damaged or weakened culverts. Pavement failure above a culvert is an indicator of impending failure due to water getting around or through the culvert wall, washing soil out of the embankment and causing the settlement.

Photo 14. Pipe Inspection by Rover©
Envirosight Inc. Rover© 900 pipe inspection crawler with lights and camera as purchased by WSDOT. The first culvert to be inspected using the new crawler and camera. Crew with motorized cable reel which is attached to the crawler and camera, supplying video feed to the monitor and recorder.
Strategies
As drainage systems age, routine inspection and eventual replacement must be planned to ensure these systems remain in good working condition. Drainage system rehabilitation may also be addressed by other highway construction projects.

WSDOT intend to develop a specific budget category for replacement of deteriorated culverts.

Prioritization Process for Selecting Projects
WSDOT is currently in the process of collecting drainage location, kind and general condition in a Roadside Inventory database. WSDOT Maintenance will be collecting condition data in the field and downloading into the database. This should result in a more comprehensive list of needs that will reduce the incidence of sudden drainage failures.

Performance
The economic and societal impacts of drainage failure can be enormous. Road closures and detours are a direct result of pavement failure due to drainage failures, sometimes lasting several days to weeks. The performance measure in this case is a reduction in the number of road closures drainage failure.

Highway Slopes and Embankments
WSDOT has identified 2,630 slopes that have the potential to adversely affect highway travel (see Photo 15). WSDOT’s Unstable Slope Management System began in 1995 to collect information about and to mitigate unstable slopes that present potential hazards to the state highway system. The Unstable Slopes Category in the Preservation Program provides a way for the Legislature to correct conditions and mitigate risks presented by such hazards.

Slope instability is classified into five categories:

- **Rock fall** is the fall of newly detached segments of bedrock of any size from a cliff or steep slope. The rock fall descends mostly through the air by free fall, bouncing or rolling. Movements are rapid and may not be preceded by minor movements.

- **Landslides** are the vertical and horizontal displacement of soil mass within a slope or embankment. Generally landslides can be divided into two categories, circular and sliding block failures. The rate of movement of landslides can vary from very slow moving to very rapid and vary in size from small cut slope failures to large failures many miles in area.

- **Debris flows** are a rapidly moving fluid mass of rock fragments, soil, water, and organic material with more than half of the particles being larger than sand size. Generally debris flows occur on steep slopes or in gullies and can travel long distances. Debris flows may result from unusually high rainfall, or rain on top of snow events and are characterized by fluid mixtures of water, soils and vegetative matter including trees.

- **Settlement** is the vertical displacement of a soil mass not associated with a horizontal movement within a slope or embankment. Generally movement is slow. Soil piping occurs when erosion of the subsurface soil, associated with groundwater flow, causes failure of the soil. (Soil piping is a particular form of soil erosion that occurs below the soil surface. It is associated with levee and dam failure as well as sink hole formation.)

- **Rock fall** is the fall of newly detached segments of bedrock of any size from a cliff or steep slope. The rock fall descends mostly through the air by free fall, bouncing or rolling. Movements are rapid and may not be preceded by minor movements.

Photo 15.

A large wedge failure involving up to 500 cubic yards occurred on September 11th, 2005 on Interstate 90 west of Snoqualmie Pass resulting in debris covering all three lanes and a single vehicle – triple fatality accident. In addition to the slope area from where the wedge failure initiated, similar wedge features in the adjacent slope areas were stabilized with slope scaling and rock anchors.
» **Slope erosion** is the wearing away of a soil mass by the actions of running water. On slopes this process can result in the overland flow of water in an unconfined sheetwash, or the development of rills (e.g., small grooves or channels in soil slopes). Along streams or rivers the process can cause the near vertical undercutting of the adjacent stream or river bank.

### Needs

WSDOT uses a database called the Unstable Slope Management System which helps manage all known unstable slopes. A numerical rating assigns a score from 33 (lowest) to 891 (highest). Slope rating is based on 12 variables as shown in Table 8.

### Inventory of Unstable Slopes

Of the unstable slopes in the Unstable Slope Management System, 43 percent are rock fall, 28 percent are slope erosion, 16 percent are landslides, nine percent are settlement and debris flow is four percent. Figure 25 shows location of unstable slopes by type of deficiency.

### Strategies

#### Approaches to Slope Stabilization

Mitigation measures vary for each type of failure:

- **Rock Fall** – Scaling (removing rock), bolting or doweling, installing drainage, installing wire mesh fabric and constructing catchment ditches (enlarged ditch) or walls, or avoiding the area by realignment of the roadway.

- **Landslide** – Reducing driving forces by removing material from the upper portion of the unstable slide mass (slope flattening by regrading) and replacing with lightweight materials. Increase the resisting forces at the bottom of the slide by constructing buttresses, berms or retaining walls with or without ground anchors. Improve surface and subsurface drainage by installing horizontal drains, or avoidance by realignment of the roadway.

- **Debris Flow** – Contain the flow using oversized drainage structures or avoidance by realignment of the roadway.

### Table 8. Unstable Slope Numerical Rating System

<table>
<thead>
<tr>
<th>Category</th>
<th>Points = 3</th>
<th>Points = 9</th>
<th>Points = 27</th>
<th>Points = 81</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem Type:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>Cut or Fill</td>
<td>Settlement</td>
<td>Slow Moving</td>
<td>Rapid Landslides or Debris Flow</td>
</tr>
<tr>
<td>Slope Erosion</td>
<td>Slope Erosion</td>
<td>Piping</td>
<td>Landslides</td>
<td></td>
</tr>
<tr>
<td><strong>Problem Type:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rock</td>
<td>Minor Rock fall</td>
<td>Moderate Rock fall</td>
<td>Major Rock fall</td>
<td>Major Rock fall No Catchment</td>
</tr>
<tr>
<td>Good Catchment</td>
<td>Fair Catchment</td>
<td></td>
<td>Limited Catchment</td>
<td></td>
</tr>
<tr>
<td><strong>Average Daily Traffic:</strong></td>
<td></td>
<td>5,000 to 20,000</td>
<td>20,000 to 40,000</td>
<td>&gt; 40,000</td>
</tr>
<tr>
<td><strong>Decision Sight Distance:</strong></td>
<td>Adequate Sight</td>
<td>Moderate Sight</td>
<td>Limited Sight</td>
<td>Very Limited</td>
</tr>
<tr>
<td>Distance</td>
<td>Distance</td>
<td>Distance</td>
<td>Distance</td>
<td>Sight distance</td>
</tr>
<tr>
<td><strong>Impact of Failure on Roadway:</strong></td>
<td>&lt; 50 Feet</td>
<td>50 to 200 Feet</td>
<td>200 to 500 Feet</td>
<td>&gt; 500 Feet</td>
</tr>
<tr>
<td><strong>Roadway Impedance:</strong></td>
<td>Shoulder Only</td>
<td>1/2 Roadway</td>
<td>3/4 Roadway</td>
<td>Full Roadway</td>
</tr>
<tr>
<td><strong>Average Vehicle Risk:</strong></td>
<td>&lt; 25% of the Time</td>
<td>25% to 50% of the Time</td>
<td>50% to 75% of the Time</td>
<td>&gt; 75% of the Time</td>
</tr>
<tr>
<td><strong>Pavement Damage:</strong></td>
<td>Minor - Not Noticeable</td>
<td>Moderate - Driver Must</td>
<td>Severe - Driver Must Stop</td>
<td>Extreme - Not Traversable</td>
</tr>
<tr>
<td><strong>Failure Frequency:</strong></td>
<td>No Failures in Last 5 Years</td>
<td>One Failure in Last 5 Years</td>
<td>One Failure Each Year</td>
<td>More Than One Failure</td>
</tr>
<tr>
<td><strong>Annual Maintenance Costs:</strong></td>
<td>&lt; $5,000 per year</td>
<td>$5,000 to $10,000 per year</td>
<td>$10,000 to $50,000 per year</td>
<td>&gt; $50,000 per year</td>
</tr>
<tr>
<td><strong>Economic Factor:</strong></td>
<td>No Detours Required</td>
<td>Short Detours &lt; 3 Miles</td>
<td>Long Detours &gt; 3 Miles</td>
<td>Sole Access No Detours</td>
</tr>
<tr>
<td><strong>Accidents in Last 10 Years:</strong></td>
<td>0 to 1</td>
<td>2 to 3</td>
<td>4 to 5</td>
<td>&gt; 5</td>
</tr>
</tbody>
</table>
I. Preservation > Other Highway Assets

- **Settlement** – Excavate the fill material and replace with low density lightweight materials such as cellular concrete or polystyrene blocks or avoidance by realignment of the roadway.

- **Slope Erosion** – Problems are not presently addressed within the unstable slope program but are included in the database. Bioengineering methods of mitigation (planting vegetation) are being implemented through research projects.

**Prioritization Process**

Unstable slopes are prioritized by rating. If there is a slope with a lower rating but is in the vicinity of a higher rated slope, it may make sense to move the lower rated slope up in the list in order to fix it at the same time and save on construction costs and disruptions to motorists.

Average Daily Traffic (ADT) is also used during this process to help refine the list. If the ADT is low, the risk is lower (fewer vehicles on the roadway, fewer vehicles within the limits of a slope and hence the chance of a slope failure while a vehicle is in the vicinity is smaller.)

With the slope rating complete, WSDOT can prepare a cost estimate to mitigate or fix the slope. The WSDOT Geotechnical Division develops the slope mitigation designs and the WSDOT Region Office adds on such things as traffic control, mobilization and other bid items. Using the slope rating and the estimate, a benefit/cost ratio can be calculated.

With this information WSDOT can assemble a list of slopes needing mitigation and their associated costs, and make decisions regarding programming.

**Performance**

Since 1985 the state highway system has experienced 21 slope failures that resulted in roadway closures in excess of one week. The minimum closure was one week with the maximum closure of one year. Landslides typically cause the longest
closures. The longest closure by a rock slide (two months) was the SR 20 – Newhalem occurrence in 2003.

The winter of 1998/99 was an especially bad year in terms of slide-related highway closures. For over six months, western Washington experienced record-breaking rainfall. In February 1999, large scale landslides began to occur in much of the region. Six routes were closed that winter and spring for up to six months.

Performance is based on reduction in the risk of accidents and roadway closures due to slope instability.

**Major Electrical Preservation**

The following list represents the types of major electrical systems that WSDOT is responsible for maintaining and operating. The primary purpose of the Major Electrical System Rehabilitation program is to keep the Systems functioning (see Photos 16 and 17) through complete system replacement or replacement of specific electronic components as necessary to maintain current operational levels.

**Major Electrical System Items**

- Traffic Signal Systems
- Ramp Metering Systems
- Illumination Systems
- Tunnel and Bridge Electrical Systems
- Dynamic Message Signs (DMS) Systems
- Highway Advisory Radio (HAR) Systems
- Closed Circuit Television (CCTV) Camera Systems
- Data Station Systems
- Permanent Traffic Recorder (PTR) Systems
- Animal Warning System
- Automatic Anti-Icing System
- Fiber Optic Communication Systems
- Communication Hubs
- Other Communication Systems, (Emergency Telephone, Ethernet, DSL, T1)
- Wireless Communication Systems
- Roadway Weather Information Systems (RWIS)
- Transit Signal Priority (TSP) Systems
- Commercial Vehicle Information Systems and Networks (CVISN) Program / Weigh In Motion Systems
- Statewide Traveler Information Systems (Web, 511, Traffic TV)
- Traffic Management Centers (TMC), (Electronic Equipment, Communication Media and Systems necessary to operate and obtain information from field devices)
- Tolling and Electronic Payment Systems
- ITS Systems for Freight Mobility (Ports/Border Crossings/On Board Trucks)
- Reversible Roadway System, (I-5 & I-90, Seattle Area)
The following section will briefly define each of the Major Electrical System items.

**Traffic Signal Systems**

WSDOT owns and is responsible for maintaining 965 traffic signals (including pedestrian signals, temporary signals and emergency signals) statewide (see Photo 18). All signals use micro-processor based controllers with active vehicle and pedestrian detection. A portion of these signals are maintained and operated by others through agreement. In general, signal systems have a life expectancy of 25 years. Many components of a signal system must be replaced or upgraded more frequently during the overall life cycle due to changes in technology or as necessary to maintain system operational performance.

**Ramp Meter Systems**

Over 138 ramp meters monitor occupancy levels on freeway ramps (see Photo 18) and help smooth freeway traffic by regulating vehicle entrance rates. Metering rates are automatically adjusted by the system based on prevailing freeway traffic conditions. In general, ramp metering systems have a life expectancy of 25 years. Similar to a traffic signal, many components of a ramp meter system must be replaced or upgraded more frequently during the overall life cycle due to changes in technology or as necessary to maintain system operational performance.

**Illumination Systems**

WSDOT maintains approximately 2,933 illumination, or lighting, systems statewide (see Photo 15). Most are in the vicinity of interchanges, intersections, chain-up areas, and transit flyer stops, with continuous lighting placed along some roadway sections as a result of congestion and safety issues. Some systems contain one or two lights while others may contain 100 or more lights on 40-50 foot light standards or 100 foot-high mast poles. As part of the illumination system WSDOT maintains 199 sign-lighters statewide which provide increased visibility for overhead signs. In general, the life expectancy of an illumination system is 25 years. During this period, various preventative maintenance activities, such as replacing light bulbs and inspecting anchor bolts, are necessary to maintain performance and safety. These types of preventative maintenance activities are funded separately through the maintenance program.

**Tunnel and Bridge Electrical Systems**

**Tunnel Electrical Systems**

Tunnel system may have some or all of the following systems:

- Fire Control, Alarm and Suppression
- Ventilation
- Air Quality (CO Sensors or other)
- Traffic Control (signals, electronic signs, etc.)
- Traffic Surveillance (CCTV)
- Traffic Detection (induction loops, video detection, radar, etc.)
I. Preservation > Other Highway Assets

- Lighting (roadway - day levels, night, emergency, faculty - day, night, egress)
- Power Distribution
- Emergency or Standby Power (generators, battery, redundant electrical services)
- Radio Re-broadcast.
- Communication (phone, emergency phone, public address)
- Security

WSDOT currently operates and maintains many tunnel systems. Three of the most complex systems are on I-90 in Seattle and Mercer Island; and on I-5 under the convention center in downtown Seattle. In general, tunnels systems have a life expectancy of 20 years.

**Bridge Systems**

All mechanical and electrical preservation work on bridges that are directly related to opening and closing the spans are funded under the Bridge Preservation Program. All other electrical items on bridges, such as roadway lighting, navigation lights, interior lighting, water sensors, intercom systems, fire systems, etc., are funded under the P3 subprogram.

Bridge systems that fall under the P3 subprogram consist of the electronics, communication media, and equipment necessary to monitor and perform traffic operations functions; ventilation; fire protection, surveillance and security; navigation lighting; and roadway lighting. WSDOT Northwest Region currently operates and maintains the following bridges:

**Movable and Floating Span Bridges**

- I-90:
  - 90/25 N & S Homer Hadley & Lacey Murrow
- SR 99:
  - 99/530 E & W 1st Ave. So.
- SR 513:
  - 513/12 Montlake
- SR 520:
  - 520/8 Evergreen Point
- SR 529:
  - 529/10 E & W Snohomish River
  - 529/20 E & W Steamboat Slough
  - 529/25 Ebey Slough
- SR 536:
  - 536/15 Skagit River (out of service since 1979)

**Bridges With Navigation Lights**

- US 2:
  - 2/3S Snohomish River
  - 2/5N Snohomish River
- I-5:
  - 5/570 Ship Canal
  - 5/645 E & W Snohomish River
  - 5/648 E & W Steamboat Slough

WSDOT also operates and maintains the Hood Canal movable bridge and 10 other bridges with navigation lighting and bridge obstruction systems statewide. In general, bridge systems have a life expectancy of 20 years.

**Dynamic Message Signs (DMS)**

Statewide, 185 DMS (see Photo 19) are used on roadways to provide motorists with important information about traffic congestion, incidents, work zones, travel times, special events, or speed limits on a specific highway segment. They may also recommend alternative routes, limit travel speed, warn of duration and location of problem, or simply provide alerts or warnings. In general, the life expectancy of a DMS system is 20 years. Periodic DMS system upgrades are necessary. Upgrades include control software and electronic components upgrades as technology advances with more advanced communication protocol such as National Transportation Communication for ITS Protocol (NTCIP).
**Highway Advisory Radio (HAR) Systems**

TMCs also operate highway advisory radio systems at 64 locations statewide. HAR systems are licensed low-power AM radio stations installed along the roadway to provide alerts and general information regarding traffic and travel conditions. The presence of a HAR transmitter is marked by a roadway sign instructing the motorist to “Tune to 1610 AM”. The 1610 frequency is one of several used by HAR radios and identified on the signs. In general, the life expectancy of a HAR system is 20 years.

**Closed Circuit Television (CCTV) Camera**

TMCs depend on field devices such as the 502 closed-circuit TV cameras used to detect and respond to incidents and congestion as well as monitoring roadway conditions. The camera images are sent to the TMCs for operations monitoring, to the Web for travelers and to the media for news broadcasts. In general, the life expectancy of a CCTV Camera system is 20 years (see Photo 20).

**Data Station Systems**

TMCs also depend on field devices such as the 479 traffic data stations which include video, radar and loop detectors. Data stations provide critical volume, speed, and occupancy data which are used for planning, design, operations, construction, and maintenance activities. This information is also used for measuring performance and providing information to the traveling public, such as travel times. The information obtained through these data stations provides critical information for WSDOT initiatives and is used in benefit/cost analyses. In general, the life expectancy of a data station system is 15 years. Depending upon the roadway condition at the data station location, periodic replacement of in-pavement loops may be necessary to maintain current performance.

**Permanent Traffic Recorder (PTR) Systems**

WSDOT’s Transportation Data Office (TDO) has 162 permanent traffic reporting systems (see Photo 21). These sites collect either (or a combination of) volume, classification, speed or weight traffic data depending on the type of sensors and traffic recorders installed at the site. PTR sites, which are managed by the TDO, work together with data stations to complete the picture for WSDOT managed roadways.

Due to Federal reporting requirements for PTR system collected data, the data quality standards for these systems are much higher than for data station systems. As a result, the life expectancy for a PTR system is estimated at 10 years.
Animal Warning Systems
WSDOT maintains six animal warning systems (AWS) installed or planned statewide. These systems are designed to inform drivers of animals (see Photo 22) entering or in the roadway along select rural roadway section. In general, the life expectancy of an AWS system is 10 years.

Automatic Anti-Icing System (AAIS)
WSDOT maintains eight Automated Anti-Icing Systems (AAIS) statewide with a life expectancy of 10 years. The primary purpose of winter highway maintenance is to provide vehicular traffic with a roadway surface that can be safely traveled. Roadway geometrics and an icy surface may create specific locations that are particularly susceptible to snow and ice related collisions. Revisions to roadway geometrics are very expensive, so problem areas typically become the responsibility of highway Maintenance staff to address the hazard through winter maintenance operations. AAIS greatly improves WSDOT’s ability to address icy roadway conditions at problems areas. A 2001 WSDOT study of an AAIS system on I-90 in North Central Region reported the following: “The analysis indicates that the proposed automatic anti-icing system is a viable and cost effective method of reducing the snow and ice related accidents in the Interstate 90 High Accident Location (HAC) under evaluation. Benefit cost ratio is greater than two (2.36) and the net benefit is over one million dollars ($1,179,274).”

Fiber Optic Communication Systems
The primary backbone of the WSDOT ITS communication network is fiber optics. WSDOT currently owns and maintains more than 220 miles of fiber optic cable. Fiber optic cable allows traffic information to be shared in a timely manner. Where these cables are not used, information travels over telephone lines at slower rates and higher costs. Fiber optics allow real-time streaming video of traffic cameras, images that help traffic managers make real-time decisions, rather than a delayed view which occurs when the information travels through telephone lines. Fiber Optic Cable has proven to be very reliable with an average life expectancy of 20 years. Periodic replacement of electronic equipment used to transmit and receive data along the fiber line, along with repair at splice points and patch panels, is necessary to maintain peak system performance.

Installation of High Density Polyethylene (HDPE) Conduit for Fiber Optic Cable (see Photo 23)
Communication Hubs
Statewide there are approximately 30 communication Hubs that support the ITS communication systems. Communication Hubs are basically an above or below ground structure where ITS communications systems from multiple systems interconnect as information from field devices is brought back to the TMC and vice versa. These hubs house large amounts of electronic equipment and allow for fiber optic cable and other communication media to be spliced. Temperature and humidity control are critical for extending system life expectancy which is estimated at 20 years, although this kind of field environment is prone to periodic replacement of some electronic equipment due to failure.
Other Communication Systems
(Emergency Telephone, Ethernet, DSL, T1)

The WSDOT manages a large communication network primarily made of copper cable. Many of the ITS systems that are operated on the highways today communicate to TMCs through copper connections. The copper connections assist in the operation of Traffic Signals, HARS, DMS, Data Stations, Ramp Meters, Illumination, CCTV Cameras and other electrical devices. The installation cost for copper systems is less expensive than the fiber optic alternative; however, the operating costs are far more expensive over time. In general, the life expectancy of WSDOT’s 250 miles of copper communication is 20 years with periodic equipment replacement.

Wireless Communication Systems

WSDOT provides wireless communications (see Figure 26 and Photo 24) in support of the department’s Intelligent Transportation Systems (ITS) and Traffic Management Centers (TMC). The Wireless communication system has two primary missions; to provide 24 hour emergency communications to the departments personnel via the TMCs, and to provide the traveling public with real time information on the conditions of the state’s highway system via the ITS program.

There are over 125 communication sites included in the system statewide. The facilities used are a variety of state owned, shared with sister agencies, and leased from private companies. These facilities
have a life expectancy of 50 years. Within the facilities is a combination of support equipment that has a life expectancy of 15 years.

Roadway/Weather Information Systems (RWIS)
WSDOT maintains and operates 94 RWIS. These systems are installed along the roadway with instruments and equipment that provide weather and road surface condition observations. This information is used to facilitate decisions on maintenance strategies and to provide information to drivers.

A typical RWIS system may measure air and road surface temperature, barometric pressure, humidity, wind speed and direction, precipitation, visibility, and road surface condition (dry, wet, freezing). In general, the life expectancy of an RWIS system is 25 years although periodic replacement of select electronic components is necessary to maintain current performance.

Transit Signal Priority (TSP) Systems
Transit Signal Priority (TSP) (see Figure 27) is a traffic signal control strategy to provide incremental benefits to public transit for the purpose of improving transit speed and reliability. Traffic signal timing is slightly modified to provide a benefit to the transit vehicle. Transit vehicle arrival times are estimated from on-street detection or from a Global Positioning System (GPS) based Automatic Vehicle Location (AVL) system.
WSDOT current operates and maintains 10 TSP systems in the greater Seattle Area. In general, the life expectancy of a TSP system is 10 years with periodic electronic component replacement.

**CVISN Program / Weigh-In-Motion (WIM) Systems**

As of July 1, 2006, the Commercial Vehicle Information Systems and Networks (CVISN) program (see Photo 25) is now providing electronic screening at 10 weigh stations statewide to 4,539 trucking companies with 40,998 trucks equipped with transponders. These 10 sites include weigh-in-motion (WIM) scales. In addition, there are three WIM sites that are under development. In general, the life expectancy of a WIM system is 10 years with periodic replacement of select electronic components.

**Statewide Traveler Information Systems (Web, 511, Traffic TV)**

The Washington State Department of Transportation (WSDOT) continues to provide valuable on-line traveler information to the public in creative and effective ways.

**Statewide Traveler Information Web Page**

www.wsdot.wa.gov/traffic

WSDOT’s Traveler Information Web site (see Figure 28) has been extremely popular with the traveling public, with the site receiving record visits during extreme weather. In general, the electronic equipment and software necessary to operate the statewide traveler information system has a life expectancy of 10 years with more frequent replacement of select components to maintain peak performance.

- **CCTV Camera Images** – Camera images are updated every minute providing travelers with a visual or roadway conditions at most critical locations around the state.

- **Travel Alerts and Slowdowns** – which combines incidents, construction, events, and anything else that might impede or slow travel on the roads.

- **Consolidated Mountain Pass Information** – with each major pass, such as Snoqualmie and Stevens passes, occupying its own page. These pages allow visitors to view camera images spanning the length of the pass, traction advisories, highway radio messages, and current and forecasted weather information.

- **Dedicated Weather Pages** – WSDOT’s weather page has led the country in using intelligent transportation systems data to provide travelers with real-time road and weather information.

- **Construction** – provides travelers with information about ongoing construction activities around the state that may impact their travel plans.

- **511** – an automated telephone information system that provides real-time traffic and weather information by simply dialing 5-1-1 from most phones. Updated every few minutes, 511 allows callers to get a variety of information:

  - Puget Sound Traffic Conditions
  - Statewide Construction Impacts
  - Incident Information
  - Mountain Pass Conditions
  - Ferry System Information
  - 800 numbers for passenger rail and airlines
  - Weather

- **Traffic TV** – Traffic camera images and the vehicle speed flow map for the Seattle area are available on select local cable channels.
**Traffic Management Centers (TMC)**

(Electronic Equipment, Communication Media and Systems necessary to operate and obtain information from field devices (see Photo 26).)

WSDOT operates seven regional TMCs: Seattle (Shoreline), Tacoma, Spokane, Vancouver, Yakima, Bellingham, Hyak (Snoqualmie Pass – winter season only) and Wenatchee. In addition, an Emergency Operations Center (EOC) is located in Olympia. This TMC provides a central location for WSDOT executives to help manage traffic operations, incident response, and maintenance during “emergency” events.

TMCs are the nerve centers for WSDOT’s operations activities. Real-time information is gathered 24 hours a day, 7 days a week from many sources including traffic detectors, CCTV cameras, ramp meters, the Washington State Patrol (WSP), road crews, WSDOT’s incident response teams, and media traffic reporters. WSDOT uses this information to coordinate responses to clear blocking collisions, deal with other problems that occur, and notify the public and the media of these events.
Although the TMC facility itself is outside the scope of the P3 program, the extensive electronic equipment, media and software that is required to communicate with and operate the field ITS equipment is a critical component of the Major Electrical System portion of the preservation program. The life expectancy of these items is estimated at 10 years in order to maintain current performance and maintain pace with technological advancements.

**Tolling and Electronic Payment Systems**

WSDOT currently maintains and operates a tolling and electronic payment system on the Tacoma Narrows Bridge (see Figure 29). In the near future, the SR 167 High Occupancy Toll (HOT) Lanes Pilot Project will collect tolls using an electronic payment system. In general, the life expectancy of the electronics, software and communication media portion of the Tolling and Electronic Payment System is estimated at 10 years with periodic replacement of select components.

**Good To Go!**

– Is the new electronic toll collection program that gives motorists the power to pay tolls on the new Tacoma Narrows Bridge span and SR 167 HOT lanes without stopping.

**ITS Systems for Freight Mobility**

(Ports / Border Crossings / On Board Trucks)

WSDOT has deployed a number of ITS Systems designed specifically to improve and monitor freight mobility. ITS transponder reading equipment located at the Ports of Tacoma and Seattle and at the Canadian border has been installed to monitor the movement of containers and trucks. These systems use electronic container door seals that are also transponders, which are designed to reduce the number of customs inspections and paperwork for trucks crossing the border with British Columbia. The transponder readers from this system, along with data-only and weigh station CVISN readers along I-5, I-90 and I-82, can also be used to provide near real-time travel time estimates for trucks. This transponder based tracking information, along with GPS tracking devices in volunteer, probe trucks can provide significant information about freight mobility in Washington State. WSDOT, working with several Canadian transportation agencies has developed an Internet-based system that archives data from these devices. In general, these types of ITS Systems have a life expectancy of 10 years, with periodic replacement and updating of some electronic equipment.

**Reversible Roadway System**

(I-5 and I-90, Seattle Area)

WSDOT maintains two reversible roadway systems (see Photo 27); one from downtown Seattle to the north along I-5; and one from downtown Seattle to the east along I-90. The reversible roadway system consists of 129 gates, 17 gate control systems, and a large number of mechanical overhead signs that help regulate the flow and direction of traffic at different times each day. In general, the life expectancy of these systems is 25 years with periodic electronic equipment replacement.
Major Electrical Preservation Needs
Continuous use of these major electrical systems; aging equipment; difficulties in acquiring older parts due to evolving technology; reduced safety of degrading insulation; and corrosion due to environmental factors presents WSDOT with the dilemma of how to plan for ongoing rehabilitation and the ultimate replacement of these systems as they approach their life expectancy. The traveling public and nearly every component of WSDOT planning, design, construction, operations and maintenance relies heavily upon the information and services these systems provide.

Major Electrical Preservation Strategies

Preventative Maintenance
Preventative maintenance activities are necessary for all major electrical systems. However, preventative maintenance is funded through the maintenance program, and not through the preservation program, P3. All electrical systems require periodic review in addition to non-scheduled maintenance caused by unpredictable events such as storms, accidents, and equipment failure. The intent of the preventative maintenance program is to reduce the possibility of an abrupt system failure. It also allows for emergency or quick replacement of those systems in order to maintain an acceptable level of service. In order to meet this objective, we must at times replace select electronic components.

Major Electrical Preservation Performance
The underlying theme behind all major electrical system items is to provide information to the traveling public, media, and WSDOT programs, and to support decisions on the operation of the highway system.

WSDOT measures the performance of the P3 program’s major electrical systems through a variety of Gray Notebook performance measures. Other performance measures, such as Signal Operations, are under development. These performance measures provide insight into the impact major electrical systems have on the traveling public and WSDOT safety and congestion reduction initiatives.

Maintenance Accountability Process (MAP) Performance Measures
The Maintenance Accountability Process (MAP) is a tool which measures and communicates the outcomes of the maintenance activities. It provides the tools to link strategic planning, the budget and maintenance service delivery. Twice a year, field inspections are made of randomly selected sections of highway. WSDOT measures, records and compares the results of our maintenance work to the MAP criteria to determine the level of service (LOS) delivered. The MAP performance measures relating directly to the major electrical systems that are rehabilitated or replaced by the preservation program are listed as follows:

» Traffic Signal Systems
» Highway Lighting Systems
» Intelligent Transportation Systems (ITS)

Weigh Station Replacement and Rehabilitation
Weigh stations (see Photo 28 and Figure 30) extend the life of roadway pavements and bridges and promotes safe travel of commercial vehicles on state highways. This is accomplished through driver and vehicle inspections and by enforcing size, weight and load laws. These inspections help reduce the number and severity of commercial motor vehicle collisions and hazardous material incidents on interstate and state highways. Commercial Vehicle Safety Alliance (CVSA) certified inspectors examine the commercial
I. Preservation > Other Highway Assets

driver’s license, medical certificate, logbook, and vehicle equipment for compliance with state law (RCW 46.32).

WSDOT compliments the Washington State Patrol’s (WSP) effort to prevent over-height and over-weight trucks from damaging the state’s pavements and bridges by rehabilitating deteriorated weigh station facilities and constructing new facilities as needed. WSDOT’s preservation program builds the off and on-ramps, installs signs lighting systems, buildings and utilities.

**Photo 28. Weigh Stations**

A Department of Highways weigh station circa 1940 on what was most likely SR 101. The truck (a ’35 or ’36 Ford) was owned by Walter Plumb Company, Copalis Beach

Weigh Station on Interstate 90 Tokio Road (milepost 231)

A typical shoulder weigh site (similar to a portable site although it is not separated from traffic)

**Figure 30. Locations of Permanent and Plug-n-Run Sites**
The Joint Operating Policy Statement (JOPS) between WSDOT and WSP states that WSDOT will work with WSP and provide “turn key” weighing facilities to WSP. WSDOT will seek the funding and build the mutually agreed-upon scales. WSDOT will then turn the scales over to WSP to maintain as outlined in the Memorandum Of Understanding between the agencies. WSP will care for the building, static scales, weigh-in-motion equipment, and pay the utilities for the building. WSDOT maintains signs, pavement, striping, outside lighting and pays to power the outside lighting.

Needs

**Inventory of Weighing Facilities**

Washington State has 48 permanent-scale weigh stations. Seventeen are located on interstate highways. Permanent fixed scales are equipped to detect axle, tandem, and gross weight violations. The Ports of Entry at Ridgefield, Bow Hill, Plymouth, and Spokane operate 24 hours per day, seven days per week, as does the scale site at Cle Elum, which also serves as an interior Port of Entry for traffic east and west bound on Interstate 90.

“Plug-and-Run” sites exist where enforcement officers operate full-sized vans equipped with a desk and work area. The officer drives onto the scale site, removes the scale head from the pedestal, activates an electronic sign, and begins the weighing process. These sites enable officers increased mobility from site to site and save tax payers large sums of money by eliminating the need for a building.

Strategies

**Approaches to Preserving Weighing Facilities**

WSDOT and WSP have a responsibility to jointly develop plans for improving and preserving commercial vehicle enforcement capabilities throughout the State of Washington.

**Prioritization Process**

In collaboration with the WSP criteria have been developed to assist decision makers in determining where funding should be allocated to achieve the goal of effective commercial vehicle enforcement for the least amount of funds possible.

Project ranking is by number of trucks, pavement condition, bridges and traffic safety (How much potential damage could we prevent). The various siting criteria, as shown in Figure 31, is weighted depending on category. (For example, utilities are important for fixed sites but not necessary for a portable site.)

Performance

With the installation of weigh-in-motion at additional sites, down time of trucks is reduced. It is estimated the operating cost of a commercial vehicle is $1.25 per minute and that an average stop at a weigh station is five minutes. The savings to the industry is approximately 70,000 hours of travel time and $5 million dollars per year!

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**Figure 31. Weigh Station Siting Criteria**

<table>
<thead>
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<th>Funded ($ in millions)</th>
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2007-2026 Highway System Plan | 49
II. Improvement

Highway Safety

What We Have Done
Consistent with the Strategic Highway Safety Plan strategies, the WTP has committed pre-existing funds (PEF), Nickel, and Transportation Partnership Act (TPA) funds to the statewide effort to reduce the occurrence of collisions on the state highway system.

Table 9 shows the WSDOT Safety Category expenditures each fiscal year for the past six bienniums. WSDOT has an ongoing commitment to Safety.

What We Are Doing Now
Highway safety investments are intended to reduce the societal costs of collisions by reducing their frequency and severity. Consequently, capital safety projects on Washington State highways have two primary approaches:

» The Collision Reduction program reactively addresses crashes based on history at a specific location. There are two elements to this program’s approach: High Accident Locations (HAL), where collisions occur at a spot location such as a specific intersection, and High Accident Corridors (HAC), where collisions may occur within several areas of a corridor section.

» The Risk Prevention program addresses locations with a higher risk of collisions, including cross-centerline and run-off-the-road incidents. This program allows WSDOT to proactively address locations with a higher than average potential for collisions based upon traffic volumes, shoulder widths, speed, vertical and horizontal curves, etc.

HAL’s/HAC’s with high societal costs are addressed in ranked priority. Today we find that most HAL’s do not reoccur from one biennium to another.

Societal Costs of Collisions
Costs based on property damage only (PDO), possible injury, evident injury, disabling injury, and fatalities are used to calculate annualized societal cost based on history. This enables WSDOT to calculate the present value benefits of proposed safety improvements by estimating the number of collisions that will be reduced.

The source of these cost factors is the Federal Highway Administration’s (FHWA) Technical Summary “The Cost of Highway Crashes”, Publication No. FHWA-RD-91-005. This summary is used for assigning dollar values for the societal cost of crashes.

2005 Data Shows an Increase in Traffic Fatalities
Over the past decade, there has been a general downward trend in traffic fatalities on Washington State’s highways, city streets, county roads, and other public roadways. Washington experienced a low point in fatalities in 2003 and 2004, with 600 and 567 deaths, respectively. However, 2005 data shows an increase following these two low years. In 2005, total fatalities on Washington’s public roads increased 14 percent, from 567 in 2004 to 649 in 2005. Of the 82 additional fatalities, county roads accounted for 32 (39 percent), state highways accounted for 30 (37 percent), city streets accounted for 23 (28 percent); other roadways experienced a decrease of 3 (-4 percent). During the same period, there was a 15 percent increase in highway fatalities at the national level.

WSDOT takes this increase in highway fatalities very seriously, and is examining ways to keep the fatality trend continuing downward. Collision data for 2006 by the Transportation Data Office indicates fatalities are down compared to 2005 (622 for 2006), but still higher than 2004. This was the case for all roads (see Table 10).

<table>
<thead>
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Federal law 23 USC § 409 prohibits the discovery or admission into evidence of “reports, surveys, schedules, lists, or data” compiled or collected for the purpose of highway safety improvement projects that might qualify for federal safety improvement funding.
WSDOT is not including lists of conceptual safety solutions in the HSP because collision locations and patterns change over time. A second reason is that planning-level safety strategies in a statewide plan are not always those chosen during project development. WSDOT anticipates looking more at corridors as opposed to individual spot location for safety projects.

Improvements in highway safety occur throughout the WSDOT highway construction program regardless of whether their stated intent is to address highway safety. This occurs because projects are required to address certain safety aspects in their design and construction.

**Needs**

WSDOT is a leader in the management of fatal and disabling injury rates nationally. Washington State has one of the lowest traffic fatality rates per hundred million vehicle miles traveled (see Figure 34) among all 50 states. WSDOT evaluates past accident history to determine strategies to further reduce fatal and disabling collisions.

Between 1999 and 2005, crossover, run-off-the-road, and intersections related collisions (see Figure 35) accounted for the greatest number of fatalities and disabling injuries. System wide, low cost safety improvements to reduce the number and severity of these types of collisions have the potential to save the lives of many Washington citizens and visitors that use our state highways. Strategies for reducing these three types of collisions are discussed later on in the Safety section.

WSDOT is working to continually improve the safety management process through approaches that are proactive. A proactive approach improves potentially problematic areas before severe collisions and the damages associated with them occur.

**Strategies**

**Target Zero**

WSDOT has developed the Strategic Highway Safety Plan, Target Zero. The plan’s mission is to identify Washington State’s traffic safety needs and guide investment decisions to achieve significant reductions in fatalities and serious injuries on all public roads. The vision for this plan is that Washington
II. Improvement > Highway Safety

Collisions are the leading cause of death in the United States for people from age 3 to 33. We understand that many of the deaths can be reduced by changes in driver behavior, vehicle design and roadway improvements. Our desire is to improve the quality of life in this state by doing our best to ensure that parents survive to parent, that children live to adulthood, and that teens don’t pay for driving mistakes with their lives.

Target Zero incorporates four traditional highway safety components commonly referred to as the “four Es”: enforcement, engineering, education, and emergency services. While WSDOT supports education and emergency service activities, these are typically a function of partner agencies, such as the Washington State Patrol and the Traffic Safety Commission. WSDOT takes a more active role in the enforcement and engineering components of the “four Es”.

**Enforcement**

The Traffic Safety Commission, State Patrol, Department of Licensing, and Department of Health take the lead on Target Zero strategies that focus on traffic and driver behavioral issues. WSDOT works...
with these and other agencies on programs such as Click It or Ticket, safety corridor projects, and ticketing aggressive drivers.

One of the largest contributors to fatal collisions is driving while intoxicated. Impaired drivers are involved in approximately 40 percent of all the fatal collisions in Washington State. Despite an increased focus on reducing the numbers of alcohol and drug impaired drivers, the rate of alcohol involvement in fatalities remains high.

Dangerous drivers, including aggressive and drowsy drivers, also contribute to fatalities. Included in this group are drivers that weave in and out of traffic, flash their lights, tailgate, street race, drive too fast for conditions, or fall asleep at the wheel. Young drivers (16-20 years old) have a higher fatal collision rate than any other age group. Legislation passed in July 2001 established the requirement of 50 hours of supervised behind-the-wheel driving time for drivers under the age of 18 before they can obtain a license.

Preliminary data collected after the law took effect show about a 30 percent drop in the number of fatalities and disabling injuries for 16- and 17-year-old drivers. New strategies and policies will be needed to address aging driver safety needs as Washington State’s population ages.

**Engineering**

Highway safety improvements are WSDOT’s main “Target Zero” focus. Focus areas for roadway improvements in the 2000 plan include a reduction in disabling and fatal collisions associated with running off the road, crossing the median of divided highways, and running stop signs or red lights at intersections. In addition to the low-cost improvement strategies previously shown above, activities in the plan included upgrading bridge rail and guardrail, installing or upgrading traffic signal systems, installing pedestrian-related improvements such as school advance warning signs, crosswalks, and islands, and upgrading standard roadway intersections to freeway style interchanges.

**Where to Invest Next**

WSDOT is working with national research groups to help improve risk assessment techniques and identify cost-effective solutions to reduce the severity of collisions.

WSDOT’s method for evaluating roadways for safety upgrades combines frequency and severity of collisions at locations in a weighted manner. This procedure identifies a significant portion of locations of safety upgrades. However, what is not apparent from the process is the cause of turnovers.
of collision locations from year to year. One main issue underlying the turnover rate is the reliability of predictions of collision risk.

Reducing and Preventing Injury Collisions
As strategies for improving highway safety continue to evolve the traditional approach is to reconstruct highways to meet current design standards. While rebuilding roadways to full design standards will reduce the risk of collisions, this approach can be very costly, particularly when the improvement has impacts to property or environmentally sensitive areas. The success of this program shows that by spending money more strategically, through the application of the appropriate standards, WSDOT can achieve the greatest safety benefit within limited resources.

More specifically, making large investments at spot locations results in fewer locations being addressed and limits the public benefit of improvements. Therefore, the preferred approach to improving highway safety is investing in improvements that are relatively low cost per site/mile and provide significant reductions in the risk of serious collisions.

A systematic approach to bringing highways up to standards provides the public safer highways at a lower cost:

- **Collision Reduction Priorities:**
  - Spot locations on the highway system with higher than average collision rates.
  - Corridor sections on the state highway system with higher than average collision rates.

- **Collision Prevention** addresses locations exhibiting a higher risk of collision frequency or high severity occurrence and includes the following focus areas:
  - Interstate safety, risk reduction, at-grade intersection, intersection improvements, pedestrian risk, and special safety initiatives.

These focus areas enables WSDOT to address potentially hazardous situations before they become a problem:

- Identify corridors with geometric and roadside elements that contribute to incident probability and increased collision severity.
- Identify improved signalization, channelization, and roundabout opportunities to reduce collision risk.
- Identify at-grade intersections in high-speed multi-lane divided highway locations exhibiting high collision potential.

Efforts to Reduce Fatalities and Disabling Injuries on State Highways
Based on analysis of the county-by-county data (see Figure 37), recommendations for reducing fatality rates focus on making improvements through a series of cost effective approaches:

1. Targeting known locations with recurring collisions
2. Improving short sections of corridors that have collision rates above the average for the roadway type
3. Making lower cost safety improvements (like rumble strips or guardrail upgrades) on routes where there are a large number of crashes throughout the corridor which are not concentrated in a particular spot or short segment.

Statewide low-cost highway improvements are saving lives almost as soon as they are implemented. These low-cost improvements include centerline rumble strips, cable median barriers, guard rails, and improved lighting and pavement markings. The costs for these highway improvements range from $40,000-$200,000 per mile, depending on the type of improvement.

Using this three-prong approach, WSDOT intends to take action against the factors within its control to help reduce fatal and disabling collision rates.

Risk Reduction
Risk reduction identifies locations where fewer collisions have occurred but the potential for collision frequency or severity is above average. The potential risk is high due to traffic volumes, and crossing into another lane or leaving the roadway would result in a severe collision. These projects are prioritized based on the potential societal cost of collisions that would be eliminated and the cost of the proposed project.
Special Safety Initiatives

Special Safety Initiatives focuses on specific low-cost fixes that can be implemented statewide to reduce or prevent collisions and their severity. These initiatives include:

» Install shoulder rumble strips, or stripes (rumble stripes are thick and make a noise, plus they are reflective at night) on rural multi-lane highways to alert sleepy drivers

» Replace guardrail installed prior to 1970 with new guardrail to meet current standards

» Install guardrail to strengthen non-standard bridge rails built before 1968 (see Photo 29).

» Install median cross-over protection on medians narrower than 50 feet wide to prevent vehicles from driving through (see Figure 38).

» Install centerline rumble strips on two lane rural highways.

» Place guard rail around mounded soil (redirectional landforms) at bridge piers.
II. Improvement > Highway Safety

- Add passing lanes as a safety strategy on two lane rural highways

**Interstate Safety**

WSDOT and the Federal Highway Administration (FHWA) agreed to create a strategy to identify non-standard features on the Interstate System and initiate a program to bring them up to appropriate standards.

Research is underway to identify the locations of above average collisions and risk and identify cost effective solutions to reduce the severity of collisions. The results are expected to be available for development of the 2009-11 budget.

**Safety Rest Areas**

**New Rest Areas**

WSDOT strives to provide a safety rest stop every 60 miles on the National Highway System, (see Appendix D) and on Scenic and Recreational Highways. The Legislature requires that any new rest areas are built in partnership between the department and another organization.

Project priorities in this category are determined by their cost effectiveness, based on an anticipated number of rest area users served. Cost effectiveness considers the benefits of reduced collisions due to driver inattention or sleepiness, and includes the construction, operation, and maintenance costs of the facility.

**Quick Facts**

- Statewide, WSDOT owns and operates 42 safety rest area facilities.
- The purpose of safety rest areas is to give fatigued drivers a safe place to stop and rest.
- The annual maintenance cost for state rest areas is over $4 million. This includes:
  - Facility maintenance
  - Landscape maintenance
  - Trash disposal
  - Utilities (electric, water, sewer)
- Parking is allowed in state rest areas for up to eight hours, unless otherwise posted. Hours are limited to prevent rest areas from being used as campsites.

**Designed With the Traveler in Mind**

Most safety rest area facilities provide these amenities:

- Rest rooms designed to meet the Americans with Disabilities Act standards
- Picnic tables
- RV dump stations - available at 19 of the 42 rest areas
- Designated pet areas for leashed animals
- Pay telephones
- Snack machines
- Motorist information - restaurants, hotels/motels, gas, local attractions
- Free coffee program at 26 of the 42 rest areas

**Intersection Improvements**

Intersection improvement projects are identified for locations where traffic volumes are growing and/or minor collisions are beginning to occur (see Photo 30). These projects improve safety by:

- Adding turn lanes or turn pockets to reduce rear-end collisions with left or right turning vehicles
- Adding signals or roundabouts as traffic volumes grow.
Roundabouts: Before and After Safety Study

To measure roundabout performance in Washington, WSDOT performed a before and after safety study of nine roundabouts located at intersections on the state highway system. The study analyzed urban and rural roundabouts as well as single-lane and multi-lane roundabouts. In all of the locations, collision data was collected for the three years prior to installation of a roundabout. Once roundabouts were open to traffic, collision data was collected in the same locations. Table 11 shows a comparison of the number of fatal and disabling injury collisions and evident injury collisions before and after installation of roundabouts.

Table 11. Total Collisions in WSDOT Study of Nine Roundabouts by Type of Collision

<table>
<thead>
<tr>
<th>Type of collision</th>
<th>Collisions Before Installation</th>
<th>Collisions After Installation</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal and disabling</td>
<td>5</td>
<td>1†</td>
<td>-80%</td>
</tr>
<tr>
<td>Evident injury</td>
<td>15</td>
<td>4</td>
<td>-73%</td>
</tr>
</tbody>
</table>

Source: WSDOT Traffic Office

†This was a disabling collision. There have been no fatality collisions in any of the nine intersections after installation of the roundabouts.

An evident injury is an injury that is verifiable by the police officer when arriving at the crash location and interviewing occupants of the vehicles (i.e. lacerations, broken bones, and incapacitation)

Federal law 23 USC § 409 prohibits the discovery or admission into evidence of “reports, surveys, schedules, lists, or data” compiled or collected for the purpose of highway safety improvement projects that might qualify for federal safety improvement funding.
Based on the analysis of the nine WSDOT roundabouts, fatal and disabling injuries dropped 80 percent. In fact, there have been no fatality collisions in the intersections after installation of the roundabouts. Evident injuries dropped an average of 73 percent at the nine locations. The results show that roundabouts improve safety. While this data represents raw numbers, analysis of rates by month show similar results. Many of the roundabout intersections in the study have also shown reduced average wait times for drivers at the intersection.

European and Australian traffic engineers have cautioned that the “learning curve” for motorists can cause increases minor crashes at multi-lane roundabouts during the “educating motorist” years, usually a period of one to two years. Nevertheless, long-term data supports the installation of roundabouts to increase safety and efficiency in intersections.

**Pedestrian and Bicycle Risk**

Walking and bicycling are integral parts of a balanced transportation system (see Figure 39). Most of us are pedestrians at some point of every day and all modes of transportation include a pedestrian component. In some areas of the state, walking and bicycling play a significant role in reducing traffic congestion.

The primary strategies for increasing biking and walking while making it safer include:

- Maximizing funding for safety needs through partnerships.
- Raising awareness of bicycle and pedestrian safety needs.
- Sharing information on bicycle and pedestrian issues between Washington’s agencies, jurisdictions, and organizations.

Locations are identified where pedestrians are at higher risk such as around schools (see Photo 32), senior centers, and transit facilities. These locations are identified by WSDOT in coordination with local pedestrian bicycle advocacy groups.

These projects reduce pedestrian risk by installing or modifying features such as:

- Sidewalks to reduce crossing distances at intersections
- Better lighting
- Advance warning signs
- Refuge islands in the center of the roadway
- In-pavement warning systems

Projects are prioritized by the potential use and cost of the proposed project.
**Prioritization Process**

One of the primary goals of priority programming is to maximize return on investment dollars. This helps ensure that transportation dollars are being spent in those areas with the highest benefit and lowest cost. The prioritization approach for this HSP update will include a combination of Safety strategies from low cost safety initiatives to moderate, and maximum fixes. Projects solutions under these strategies are based on available funding, and project benefits, and in some cases the solutions chosen are a first step towards a future, more permanent and costly fix that may be warranted as additional funding becomes available.

**Performance Measures**

WSDOT can’t prevent all traffic collisions. However, our goal is to make them more survivable. More importantly, the results of our success will be shown by fewer deaths and disabling injuries, and when collisions do occur, and our goal is that those involved make a full and complete recovery.

Performance measures are the indicators used to determine if a project, or type of projects are worth the expenditure of public funds required to build them in the first place. Safety Program performance measures include reduction in the number of:

- Fatal and disabling collisions
- Crossover head on collisions
- Recurring congestion related crashes
- Run off the road collisions
- Enter at angle collisions
- Same direction/Rear end collisions
- Bicycle/Pedestrian Vehicle collisions
- Fixed object collisions
- Driver fatigue collisions
Mobility

Washington State highways carry millions of people billions of miles every year. These highways traverse a variety of geographical areas ranging from densely populated urban areas and suburbs to rainforests, mountain passes and deserts. Bridges carry highway traffic over rivers, lakes and parts of the Puget Sound. Where bridges cannot be built, ferries carry travelers and freight.

Looking Back ... to 1980 (see Figure 40), there were over four million people living in Washington State with nearly three million of them traveling over 15 billion miles per year on over 7,000 miles of state highways. Many of these travel miles were accumulated as people commuted to and from almost two million jobs. Over the next 25 years, Washington’s economy prospered adding over one million new jobs by 2005. Population increased to over six million. The combination of more people and more jobs increased the number of licensed drivers making more trips on state highways, totaling more than 31 billion miles traveled annually by 2005. This growth used up most of the capacity of the urban and suburban highway system built during the 50s, 60s and 70s. Very little new highway capacity was added during the 80s and 90s. Today, many urban and suburban highways have reached capacity and travelers must endure longer commute times due to slow and unreliable travel speeds.

Description of the Issues

Looking Ahead ... to 2030 (see Figure 41), Washington’s population is expected to grow to over eight million people, the number of licensed drivers to over six million, the number of jobs to over four million. This continued growth will increase the number of miles traveled on state highways to over 51 billion by 2030. This continued growth will place even more strain on the already strained network of highways, leaving many travelers stuck in traffic longer. This means that by 2030, without substantial new capacity or significant changes that affect how and when we travel, users of Washington State’s transportation system will experience more congestion resulting in less reliable movement of freight and goods, lower travel speeds, increased delay and higher consumer costs as consequences of an overloaded system.

Major Factors Contributing to Congestion

(see Figure 42)
The growth in travel demand, especially during peak hours has caused many of the urban and suburban highways in Washington State to operate less efficiently. This decreased efficiency further consumes the limited capacity of the highway system, leading to more congestion (recurring congestion). Non-recurring congestion - congestion resulting from weather, roadway construction, collisions, vehicle breakdowns, etc., - further reduces the operating efficiency of the highway system. On a fundamental level, failure to price the use of roadway capacity contributes to unconstrained demand and causes congestion. The major factors that contribute to congestion, based on a national summary from the Federal Highway Administration augmented by additional factors* identified by WSDOT, are as follows:

* Bottlenecks
* Traffic Incidents
* Weather
II. Improvement > Mobility

» Work Zones
» Signal Timing
» Special Events
» Land Use *
» Ferry Traffic *
» Fluctuations in Normal Traffic

Bottlenecks
WSDOT has separated congested locations into two categories, bottlenecks and chokepoints. Bottlenecks are places where the physical attributes of a roadway change in a manner that impacts the flow of traffic. Typical bottlenecks are locations where the number of lanes decreases; the roadway physically narrows either in shoulder width or lane width and narrow bridges. WSDOT defines chokepoints as places where congestion occurs because of traffic interference and/or the roadway configuration (examples: highway interchanges, lack of turn lanes at intersections, seasonal road closures, etc.). Bottlenecks and chokepoints greatly influence the flow of traffic, whether it be long backups of vehicles trying to exit the highway, vehicles having to dramatically reduce their travel speeds when leaving one freeway to enter another (highway to highway connections) or vehicles slowing down as they cross a narrow bridge.

Traffic Incidents
Traffic Incidents typically include collisions, disabled vehicles, debris on the roadway, spills, and roadside distractions that alter driver behavior (e.g., roadside construction, patrol car with flashing lights or a fire beside the highway) and other events that impede the normal flow of traffic. For every minute a lane remains blocked, four to ten minutes of congestion may result.

Weather
Weather, such as the rain storms in November of 2006 where heavy rainfall caused flooding, sink holes and landslides, resulting in the temporary closure of more than a dozen highways in Western Washington for several days. Mountain passes periodically close for avalanche control. Snowfall, ice, heavy fog, and blinding sun may also cause delay.

Work Zones
A work zone is an area of a highway with construction, maintenance, or utility work activities. The impacts to traffic flow from work zones can vary widely depending on the amount of work undersay, the length of time the work zone is in place and any detours, or lane closures caused by construction.

Signal Timing
Signals cause additional delay to drivers. In fact, minor side street traffic may experience excessive delay, particularly during off-peak hours. Because of this, drivers may actually avoid the signalized corridors and switch to alternate routes or to residential streets not designed to handle through traffic.

Special Events
Special events like sporting events, political rallies and parades can cause temporary but major impacts to normal travel conditions expected by motorists.

Land Use
The state transportation system is directly impacted by local transportation and land use choices. Insufficient local street networks, zoning that encourages sprawling development, inefficiently managed access, and development that encroaches on state highway corridors can compromise existing and

Figure 42. The Sources of Congestion
National Summary

According to the Federal Highway Administration’s 2004 report Traffic Congestion and Reliability: Linking Solutions to Problems, the majority of congestion is caused by bottlenecks. Traffic incidents are the next highest contributor followed by inclement weather.
future capacity and safety of the state transportation system. Preserving corridor capacity by making land use choices that protect the public’s investment in the state transportation system will reduce the need for costly improvements.

The responsibility for land use planning and regulation resides with local governments. Most counties and cities plan under the Growth Management Act (GMA). The GMA defines a state policy framework and certain minimum requirements for local comprehensive plans and development regulations. The GMA’s intent is to address uncoordinated and unplanned growth and to express common goals for the conservation and wise use of land. The GMA also promotes regional coordination by requiring that comprehensive plans be consistent with countywide planning policies and regional transportation plans.

WSDOT’s land use role under the GMA is largely advisory since local comprehensive plans and regulations do not require state approval and local governments are not required to take action based on agency review comments. State agencies can appeal local land use decisions to one of the three growth management hearings boards.

Finally, WSDOT can minimize the adverse impacts of local land use decisions through its access control policies. WSDOT has different degrees of influence over access depending on a highway’s classification and location. WSDOT is the permitting authority for limited access and managed access highways in unincorporated areas. Cities and towns are the permitting authorities for managed access highways within their boundaries and are required by state law to adopt access standards that meet or exceed WSDOT standards.

**Ferry Traffic**

Communities that are home to ferry terminals face unique transportation challenges. Holding areas for ferry traffic waiting to load consumes considerable space within a community. In addition, offloading vehicles from a ferry create a platoon of vehicles that is difficult to merge with or cross through, often bringing local traffic to a standstill. As residential growth continues in communities on the west side of Puget Sound and major job opportunities remain located on the east side of the Sound, additional ferry trips, ferry terminal improvements and roadway improvements will be needed to accommodate the increased travel demand.

**Fluctuations in Normal Traffic**

Traffic varies from day to day (see Figure 43). Some days, traffic volumes are higher than normal leading to significantly longer travel times, other days traffic volumes are below normal and traffic flows freely without delay.

Any one of the above “Major Factors Contributing to Congestion” can cause traffic to slow below an acceptable level. When two or more of these factors are combined, traveling on the highway becomes difficult. This interaction between multiple factors creates a dynamic and unpredictable series of conditions that is rarely the same from one day to the next, one highway to another or even from one hour to another. For example, the travel time that one motorist experiences leaving home at 6:30 a.m. may be completely acceptable, but another motorist who leaves home 30 minutes later experiences a travel time that is more than twice as long. These motorists’ experiences can change dramatically if the next day there is a lane blocking collision, or if it is raining.
II. Improvement > Mobility

To make matters even more complex some of these situations can cause other events to occur. Consider the following:

» When traffic volumes are above normal on one highway, many commuters may decide to take an alternate route causing volumes to spike and results in traffic slowing to a crawl.

» Even moderate congestion can cause an increase in collisions as the following distance between vehicles is reduced and drivers become distracted.

» Signal timing on a major local arterial may cause vehicles on highway off ramps to backup onto the highway shoulder, reducing through capacity.

» Weather can cause poor visibility leading to slow downs.

» Drivers distracted by a collision generally slow down and may cause additional collisions as their attention leaves the roadway ahead of them.

Needs

In previous updates to the Highway System Plan, WSDOT targeted capital improvements to restore free-flow operating conditions (travel at posted speed 24 hours per day) which created expensive projects that limited the ability of WSDOT to address congestion on a statewide basis and subsequently created a situation where more roadways have now become congested. There is not enough state or local money or land to build sufficient highway capacity to reach free-flow conditions statewide. Therefore, WSDOT has set a goal in the WTP to manage the State Highway system to achieve maximum throughput. Typically, the maximum throughput of vehicles on a highway, about 2,000 vehicles per lane per hour, occurs at speeds of 42-51 mph, or about 70-85 percent of the posted speed. When travel speeds fall below 70 percent of posted speed, or about 42 mph, the highway no longer operates efficiently. WSDOT has targeted this condition as the threshold for determining when a highway requires capital improvements to restore efficient operating conditions.

Bottlenecks and Chokepoints

To identify a bottleneck or chokepoint location for this update, WSDOT regions followed the guidelines established as follows.

First, the location under consideration had to fit the definition of being either a chokepoint or bottleneck as explained previously under Bottlenecks. Second, the observed congestion must be supported with traffic data and analysis models. If congestion is a problem today or anticipated within the next 20 years, it also must satisfy one of the following applicable criteria:

» The congestion problem impacts the flow of mainline through-traffic. Mainline traffic flow is considered to be impacted when through-vehicle peak-hour speeds are equal to or less than 70 percent of the posted speed (see Figure 44).

» Traffic flow criteria for ramps will also be considered to determine if the congestion is caused by on/off ramp traffic.

An extensive list of bottleneck and chokepoint locations and solutions has been developed for this update of the HSP (see Appendix I: Bottlenecks and Chokepoints). Additional locations will be identified through future analysis for inclusion in updates to the HSP.

Figure 44. Relating Speed and Volume
I-405 Northbound at 24th NE, 6-11 am Weekdays in May 2001
Hourly Volume/Lane

- Much lower speed, lower throughput
- Slightly higher speed, lower throughput
- Max throughput is reached at roughly 45 mph

- Much lower speed, lower throughput
- Slightly higher speed, lower throughput
- Max throughput is reached at roughly 45 mph
Congested Corridors

To identify where congestion on corridors exists today, computer models were used to identify highways where vehicles currently travel below 70 percent of the posted speed during the peak hour, as shown in Figures 45 and 46. This is the criteria used to determine both Interstate and non-Interstate congested corridors. It is important to note that the analysis performed does not reflect the impact of congestion associated with local roads, ramps, interchanges, weather, special events, construction, collisions or incidents.

For long-range planning purposes, future-year conditions were forecast to determine when and where congestion will occur. Computer analysis was used to forecast 24-hour operating conditions for the year 2030 to identify locations where the peak-hour travel speeds fell below 70 percent of the posted speed. Of those locations, the highway segments with the most significant delay regionally (or at the county level) were chosen as study corridors for this update. Routes that were identified but not studied will be addressed in future updates. These projected future conditions reflect the completion of the mobility projects included in both the 2003 “Nickel” funding package and the fully funded projects included in the 2005 Transportation Partnership Act (TPA). Again these projections do not reflect the impact of congestion associated with local roads, additional impacts associated with ramps, interchanges, weather, special events, construction, collisions or incidents.

Strategies

The 2003 “Nickel” funding package and the 2005 TPA funding package will generate several billion dollars toward a specific list of mobility projects selected by the Legislature. This revenue will complete many projects and begin or continue work on the projects listed (see Figure 47). With the enactment of these funding packages, the Legislature set the priority for future projects and direction for transportation investments. Therefore the completion of the projects partially funded is seen as a high priority for WSDOT’s future mobility program.

This presented WSDOT with a huge challenge to balance funding for all existing and future needs. Given this challenge, WSDOT needed to develop an approach for completing the partially funded 2003 “Nickel” and 2005 “TPA” projects while minimizing the growth in congestion on other corridors. To manage congestion relief and effectively prioritize state highway system needs, an implementation approach (see Appendix J) was developed to ensure future solutions followed the established Legislative priorities and maximized all current and future revenue. What follows in this update is an incremental, tiered approach, where every improvement builds upon previous work so that no work is wasted. This approach separates strategies into three investment tiers to be implemented incrementally to maximize every dollar invested. The three tiers are as follows (see Figure 48):
Figure 45. Peak-Hour Operating Conditions Experienced in 2005 on State Highways

Note: These conditions do not reflect the impact of congestion associated with local roads, additional impacts associated with ramps, interchanges, weather, special events, construction, collisions or incidents.

Prepared by: Systems Analysis and Program Development (November 2007)
Figure 46. Projected Peak-Hour Operating Conditions for 2030 on State Highways

Note: These projected future conditions reflect the completion of the mobility projects included in both the 2003 “Nickel” funding package and the fully funded projects included in the 2005 Transportation Partnership Act (TPA). These projections do not reflect the impact of congestion associated with local roads, additional impacts associated with ramps, interchanges, weather, special events, construction, collisions or incidents.

Prepared by: Systems Analysis and Program Development (November 2007)
Tier I – Focuses on low-cost projects that deliver a high return on capital investment and have short delivery schedules. These include incident management, ITS, access management projects, ramp modifications, turn lanes and intersection improvements.

Tier II – Will focus on moderate to higher-cost improvements that further reduce congestion on both highways and local roads. These include improvements to parallel corridors (including local roads), adding auxiliary lanes, and direct access ramps.

Tier III – Focuses on the highest-cost projects that can deliver corridor-wide benefits. These include commuter rail, HOV/HOT lanes, adding general purpose lanes and interchange modifications.

Tier I Strategies
Tier I strategies are typically lower-cost projects that deliver a higher return on capital investments and have the shortest delivery schedules.

Active Traffic Management (see Figure 49)
Active Traffic Management (ATM) is the integration of multiple strategies that incorporate current and future technologies to provide “real-time” lane management. This management strategy allows WSDOT to respond to changing traffic levels and roadway conditions to regulate the flow of vehicles to get the fullest use of existing highway capacity.

ATM begins with extensive data collection. WSDOT performs detailed analysis of this data to create new strategies, modify existing strategies, develop new and update existing traveler information systems to provide better:

» Travel Time Reliability
» Vehicle Throughput
» Safety
II. Improvement > Mobility

Figure 49. Active Traffic Management

Data Collection
- Closed Circuit Television (CCTV) Camera
- Data Station Systems
- Permanent Traffic Recorder (PTR) Systems
- Roadway/Weather Information Systems (RWIS)

Traffic Management Centers (TMC)
- Incident Management
- Ramp Metering
- Traffic Signal Timing and Synchronization
- Work Zone Management
- Traffic Signal Priority Systems
- Commercial Vehicle Information Systems and Networks (CVISN)
- Lane Control
- Variable Speed Limits
- Hard Shoulder Running
- Dynamic re-routing
- Event Management
- Tolling Technologies for System Management

Active Traffic Management

Strategies
- Incident Management
- Traveler Information
- Work zone Management
- Transit Signal Priority Systems
- Commercial Vehicle Information Systems and Networks (CVISN)
- Lane Control
- Variable Speed Limits
- Hard Shoulder Running
- Dynamic re-routing
- Event Management
- Tolling Technologies for System Management

Initial steps are underway to determine the appropriate application of ATM techniques and where ATM would be most beneficial to implement.

Looking forward ... advanced technology will become standard on more vehicles, better roadside technology will be available to WSDOT which will enable vehicles to interact with ATM information systems providing more efficient use of the highways of the future. Imagine having a vehicle that can sense the location of other vehicles on the road and activate variable cruise control and collision avoidance systems. A non-connected train of vehicles such as these, all communicating directly with each other, would allow them to safely travel at close distances and high speeds, while improving current highway system efficiency. There are vehicles available today with smart technologies built-in, such as navigation, and collision avoidance.

Data Collection
Data collection is critical to the operation of an actively managed highway system. The following data collection systems are in use today to help WSDOT manage and plan for creating a more efficient transportation network. These systems include:
- Closed Circuit Television (CCTV) Cameras
- Data Station Systems
- Permanent Traffic Recorder (PTR) Systems
- Roadway/Weather Information Systems (RWIS)

Closed Circuit Television Cameras
TMCs depend on field devices such as the 502 closed-circuit TV cameras used to detect and respond to incidents and congestion, as well as monitor roadway conditions. The camera images are sent to the TMCs for operations monitoring, to the web for travelers and to the media for news broadcasts.
Data Station Systems
TMCs also depend on field devices such as the 479 traffic data stations which include video, radar and loop detectors. Data stations provide critical volume, speed, and occupancy data which are used for planning, design, operations, construction, and maintenance activities. This information is also used for measuring performance and providing information to the traveling public, such as travel times. The information obtained through these data stations provides critical information for WSDOT initiatives and is used in benefit/cost analyses.

Permanent Traffic Recorder Systems
WSDOT TDO has 162 permanent traffic recording systems. These sites may collect volume, classification, speed or weight traffic data, or any combination of these, depending on the type of sensors and traffic recorders installed at the site. Permanent traffic recorder sites, which are managed by the TDO, work together with data stations to complete the picture for WSDOT managed roadways.

Roadway/Weather Information Systems
WSDOT maintains and operates 94 RWIS stations, strategically located along the state highway system to provide “live” weather and road condition reports. This information is used to coordinate operational and maintenance activities and provide detailed traveler information.

Traffic Management Centers (TMCs)
WSDOT operates seven regional TMCs; Seattle in Shoreline (see Photo 33), Tacoma, Spokane, Vancouver, Yakima, Bellingham, Hyak (Snoqualmie Pass – winter season only) and Wenatchee. In addition, an Emergency Operations Center (EOC) is located in Olympia. This TMC provides a central location for WSDOT to help manage traffic operations, incident response, and maintenance during “emergency” events. TMCs are the nerve centers for WSDOT’s operations activities. Real-time information is gathered 24 hours a day, 7 days a week from many sources including traffic detectors, CCTV cameras, ramp meters, the Washington State Patrol, road crews, WSDOT’s incident response teams, and media traffic reporters. WSDOT uses this information to coordinate its response to incidents or emergencies, and notify the public and the media of these events.

Incident Management
Collisions and disabled vehicles disrupt traffic where little or no congestion exists. On congested highways, collisions and incidents can bring traffic to a stand still (see Photo 34 and Table 12).

Faster clearance not only opens travel lanes, but reduces the risk of secondary accidents (rear-enders in the back-ups) that block the roads all over again.

Incident management is a reactive approach to addressing collisions. Incident response teams respond to collisions or other incidents, such as hazardous material spills, to reduce delay caused by these incidents. (Incident Response Team (IRT) members are a specially trained group of WSDOT maintenance employees who respond to blocking incidents on our state’s highways. Their main function is to clear roads, help drivers and restore the normal flow of traffic as safely and quickly as possible.

Expansion of the Incident Response program in July, 2002, mobilized several IRT units from a 24/7 “call-out” mode to a peak traffic period “roving” mode. It also doubled WSDOT’s IRT fleet to 38 vehicles, adding 19 new roving peak traffic period units. Enhanced incident response patrols were instituted on I-405 which reduced the average clearance time for incidents by over 40 percent.

The 2002 expansion was reauthorized by the 2003 state legislature, enabling WSDOT to formally establish a statewide IR program partnership with WSP, private tow companies, and media sponsored
“motorist assistance van”. During peak travel periods IR program units “roam” established areas and provide assistance wherever needed to reduce incident clearance times. The expansion has also increased the WSDOT IRT 24/7 call-out capabilities.

WSDOT’s IR program has shown positive results in reducing non-recurrent congestion. Although the number of incidents WSDOT responded to has doubled since July 2002, the average clearance time for all incidents has remained constant. The goal is to maintain or improve that time. For more information about Incident Response, please visit the Incident Response web page at: www.wsdot.wa.gov/operations/incidentresponse

### Ramp Metering
Ramp meters are stop-and-go signals located on entrance ramps to the highway. They control the frequency with which vehicles enter the flow of traffic on the highway.

Ramp meters are a cost-effective method of relieving traffic congestion (see Figure 50 and Photo 35). By increasing the efficiency of freeway use, ramp meters save taxpayers costs associated with building new lanes. Ramp meters have reduced rear-end and sideswipe collisions by over 30 percent.

### Traffic Signal Timing and Synchronization
Synchronizing traffic signals (see Figure 51) is recognized as one of the most effective techniques for cutting traffic congestion on arterials. Studies show that in some locations, the benefit of reduced delay compared to the cost of timing may be as high as forty to one.
Work Zone Management

Highway construction and work zones can cause congestion. Lanes may be narrowed, or even closed, and traffic detours and neck-downs are frequent collision locations. Construction program impacts require traffic management strategies to be considered starting at the planning stage including:

» Incentives for contractors to minimize highway traffic disruptions.
» Enhanced law enforcement to reduce inattentive driving and speeding that causes work zone accidents.
» Off-peak construction work hours to avoid peak period traffic.
» Total corridor closure for expedited project completion.

Transit Signal Priority Systems

Transit Signal Priority (TSP) (see Figure 52) is a traffic signal control strategy that benefits public transit by improving transit speed and reliability. Traffic signal timing is slightly modified, allowing the transit vehicle to move through an intersection more quickly. Transit vehicle arrival times are estimated from on-street detection or from a Global Positioning System (GPS) based Automatic Vehicle Location (AVL) system. WSDOT currently operates and maintains 10 TSP systems in the greater Seattle Area.

Lane Control

Lane control offers WSDOT the ability to temporarily close a travel lane electronically with a lane control sign for construction, collisions or the clearing of debris. Lane control signs clearly display notification to travelers about lane usage. Lane control signs give drivers advanced warning about lane closures or advise them to change lanes to reduce the impacts associated with temporary lane closures.

Variable Speed Limits

Variable speed limits can be used when travel conditions warrant slower traffic, such as on mountain passes during winter storms. Reducing speed limits is a way to manage congestion and road safety.
Lowering the speed limit when needed will help maintain an even flow of traffic and prevent further congestion.

**Hard Shoulder Running**

“Hard shoulder running” means using the highway shoulder as an additional travel lane when congested conditions call for additional capacity. Hard shoulder running is allowed only when an overhead sign indicates it is available for use; otherwise, the shoulder should only be used during an emergency.

**Dynamic Re-routing**

Dynamic re-routing enables WSDOT to re-route vehicles to alternative routes when multiple lane closures exist on a highway.

**Event Management**

WSDOT works with event planners to determine the amount of impact an event may have on traffic flow and how to address these impacts.

**Tolling Technologies for System Management**

New technologies and strategies show promise as a means to both affect the level of system use and increase financial support for transportation projects, especially in congested corridors. For example, with the opening of the Tacoma Narrows Bridge in 2007, WSDOT began tolling operations for the first time in nearly two decades. This project features electronic toll collection, which is new to Washington, along with traditional toll booths. The electronic tolling system is called “Good To Go” which allows non-stop toll collection (see Figure 53). “Good To Go” uses transponders in vehicles to charge accounts when the vehicle travels through the electronic toll booth. “Good To Go” will also be used on the SR 167 High Occupancy Toll (HOT) Lane Project. The potential applications of tolling technologies for system management includes several strategies (also called “congestion pricing”):

- System-wide Tolling
- Segment Tolling
- Cordon Tolling
- HOT Lanes

**System-wide Tolling**

System-wide tolling imposes fees which are based on actual road use throughout the entire system. “Dynamic Pricing” (variable pricing based on demand) may be applied in this form of congestion pricing.

**Segment Tolling**

Segment tolling is in wide practice in eastern states where entire roadways are tolled. This is a more traditional method of tolling roadways, with toll booths set-up across the entire width of the road where fees are collected. With systems such as “Good To Go” the large queues that form at toll booths could be eliminated to improve efficiency.

**Cordon Tolling**

“Cordon tolling” charges all vehicles a fee based on the time of day to reduce the demand for specific areas such as the Central Business District (CBD). This type of tolling has proven very effective in reducing the congestion experienced in London.
In the United States large cities such as New York are considering this form of pricing to ease the daily “gridlock” that cripples the movement of people and freight within several areas of the city.

HOT Lanes
See HOV/HOT Lanes under Tier III Strategies.

Traveler Information Systems
Traveler information systems leverage the data collection efforts of WSDOT to provide motorists with detailed information that allows them to make route or timing decisions before or during their trip. WSDOT makes this information available through multiple delivery systems including:
- Dynamic/Variable Message Signs
- Highway Advisory Radio
- 5-1-1 Travel Information
- Statewide Traveler Information Web Page

Dynamic Message Sign (DMS)
Statewide, 185 dynamic message signs (DMS) are used on roadways to provide motorists with important information. WSDOT can program these electronic signs (see Photo 36) to relay information about traffic congestion, incidents, work zones, travel times, special events, or speed limits on a specific highway segment. They may also recommend alternative routes, limit travel speed, warn of duration and location of problems, or simply provide alerts or warnings.

Highway Advisory Radio (HAR) Systems
HAR systems are licensed low-power AM radio stations installed along the roadway to provide alerts and general information regarding traffic and travel conditions. The presence of a HAR transmitter is marked by a roadway sign instructing the motorist to “Tune to 1610 AM”. The 1610 frequency is one of several used by HAR radios and identified on the signs.

511 Travel Info
Real-time traffic and weather information is available by simply dialing 5-1-1 from most phones. Updated every few minutes, 511 enables callers to get a variety of information:
- Puget Sound Traffic Conditions
- Statewide Construction Impacts
- Incident Information
- Mountain Pass Conditions
- Ferry System Information
- 800 Numbers for Passenger Rail and Airlines
- Weather

Statewide Traveler Information Web Page
The statewide traveler information web site delivers “real-time” information about current or expected travel conditions at www.wsdot.wa.gov/traffic, including:
- Traffic Flow Maps – displays current travel conditions graphically on a dynamic map which is updated every few minutes (see Figure 54).
- Travel Times – displays current travel times between some of the most heavily traveled routes in Washington State along with the average travel times for the specific time and date. This site is updated every five minutes.
- Travel Alerts and Slowdowns – which combines incidents, construction, events, and anything else that might impede or slow travel on the roads.
- CCTV Camera Images – Camera Images are updated every minute providing travelers with a visual or roadway conditions at most critical locations around the state.
II. Improvement > Mobility

» **Construction** – provides travelers with information about ongoing construction activities around the state that may impact their travel plans.

» **Mountain Pass Information** – These pages allow visitors to view camera images spanning the length of the pass, traction advisories, highway radio messages, and current and forecasted weather information. Each major pass, such as Snoqualmie and Stevens, has its own web page.

» **Weather** – WSDOT’s weather page uses intelligent transportation systems data to provide travelers with real-time road and weather information.

**Access Management**
Managing access to state highways by limiting driveways and cross traffic movement preserves highway capacity where growth is expected. Access management also maximizes existing highway capacity and safety where development has occurred.

For more information about Access Management, please visit the Access and Hearings Unit web site at: [www.wsdot.wa.gov/eesc/design/access](http://www.wsdot.wa.gov/eesc/design/access).

**Ramp Modification**
Ramp modifications can vary widely. Ramps can be extended, widened or realigned to reduce the sharpness of a curve. Ramp modifications can also include reconstruction to create braided or loop ramps which can greatly improve efficiency.

**Turn Lanes**
Turn lanes can be added to intersections, ramps and driveways to allow travelers a place to slowdown before making a turn without causing mainline traffic to slowdown or stop.

**Intersection Improvements**
Intersection improvements, such as adding turn lanes improve the efficiency of traffic movements and can reduce the risk of collisions.

**Roundabouts**
A roundabout (see Photo 37) is a circular intersection where traffic flows around a center island. Roundabouts are safe, efficient and less costly than a traffic signal. Since vehicles entering the roundabout are required to yield to traffic in the circle, more vehicles can move through the intersection with less delay. Roundabouts also accommodate the turning radius of large vehicles, like semi-trucks and buses. For more information about roundabouts, please visit the Roundabouts web page at: [www.wsdot.wa.gov/Projects/roundabouts](http://www.wsdot.wa.gov/Projects/roundabouts).

![Figure 54. WSDOT Traffic Flow Map Web Page](image)

![Photo 37. Roundabout](image)
Transportation Demand Management (TDM)

Transportation Demand Management (TDM) is an umbrella term for strategies that reduce trips or shift use of the roadway to off-peak periods. TDM strategies include:

- **Commute Trip Reduction (CTR) Programs** –
  The CTR Program uses partnerships between employers and government to encourage change in commuting habits through education and incentives. By encouraging people to ride the bus, train, vanpool, carpool, walk, bike, telecommute, or compress their workweek, the CTR program removes approximately 19,950 vehicles from the state’s roadways every morning. This saves space on the roads and reduces air pollution by about 5,000 tons and gasoline consumption by about six million gallons each year. Nearly 1,100 worksites in Washington State participate in the program. For more information about transportation demand management and CTR programs, please visit the Transportation Demand Management web page at: www.wsdot.wa.gov/tdm.

- **Vanpools** – The Puget Sound region leads the nation in vanpooling. There are approximately 1,353 vanpools in Puget Sound; they remove approximately 9,400 vehicles from area roads each morning. For more information about vanpools, please visit the Commute and Travel Info web page at: www.wsdot.wa.gov/choices/rideshare.cfm.

- **Park and Ride Lots** – Park and ride lots enhance the convenience of transit, vanpools, and carpools. WSDOT owns 62 lots in Puget Sound, with 12,000 parking spaces. King County park and ride lots have an average occupancy of 91 percent. The WTP has targeted $200 million towards the implementation of a park-and-ride program in coordination with transit systems. This program would include alleviating overcrowding at existing lots, providing safety and security, and accommodating growing demand. For more information about park and ride lots available throughout Washington State, please visit the Commute and Travel Info web page at: www.wsdot.wa.gov/Choices/ParkRide.cfm.

Planning for Land Use

Using existing highway capacity efficiently through land use choices that preserve the public's investment in the state transportation system, can help reduce the need for costly improvements.

WSDOT is striving to more effectively use its review authority under the GMA and State Environmental Policy Act (SEPA) to encourage local governments to make choices that protect the capacity and safety of state highways. Local land use choices include developing adequate local street networks, approving transportation-efficient land-use policies, adopting sufficient access-permitting standards and procedures, and using SEPA to its fullest to minimize the adverse impacts of local land use decisions on state highways.

Tier II Strategies

Tier II strategies are typically moderate to higher-cost projects that deliver potential network benefits to both highways and local roads. These strategies should be considered only after all applicable Tier I strategies have been implemented.

Improve to Parallel Corridors (including local roads)

There are times when widening a congested roadway is not feasible. One approach to adding capacity is widening a parallel roadway which can provide travelers an alternate route to the same destination.

Adding Auxiliary Lanes

Auxiliary lanes can connect two interchanges, add passing opportunities on two-lane highways or provide slow moving vehicles a lane when going up hills or mountains.

Adding Collector-Distributor Lanes

Adding a collector-distributor lane that begins before an off ramp and extends beyond the on ramp of closely spaced interchanges improves the efficiency of the interchanges. It also reduces the impact of vehicles entering and exiting the highway, thus improving vehicle throughput for general purpose lanes.
Direct Access Ramps
WSDOT is building High Occupancy Vehicle (HOV) direct access ramps throughout the Puget Sound area for Sound Transit. Direct access ramps allow buses, carpools and vanpools to directly access the HOV lanes from park and ride lots and local streets. Carpools, vanpools and buses no longer have to weave across the general-purpose lanes when they can connect directly with HOV lanes. Direct access ramps improve safety, reduce congestion, save time, and increase reliability for both HOVs and general-purpose traffic. For more information about direct access ramps, please visit the Direct Access Ramps web site at: www.wsdot.wa.gov/HOV/directaccessramps.htm.

Tier III Strategies
Tier III strategies are the highest-cost projects that can deliver corridor-wide benefits. These strategies should be considered only after all applicable Tier I and Tier II strategies have been implemented.

HOT Lanes
High Occupancy Toll (HOT) lanes are lanes that are open to carpools, vanpools and transit and toll-paying solo drivers. Tolls for HOT lanes are set to assure that these lanes keep flowing even when regular lanes are congested. HOT lanes can be built for this purpose or can be converted high occupancy vehicle (HOV) or general-purpose lanes. Toll rates are adjusted automatically to regulate demand (“Dynamic Pricing” or variable pricing based on demand) and to ensure HOT lane traffic flows at 45 miles per hour or faster, even when the regular lanes are congested. HOT lanes provide drivers who are willing to pay for a faster trip an option to avoid congestion. By allowing toll-paying solo traffic to use carpool lanes we could:

» maintain good traffic flow for transit, carpools and vanpools
» make better use of the lanes
» improve service for those who choose to pay a toll
» make the other lanes slightly less crowded
» generate some money to improve transportation

Almost 20 different projects using or studying HOT lane applications are currently underway in the United States. The first HOT lane in Washington State will be tested on SR 167 between Renton and Auburn (2008). This pilot project will test the HOT Lane principle for potential application in other parts of the Puget Sound Region. For more information about the SR 167 pilot project, please visit the SR 167 Pilot Project web site at: www.wsdot.wa.gov/projects/sr167/hotlanes.

WSDOT is examining several future projects for system management strategies that are expected to include value pricing to improve and assure roadway use efficiency. These projects include the SR 520 Floating Bridge, Columbia River Crossing and perhaps others. These projects were also identified as part of the Washington Transportation Commission’s 2006 Comprehensive Tolling Study as projects worthy of consideration within the next 10 years.

HOV Lanes
High Occupancy Vehicle (HOV) lanes, sometimes called carpool or diamond lanes, are highway lanes reserved for the use of carpools, vanpools, buses and personal vehicles with two or more occupants unless otherwise posted. They are typically separated from other traffic by a solid white line, and are identified by signs and diamond symbols on the pavement. The HOV system is a key part of our state’s highway network, enabling commuters to get to work with more reliability, and provides an incentive to take the bus, carpool, or vanpool. They are intended to maximize the movement of people rather than vehicles. An average HOV lane often carries 1½ times as many people as the average adjacent lane during rush hours. On I-5 in north Seattle the HOV lane carries almost three times as many people during the afternoon rush hour. The HOV system has been so successful that most of the HOV lanes are now congested during the peak commuting periods. Innovative technology and other system management tools will be necessary to help keep these lanes moving in the future. For more information about HOV lanes, please visit the HOV web site at: www.wsdot.wa.gov/HOV/#whatareHOV.
**Ferry Terminals and Multi-Modal Connections**  
(see Photo 38)

In Island and Kitsap counties and on Vashon Island, transit service is timed and linked with ferry schedules. In downtown Seattle, there is frequent transit service, but not specifically linked to ferry schedules. New inter-modal connection issues will emerge with the construction of new inter-modal ferry terminals in Mukilteo and Edmonds, which may have connections to commuter rail services.

Washington State Ferries has received funding from the state legislature to move forward with two new multimodal terminal projects in Mukilteo and on Bainbridge Island. Another is in the planning stage in Edmonds.

However, additional ferry trips will exacerbate current highway problems that ferry commuters experience on a daily basis. While it may be financially, environmentally, and in some areas, politically unrealistic to suggest the construction of new roadways or widening of existing connections, operational improvements that increase the efficiency of the existing roadway network should be considered. Coordinated signal timing along these routes, better signing to help prevent vehicles from blocking driveways and local intersections, better defined ferry holding lanes, turn lanes at major intersections and transit queue jumps at signalized intersections are strategies that should be considered to help mitigate the adverse effect of ferry traffic platoons.

It may also be effective to build roadways over or underpasses at strategic locations to allow local traffic to cross above or below long lines of ferry traffic.

It is also important that public transit agencies develop their respective schedules so that they are in alignment with ferry schedules. The strain placed on the state highway and the local roadway networks can be lessened if more ferry passengers can be convinced to use public transportation to reach their destinations. For this to occur, transit service must be convenient for ferry passengers to their destination. For more information about ferry services available throughout Washington State, please visit the Commute and Travel Info web page at: www.wsdot.wa.gov/choices/ferries.cfm.

**Interchange Modification**

Interchange modifications can range from ramp reconfiguration to full reconstruction with an entirely different design to accommodate projected future traffic patterns.

**Add General Purpose Lanes**

Adding general purpose lanes to an existing highway increases capacity in either one or both directions.

**Performance Measures**

Traditional highway performance measurement is based on a grading system using the letters A-F to determine the “Level of Service” (LOS) provided or projected on a roadway. This method is difficult to quantify for many because it is not directly tied to “Travel Speeds” or “Travel Time.” The relationship between traditional LOS and the percent of posted speed, used for determining congestion in this HSP update, is graphically represented in Figure 55.

Some of the performance measurements currently used or under development are explained below.

- **Travel Time** – The amount of time it takes a vehicle to travel between two given points.

- **Delay** – WSDOT uses daily total vehicle hours of delay. This delay is calculated by finding the difference between the travel time of vehicle moving at speeds below 85 percent of the posted speed and the travel time of vehicles that are traveling at 85 percent of the posted speed.
» **Duration of Congestion** – This number of hours per day in which average weekday travel speeds on a highway falls below 70 percent of the posted speed.

» **Maximum Throughput** – A measure used to demonstrate when a freeway is being used most efficiently. Maximum throughput is the greatest number of vehicles traveling at the optimal freeway speed occurring between 70 to 85 percent of the posted speed limit.

![Figure 55. Comparing Level of Service (LOS) to Percent of Posted Speed](image-url)

<table>
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<th>LOS</th>
<th>Description</th>
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<tr>
<td>LOS A</td>
<td>Above Posted Speed 60+ m.p.h.</td>
</tr>
<tr>
<td>LOS B</td>
<td>Posted Speed 60 m.p.h.</td>
</tr>
<tr>
<td>LOS C</td>
<td>Above 85% of Posted Speed to Posted Speed 52 m.p.h. to 60 m.p.h.</td>
</tr>
<tr>
<td>LOS D</td>
<td>70% to 85% of Posted Speed 42 m.p.h. to 51 m.p.h.</td>
</tr>
<tr>
<td>LOS E</td>
<td>Below 70% of Posted Speed Below 42 m.p.h.</td>
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![Mobility: Funded vs. WTP Unfunded Targets](image-url)

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<th>WTP Unfunded Targets ($ in millions)</th>
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<td>Mobility Total (Includes Maintenance and Operations)</td>
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<tr>
<td>Highway System Plan Total</td>
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</table>

63.5% Funded
36.5% Unfunded
Economic Vitality

Freight Transportation Network

Transportation system investments are intended to generate overall economic prosperity to citizens in the state. They are focused on improving the reliable performance of the freight transportation network for the users and customers of the system. These improvements are necessary to support Washington’s role as a global gateway, our own state’s manufacturers and agricultural growers, and the state’s retail and wholesale distribution system.

Washington State’s strategic investment plan for the freight transportation network is supported by the WTP Freight Report, which was presented to decision-makers in 2005 and 2006. It is organized in three chapters that explain Washington’s role as a gateway state, how freight transport supports both Washington’s regional economies, and the role of the local distribution system.

The report analyzes original research and existent information about Washington State freight customers, to inform decision-makers:

» Who are the customers of the state’s freight transportation network

» Why freight customers matter in terms of jobs and contribution to gross state revenues

» What performance the customers expect from the freight transportation network

» Where key performance gaps are located

» How decision-makers may make the most productive strategic investments in Washington State’s freight transportation network

The report provides context for the system’s assessment by featuring more than a dozen case studies of Washington State freight carriers, producers and distributors. It defines terms to create a common vocabulary, and summarizes data from state and federal freight studies relevant to Washington. To view the freight report, please visit www.wsdot.wa.gov/freight/default.htm.

Overview of Washington State’s Freight Transportation Network

The three components of Washington State’s transportation network that are essential for freight movement are:

» Global Gateways – International and National Trade Flows Through Washington

» Made in Washington – Regional Economies Rely on the Freight Transportation Network

» Delivering Goods to You – The Retail and Wholesale Distribution System

These components underpin our national and state economies, support national defense, directly sustain hundreds of thousands of jobs, and distribute the necessities of life to every resident of the state everyday.

First, Washington is a gateway state, connecting Asian trade flows to the U.S. economy, Alaska to the lower 48 states, and Canada to the U.S. West Coast. About 70 percent of international goods entering Washington gateways continue on to the larger U.S. market. Thirty percent become part of Washington’s manufactured output or are distributed in our retail system.

Second, our own state’s manufacturers and farmers rely on the freight transportation network to ship Washington-made products to local customers, to the big U.S. markets in California and on the East Coast, and worldwide. Washington’s producers generate jobs in every region in the state.

Finally, Washington’s distribution system is a fundamental local utility, since without it our citizens would have nothing to eat, nothing to wear, nothing to read, no spare parts, no fuel for their cars and no heat for their homes. In other words, the economy of the region would no longer function.

The value and volume of goods moving on the freight transportation network is huge and growing.
II. Improvement > Economic Vitality

Description of the Issues
What are the findings?

Globalization, competitive industry trends, and new technologies are pushing freight volumes up twice as fast as Washington's overall population and traffic growth. Without strategic investment by the public sector, our natural population growth, intensified by these three trends, will choke international trade flows through the state, undermine regional economies, and spill over into competition for road capacity in congested metro centers. With strategic investment, Washington will continue to compete.

While Washington State’s population grew from over four million to over six million from 1980 to 2005 (almost 50 percent) and is projected to grow to over eight million (over 37 percent increase) by 2030, growth in the freight system is increasing at a much higher rate.\(^1\) Truck trips increased by 94 percent on the Interstate 5 corridor, and by 72 percent on the Interstate 90 corridor, in the 10 years between 1993 and 2003.\(^2\) From 1998 to 2020, freight volumes in Washington State are expected to increase by 80 percent.\(^3\)

Global Gateways – International and National Trade Flows Through Washington

- Washington State is an important and growing gateway for trade access to the Pacific Rim, Canada and U.S. (see Figures 56, 57, and 58).

The state’s global gateways freight transportation network serves the national economy and national defense.

It also provides competitive advantage for logistics and trade, manufacturing, agribusiness and timber/wood products sectors.

Globalization, in particular the emergence of China and Asia as an important part of the factory floor for the United States, will double the volume of imported container freight entering the Ports of Seattle and Tacoma by 2025.\(^4\) Midwest and East Coast consumers, at the far end of the Asia-to-United States supply chain, purchased about three-fourths of the international goods entering Washington ports in 2005. Most of these goods are shipped to the Midwest in containers via rail.

Washington’s exporter and importer distribution facilities are concentrated in the Kent and Auburn Valley. They have no practical alternative to the state’s most heavily used north-south freight routes:

- Interstate 5
- Interstate 405-SR 167
- SR 99-Alaskan Way Viaduct
- SR 509

Delay costs everyone. Consumer goods cost more. Shippers turn fewer shipments to the ports. Manufacturers have shorter windows to ship air cargo. Worst of all, it takes more trucks to ship the same volume, as each truck gets fewer trips per day.

Global security needs and our national defense depends on the United States’ ability to rapidly project force when needed. Fort Lewis is the only Power Projection Platform on the West Coast. In the event of a major conflict, essential equipment and supplies will rush to Fort Lewis from all over the United States by rail and road, then ship through the Ports of Tacoma, Olympia and Seattle to support the troops. The military traffic will attempt to surge through highway freight networks that have already reached their capacity limits on Interstate 5 in Central Puget Sound.\(^5\)

Washington’s largest waterborne export is food, mostly grain. Eighty-five percent of eastern Washington wheat is shipped to Asia via Columbia River ports, but farmers struggle to get product through the state’s freight transportation network.\(^6\) For example, growers can’t get produce off the farm up to two months a year due to weight-restrictions on county roads.

By far, Washington’s largest waterborne import is crude oil from Alaska, shipped to the state’s refineries.\(^7\) Refined product: gas, diesel and jet fuel,

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\(^1\) Washington State Office of Financial Management
\(^2\) Washington State University, Strategic Freight Transportation Analysis
\(^3\) U.S. Department of Transportation
\(^4\) BST Associates. 2004 Marine Cargo Forecast
\(^5\) Surface Deployment and Distribution Command – Transportation Engineering Agency
\(^6\) Washington Wheat Commission
\(^7\) U.S. Army Corps of Engineers
then moves by pipeline or barge to distribution centers and is trucked to gas stations. The Olympic Pipe Line, currently operating at close to 100 percent capacity, has no plans to add pipeline capacity in the state.8

8Energy Information Administration
Cross-border truck volumes (see Figure 59) have nearly doubled at western Washington crossings over the past 11 years. This growth has strained border crossing facilities and enforcement agencies processes, resulting in queues of trucks north and southbound.

**Made in Washington – Regional Economies Rely on the Freight Transportation Network**

Our state’s regions (see Figure 60) have built strong and distinct economies based on industry and agriculture. Regional manufacturing, agriculture, construction, and forestry depend on an effective and efficient freight transportation network.

Over 519,000 jobs in regional manufacturing, agriculture, construction and forestry depend on Washington’s freight transportation network, and accounted for $145.7 billion, or 36 percent of all state gross business revenues in 2005. Transportation is especially important for Washington agriculture because the state produces about three times as much food – and for some commodities up to 20 times as much on a tonnage basis – as it consumes, and it is separated by long distances from the majority of the nation’s consumers. More efficient freight systems will help Washington manufacturers compete in the larger West Coast market.

Competitive pressure to cut inventories from every step in the manufacturing process is reshaping industrial supply chains, and causing more frequent freight shipments. The Boeing Company, employing 65,000 in Central Puget Sound, is Washington’s largest manufacturer with $22.7 billion in airplane revenues in 2005. Boeing’s dependence on the state’s freight transportation network will become even greater as it sets new levels of efficiency in the manufacture of the new 787 Dreamliner. Although Boeing has historically made planes from up to a million smaller pieces and shipped them by truck, train and boat, its new strategy to gain efficiency is based on major component assembly. Fewer parts, with more frequent deliveries, will support their just-in-time inventory reduction strategy.

Cost-saving inventory reduction strategies are also underway at thousands of other mid-market manufacturers and producers around the state. For example, the Vancouver Frito-Lay plant receives up to 50 truckloads of fresh potatoes each week from growers in the Columbia Basin. The plant keeps just enough potatoes on hand for one eight-hour shift; if the potatoes do not arrive on time, the plant cannot run. WaferTech’s one-million-square-foot semiconductor foundry in East Clark County can’t function without fast and reliable air cargo; if a tool is delayed overnight in the supply chain from Taiwan, the plant will shut down and idle 1,000 employees. Farmers ship vegetable produce over 200 miles from Prosser to Costco in Central Puget Sound, and are required to deliver within 15 minutes of their scheduled appointment.

These competitive trends are repeated in thousands of manufacturing plants, construction sites, agricultural growers and processors, and distributors facilities in Spokane, Bellingham, TriCities and across the state – driving logistics practices toward perfect flow that puts more trucks on the road, more frequently, with ever-shorter delivery windows.

Spokane regional manufacturers and health care system practitioners, and eastern Washington agricultural growers and processors, all cite severe winter weather closures on Interstate 90 at Snoqualmie Pass as eastern Washington’s top freight priority. They ship to customers in Central Puget Sound, so fixing delays on Interstate 5 from Everett to Olympia comes in a close second.

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9 Whatcom Council of Governments
10 Washington State Office of Financial Management and Washington State Department of Revenue
11 Washington State University, Strategic Freight Transportation Analysis
Northwest and southwest Washington manufacturers and trucking firms are also shipping to the Central Puget Sound region, so they put fixing the Interstate 5 corridor at the top of the list.

The Columbia Basin/north central Washington agricultural center leads the nation in apple and potato production. Apples and potatoes must be shipped in refrigerated truck or rail cars; 90 percent are trucked to market. Continued refrigerated truck shortages are likely due to seasonal peak demand and an ongoing pull from other U.S. regions for refrigerated capacity.

**Delivering Goods to You – The Retail and Wholesale Distribution System**

Distribution is a critical component of the freight transportation network, as it produces up to 80 percent of all truck trips in metropolitan areas, and serves the retail, wholesale and business services sectors.\(^{12}\) Over 732,000 jobs are involved in the distribution system; accounting for $221 billion in 2005 gross business revenues, equal to 71 percent of total state revenues.\(^{13}\) An enormous variety of goods are handled on this system; food and groceries, fuel, pharmaceuticals and medical supplies, retail stock, office supplies and documents, trash and garbage, construction materials and equipment.

Washington State’s modern service economy depends on speed of delivery through the freight transportation network. Distribution companies must provide fast and ubiquitous service that is reliable under all conditions. FedEx and UPS drivers do not go home until every package is delivered. Hospital patients cannot wait for drug deliveries. These companies rely on Interstate 90 and the core freight transportation network grid to reach population centers.

\(^{12}\)Cambridge Systematics, with TranSystems Corporation, Heffron Transportation, and the University of Washington

\(^{13}\)Washington State Office of Financial Management and Washington State Department of Revenue
The most common method of distributing goods is by truck from large distribution centers to stores and businesses. When those trucks run into congestion, companies compensate for delays by sending more trucks out on the road, causing even more congestion. Land use costs are also causing higher truck volumes. For example, in response to increased consumer demand for a wider variety of food products, grocers are increasing overall store size and shelf space. But back-storage space doesn’t generate sales, so modern grocery stores are reducing expensive, non-productive storage space. This requires more frequent deliveries in smaller quantities (see Figure 61); one Seattle specialty grocery store, for example, receives 375 truck deliveries per week.\textsuperscript{14}

New technologies enable companies to track more and more trucks, balance their inventories and capital usage, while managing very tight delivery windows. For example, UPS and FedEx’s high-tech logistics services allow companies to track inventory on the Internet no matter which warehouse, truck, or other location holds their products. By implication, the greatest increase in overall truck volumes will be seen in many more, smaller trucks on the roads.

Growing urban areas need daily delivery of consumer goods; most are coming from the state’s major distribution hubs in Central Puget Sound. In order to achieve population and employment growth, the freight transportation network must be able to provide delivery of consumer goods to residents everyday.

Needs

The following are representative needs for the Global Gateways, Made in Washington and Delivering Goods to You Freight Transportation Network:

» There are deficiencies on the core freight transportation network grid in Central Puget Sound:
  – Congestion on the I-5 corridor from Everett to Olympia
  – Missing highway links and aging structures such as SR 509 and SR 167, and the Alaskan Way Viaduct
  – Aging structures such as Alaskan Way Viaduct (see Figure 62)

» The I-5 Columbia River Bridge is at capacity and needs to be replaced

» I-90 Snoqualmie Pass improvements to prevent severe weather closures

» A local truck route program is needed to connect ports to the core freight transportation network grid

» Washington-Canadian border delays, congestion and security issues

» Ground access for air cargo: SR 518

» Grade separations at high-impact locations

» Operational improvements: complete statewide Weigh-In-Motion system, communications/ITS, truck rest stops

» Local roads are closed or weight restricted to heavy trucks for up to two months a year during spring thaw.

» A local truck route program is needed to connect industry to the interstate and the state highway system.

» A solution is needed for refrigerated truck and railcar shortages.

» A local truck route program is needed to connect distributors and urban areas to the interstate and the state highway system

» Construction planning on truck routes

\textsuperscript{14}Heffron Transportation, Inc.
Operational improvements and active management of the system to ensure that high-value, time-critical deliveries must move quickly through the freight distribution system

**Strategies**

The freight transportation network relies heavily upon a safe, efficient and reliable state highway system. Some of the strategies that improve the movement of freight are outlined in the Mobility section of this plan (see page 67). Strategies that are directly tied to the freight transportation network are currently under development and will be outlined in the next HSP update.

**Performance Measurement**

Transportation agencies throughout the United States are just beginning to think about how to create freight performance measures, and how to collect the data needed to tell them whether their improvement efforts are succeeding or not. The purpose of freight performance measures is to help us know whether public investments and strategies deliver the level of performance desired by the state’s freight customers. WSDOT’s Freight Systems Division is developing freight performance measures that matter to customers: manufacturing, agribusiness, construction, timber/wood products, wholesale and retail distribution sectors, and trucking, rail, barge, air cargo, freight integrators and logistics sectors. Examples of Washington State freight transportation network performance measures may include:

1. **Goal:** Reliability of truck deliveries is highly valued by retailers, wholesalers, manufacturers, construction companies, and trucking companies as it reduces the need to hold expensive buffer stock (inventory) and enables efficient labor planning. Unreliability on the road system is the biggest cost driver in the delivery system. Improved reliability of the freight transportation network would improve our state industries’ comparative advantage and lower the price of consumer goods for Washington’s citizens.
II. Improvement > Economic Vitality

Problem Statement: About 80 percent of all truck trips occur in metro centers, where highway and road congestion cause increased system unreliability.

Measure: Reliability of the urban freight transportation network is created by reducing variance around the mean for truck deliveries from origin to destination. WSDOT is developing a data framework to track variance in the urban truck delivery system.

2. Goal: Washington State agribusiness, manufacturers and timber/wood products companies need to be able to ship their products to customers everyday of the year. Removing persistent barriers to the freight transportation network will enable our state’s agribusiness and manufacturing sectors to become more reliable vendors to global and regional buyers.

Problem Statement: Snoqualmie Pass on I-90 is often closed during severe weather, and county roads are weight-restricted up to four weeks a year to large trucks during seasonal spring-thaw conditions. These two freight transportation network barriers intermittently block Washington’s farmers and manufacturers access to their customers. About 28 percent of goods shipped over Snoqualmie Pass are agricultural products and 19 percent are manufactured goods. Weight-restricted county roads in eastern Washington are used by most regional agribusiness, wood and mining producers; northwest Washington also weight restricts roads to manufacturers and agribusiness.

Measure: The number and percentage of total acres of agricultural production and industrial-zoned land in Washington State that have road access to their markets, 365 days per year.

3. Goal: Increasing the efficiency of Washington State’s freight transportation network will lower in-state freight transportation costs and improve our state’s manufacturing and agribusiness sectors’ comparative advantage over like sectors in other regions.

Problem Statement: Freight-dependent industries spend a high percentage of total production costs on transportation and these costs add little value for buyers. Agribusiness is particularly sensitive to transportation costs as Washington is far from major population centers, and transportation costs can be the differentiating factor for buyers.

Measure: The Freight Systems Division conducted a statistically-valid survey of manufacturers, agribusiness, timber/wood products and wholesale companies in seven regions in Washington State in 2004 and in 2007 to measure their total transportation costs as a percentage of Costs of Goods Sold (COG) and total logistics costs as a percentage of COG.

The Freight Systems Division is also considering performance measures and associated data collection proposals to gauge progress towards:

» Making major cargo airports attractive for truck deliveries and pick ups

» Improving truck access and flow on highway networks in the state’s metro centers

» Improving truck efficiencies between national mega-regions such as Vancouver B.C./Bellingham, Seattle/Bellevue/Tacoma, Portland/Vancouver WA, San Francisco/Oakland, and L.A./Long Beach.

Community Economic Development

Recent trends show new investments in smaller communities leading to higher employment growth. A regional shift in economic investment to smaller communities reflects the higher costs associated with establishing businesses within more densely populated areas. Economic development within smaller communities is evident in the technology sector and new industries.

This regional shift is clearly visible in the technology sector. Established technology-rich communities like Seattle, Vancouver and Spokane have experienced a drop in technology jobs over the last two years, while Bellingham, the Tri-Cities and Bremerton all exhibited strong technology job growth.
Development of new industries in smaller communities has also created employment growth. The increased presence of Washington State as a premium wine producer has produced a secondary effect in communities with wineries, tourism. The popularity of wine tours adds additional employment growth to these communities.

**Scenic Byways**

WSDOT is committed to work with local communities to create the partnerships needed to develop the necessary access to scenic, recreational and cultural resources. WSDOT has established a number of highways as “Scenic Byways” to support tourism and recreational opportunities within Washington State. Working with local communities to identify the locations where access is needed to support these emerging industries will be an ongoing effort expanded in future updates of the HSP.

<table>
<thead>
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<th>Economic Vitality: Funded vs. WTP Unfunded Targets</th>
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<tr>
<td>Funded ($ in millions)</td>
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<tr>
<td>Economic Vitality Total</td>
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<tr>
<td>Highway System Plan Total</td>
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</table>
Health and the Environment

Investing in our transportation system can help align citizens’ goals for a healthy environment. Environmental elements (see Figure 63) are considered part of every project’s design, construction, operation and maintenance.

Highway capacity and widening projects are designed to:

» Manage stormwater by removing pollutants and controlling flow

» Protect the quality of groundwater

» Control erosion of streambanks and reduce surface run-off

» Provide fish passage

» Allow habitat connectivity for wildlife

» Build barriers to reduce traffic noise on neighborhoods

» Replace and improve wetland functions

» Protect cultural and historic resources

» Minimize air pollution

» Provide bicycle/pedestrian facilities as needed.

WSDOT plans to continue investing in stand-alone environmental retrofit projects to fix problems along the existing highway system.

These retrofit projects include:

» Remove culverts that keep fish from reaching upstream habitat

Providing habitat connectivity where there is a high incidence of vehicles striking wildlife

» Reduce highway noise in areas not addressed by past construction projects

» Manage stormwater on highways that do not treat runoff or control flow

» Fix stretches of highways that suffer from repeated flooding or streambank erosion

» Provide pedestrian crossings near schools, senior centers, and parks

Figure 63. Seven Core Elements to WSDOT’s Environmental Management Systems

» Legal and other requirements clearly outline all environmental laws, regulations, and agreements that apply to operations.

» Written procedures instruct staff and contractors how to conduct work activities in compliance with requirements.

» Training ensures those that conduct certain activities know how to do the work in a compliant manner.

» Roles and duties ensure WSDOT staff and contractors know what they are to do under the EMS.

» Inspection, monitoring, and corrective action ensure a process is in place to check WSDOT’s work for compliance and correct any problems.

» Documentation allows WSDOT to evaluate the operation of the EMS, and communicate results to the public and within the department.

» Performance measurement compares WSDOT’s performance against pre-determined targets, with results reviewed by management and reported to the public.

Fish Passage Barrier Removal

Why is Fish Passage an Issue for WSDOT?

Salmon and other fish need access to freshwater habitat for spawning and juvenile rearing. WSDOT recognizes that many highway culverts are barriers to fish passage and removal of fish barriers is important to the restoration of fish habitats and salmon recovery efforts. Highway culverts can act as barriers to fish passage when:

» The culvert outlet is too high and exceeds the jumping capabilities of fish
WSDOT’s Fish Passage Barrier Removal Program began in 1991 to identify and remove barriers to fish passage. This is a cooperative effort with the Washington Department of Fish and Wildlife (WDFW). WSDOT contracted with the WDFW to inventory, identify, and prioritize state-owned culverts that are fish passage barriers. In September 2007, WDFW completed the state-wide inventory of WSDOT’s highway system (approximately 7,000 miles). The data from the final inventory is still being tabulated. The WSDOT 2007 Fish Passage Inventory reported:

- 6,210 culverts have been inventoried statewide
- 3,142 culverts are in fish-bearing streams
- 1,676 of the culverts in fish bearing streams were identified as barriers.
- 1,266 WSDOT-owned fish passage barriers that are in need of modification or replacement were identified as having significant habitat gain. Significant habitat gain can be described as adding more that 200 meters of habitat by removing a barrier from a fish bearing stream.

**Fish Barrier Removal Strategies**
WSDOT evaluates and corrects fish passage barriers using a three-pronged approach. First, as road capacity and widening projects are constructed, fish passage barriers are removed whenever a Hydraulic Project Approval (HPA) is required for construction work on a culvert located within the project area on a fish bearing stream. Combining fish passage correction with road project construction decreases costs eliminating duplication in equipment and personnel mobilization. Second, fish passage barriers are removed using dedicated Environmental Retrofit budget category funding to correct the highest priority fish passage barriers within the Fish Barrier Removal Plan. Third, in the Environmental Retrofit category, some fish passage barriers are corrected when WSDOT identifies and fixes failing culverts.

Since 1991, WSDOT completed 205 fish passage projects opening 480 lineal miles of habitat (see Photo 39).

WSDOT spent $46 million since 1991 for inventory and correction of fish barriers. $20 million was spent on the fish passage inventory and $26 million on correction. In 2006, 20 high priority fish passage projects were completed including seven stand-alone projects. More information on these projects can be found at: www.wsdot.wa.gov/Environment/Biology/FP/fishpassage.

**Prioritization Approach for Strategies**
WSDOT will continue to fix culvert barrier projects (see Photo 40) during highway widening and capacity improvement projects. Culvert barriers identified within the project limits are fixed whenever an HPA is required. If the highway project includes a fish barrier culvert within the project limits, but the culvert does not require an HPA, WSDOT is not required to fix the culvert, but may exercise discretion and fix the barrier on a case-by-case basis depending on the quality and quantity of the habitat gained and cost of the culvert replacement.
WSDOT’s current strategy for the fish barrier removal work in the Environmental Retrofit budget category is to continue to focus on fixing the highest priority fish passage barriers. Some barrier corrections provide more habitat gain than others and projects to correct the barrier can vary widely in cost. The highest priority barriers are those that open up the greatest amount of high-quality fish habitat at the lowest cost. The rate of barrier correction depends on the amount of funding the legislature approves for the WSDOT fish barrier removal program.

Each biennium dedicated funding within the WSDOT Environmental Retrofit budget category is set aside for correction of ranked, high priority fish passage barriers identified during the WDFW inventory. Projects are prioritized to provide the largest gains in habitat and the greatest production benefits for both migrating and resident fish species. Many factors determine a project’s priority including: the degree of passage improvement, potential increase in production for specific species resulting from the gained habitat, amount of habitat gained, benefits or drawbacks from increased mobility to species present, stock status of species present, and cost of the project. All these factors are consolidated in a numeric priority index model, which provides an objective priority ranking for each project. These projects are contained within the WDFW Fish Passage and Diversion Screening Inventory Database.

How Does WSDOT Characterize the Benefits and Performance?

WSDOT characterizes benefits as the lineal miles of habitat opened up as a result of barrier removal. WDFW inspects each corrected barrier the first year after construction. Each project is checked for fish passage use, and certain sites are selected for long term studies to see if fish use continues and whether the design of the structure is working as intended.

Ten Year Planning Document

At WSDOT’s request, WDFW has prepared a prioritized list of fish passage projects to be constructed and evaluated over the next ten years. The Ten Year Plan is the result of a process of project evaluation, scoping, development of conceptual designs, and budget development. The plan is regularly updated as projects are identified, prioritized, scoped, and refined. Project scoping is a multi-phased process that is carried out by WDFW biologists, environmental engineers, and WSDOT regional staff.

Habitat Connectivity

Why is Habitat Connectivity an Issue for WSDOT?

Washington is a biologically diverse state with over 650 vertebrate species. More than 63 of these are currently designated under the federal Endangered Species Act, including 38 terrestrial species. The state highway system is present in the majority of the habitat types of the state. There is strong public support for transportation solutions that include ecological considerations as part of meeting transportation objectives.

There is a growing understanding of the impacts of roads on wildlife and habitat. This is important from a natural resource conservation perspective as well as a matter of public safety. The 2005 publication by the National Academies of Sciences “Assessing and Managing the Ecological Impacts of Paved Roads” identifies how roads can constitute barriers to animal movement, lead to habitat loss, and in some cases can contribute to the decline of imperiled wildlife populations. Animal-vehicle collisions pose a serious hazard for motorists as well as a significant source of wildlife mortality. WSDOT annually records about 3,000 collisions with deer and elk on state highways (see Figure 64). A new WSDOT Secretary’s Executive
Order “Protections and Connections for High Quality Natural Habitats (E 1031.00) discusses the importance of protecting high quality habitats and species and the need to develop and follow design criteria for transportation structures that help promote fish and wildlife movement and minimize habitat degradation.

Measures such as enlarged stream crossing structures, wildlife crossing structures (see Photo 41 and Figure 65), animal detection and warning systems, and fencing have proven useful in reducing some of the problems, but these need to be applied in a strategic manner to get the best gain. Significant effort has been made in a few areas of the state, such as the I-90 Hyak to Easton corridor, but in Washington, the attention has largely been opportunistic, and project by project. To provide the best benefit for habitat connectivity as well as helping reduce the potential for animal-vehicle collisions, a system for identifying and prioritizing key areas statewide is needed. This can then be used to develop location specific solutions in a strategic manner.

Photo 41. Rock Knob Wildlife Crossing

Before.

After.

WSDOT is planning to build 14 wildlife crossings on I-90 using funds from the 2005 TPA Funding Package. These structures will be used to control wildlife crossings on a 15-mile stretch of road from Hyak to Easton. Wildlife overpasses and underpasses will be placed in areas that are heavily used wildlife crossing spots, connecting wildlife habitats on either side of the highway and in a large median area between the eastbound and westbound lanes. Ideas being considered for monitoring techniques include “track pits” (freshly-turned earth that is checked periodically for animal tracks) and hidden videocameras. WSDOT is currently examining structures in Arizona, Montana, and Canada to discover best practices in developing the structures and monitoring their usage. Construction could begin in 2011. For more information, visit www.wsdot.wa.gov/Projects/I90/HyaktoKeechelusDam/
How Can WSDOT Contribute to a Solution?
While there is a growing body of knowledge about how to better address wildlife habitat connectivity, research is needed to help identify high priority focus areas in the state. This research would be used for addressing wildlife connectivity statewide and to make preliminary recommendations for addressing connectivity. Working with existing GIS data, and other existing information including local expert knowledge, it would be possible to develop a habitat connectivity plan for the highway system. This would include locations of notable habitat areas for large terrestrial animals such as deer, elk and cougar, as well as for other species that are of special conservation management concern. This prioritization plan should also include locations where there are lands managed for habitat protection (i.e., parks, preserves, forest service land) and highway locations where significant animal-vehicle collisions occur.

Potential Benefits of Addressing This Issue
This research effort would provide a basis for determining the locations of key focus areas for animal connectivity. This could be used in project identification and scoping to identify where the best opportunities for improving connectivity and reducing animal-vehicle collisions are, and to allow these locations to be more easily included in long-term project planning. With a well developed system of habitat corridors, WSDOT will gain a better understanding of the scope and scale of the issue and can develop proactive strategies for improvements. This would also help with demonstrating compliance with federal regulations (SAFTEA LU section 6001) that directs states to incorporate natural resource information into transportation planning.

Habitat Connections
What is the Problem?
Transportation systems have the potential to impact habitat in ways that include:
- Direct effects such as noise disturbance or wetland fill
- Habitat fragmentation
- Barrier effects that impede the movement of fish and wildlife.
- Vehicle-wildlife collisions.

WSDOT recognizes the importance of habitat connections at the policy level.

Strategy to Address the Need
WSDOT is working on developing a habitat connectivity plan that will identify areas where habitat connectivity must be maintained. These will include priority areas where highways intersect important wildlife habitats, wildlife migration routes, and lands under special management for the protection and enhancement of wildlife (like wildlife refuges) and areas with high animal vehicle collisions. These areas will be prioritized as low, medium and high priority for retrofit. The prioritization process will consider many factors including, but not limited to, migration needs of ESA listed species, rate of animal-vehicle collisions, management of adjoining landscaped (i.e., wildlife refuges, national forest etc.), and highway areas that are wider than normal.

Performance
Effectiveness of the program will be measured by the methods that relate to the solutions implemented. Typical measures may include reductions in the numbers of animal-vehicle collisions, a measure of the number of connectivity structures installed per mile, frequency of use of connectivity structures, miles of habitat corridors connected etc.

What are the Benefits?
The benefits of this program are improved public safety by a reduction in animal vehicle collisions and improved animal connectivity between important habitat areas. Careful analysis will help WSDOT determine the highest priority locations where habitat connectivity investments should be made.

Fixing Chronic Environmental Deficiencies
What is a Chronic Environmental Deficiency and Why is This a Problem for WSDOT?
Chronic environmental deficiencies (CEDs) are locations along the state highway system where recent, frequent, and chronic maintenance and/or repairs to the state transportation infrastructure are causing impacts to fish and/or fish habitat. WSDOT established a collaborative process with the WDFW to move away from the repetitive repair of infrastructure and instead concentrate on long-term solutions.
(see Figure 66) to optimize environmental improvements for fish and fish habitat while also addressing transportation infrastructure needs. A repetitive maintenance project becomes a CED when there are at least three or more repairs to the highway within a ten-year period that are causing impact to fish and/or fish habitat. WSDOT and WDFW coordinate on the identification, scoping, design, and construction of CED correction projects.

WSDOT uses funds from its Environmental Retrofit budget category to identify CED projects on state highways. WSDOT and WDFW coordinate on the identification, scoping, design, and construction of CED correction projects. WSDOT funds CED correction projects through a stand-alone retrofit program.

The 2005 Legislature provided $52 million to fund 10 retrofit projects.

**How Do We Prioritize CED Projects?**

The process for prioritizing CEDs (see Figure 67) is collaborative and includes technical (engineering and biological) construction/maintenance, and policy components. It is an integral part of a cycle that includes CED site identification, prioritization, scoping, design, funding, permitting, construction, and evaluation. Data for the prioritization are supplied in several steps of the CED project pre-scoping cycle.

**Description of Benefits of Implementing the CED Program**

The program reduces maintenance costs for chronic repairs, reduces flooding risk, and improves negative impacts to habitat for important fish species. Benefits can be measured by the reduction in maintenance work and the reduction in the size of the area impacted by the repetitive maintenance work (i.e. reduction of impacted area with removal of rip rap required for a repetitive river bank stabilization project).

**Stormwater Management**

WSDOT has come a long way toward aligning citizen’s goals for a clean and healthy environment with meeting their transportation needs.

**Figure 66. Project Costs**

Over the last 20 years, WSDOT has spent approximately $2.2 million for repair work at this site.

One alternative considered was to realign U.S. 101. Estimated project costs were $10.0 million and did not include mitigation costs for major environmental impacts.

Total project costs were approximately $7 million. Eighty seven percent of the project costs were paid by the Federal Highway Administration.

Today’s highway construction projects integrate environmental components into project design, budget, construction and operation. WSDOT is now making major investments in erosion and sediment control protection and stormwater management. This is in response to specific permit requirements as well as best practices that demonstrate our environmental commitment (see Table 13).

Public discussion of emerging issues, advances in scientific knowledge, and evolving practices also inform us of additional needs and priorities.
Improving our Performance: Stormwater Management

Today’s focus is on managing stormwater runoff for flow control and pollutant treatment (see Photo 42), inventoring discharge outlets, and investigating the performance of stormwater best management practices in terms of their ability to remove pollutants from stormwater. WSDOT is continually learning more about the performance of various stormwater practices used by WSDOT and state, tribal, and local jurisdictions. Monitoring helps transportation agencies and regulators evaluate the effectiveness of treatment facilities and helps match the right treatment to each unique situation. WSDOT continually reviews performance monitoring data and routinely updates its policy manuals and technical guidance for use by the people who design stormwater facilities. As an example, WSDOT’s research has shown that grass-lined swales can effectively reduce most pollutants from runoff and are very economical to build and maintain. WSDOT is now working with the State Department of Ecology and

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<th>After Treatment (lbs)</th>
<th>Effectiveness vs. Goal set by DOE (% removal)</th>
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Source: WSDOT Environmental Services Office

Table 13. Stormwater Treatment Facility Effectiveness

WSDOT built 42 stormwater treatment facilities in Western Washington between July 2004 and June 2005. In response to municipal stormwater permit requirements, WSDOT has built 741 stormwater treatment facilities in King, Snohomish, Pierce, and Clark counties since 1996.
other agencies on acceptable approaches to manage stormwater and flow control more broadly within a watershed.

Expanding the menu of available stormwater management techniques also helps to build connections between transportation investments and other community goals such as landscape design and watershed initiatives.

There are numerous strategies and policies that guide how stormwater is addressed on various projects. In most cases where new pavement or structures are constructed, all stormwater from the new surfaces is treated for quality and quantity. Solutions vary from simply utilizing existing vegetation, soils, and topography along roadsides to effectively provide flow control and runoff treatment through natural dispersion and infiltration to more highly engineered systems such as linear sand filters consisting of a two-chambered vault. Linear sand filter systems typically consist of two cells or chambers, one for settling the coarse sediment in the runoff entering the filter facility and the other for housing the sand filter media and underdrain outlet system. Treating stormwater outside the immediate project footprint is sometimes allowed.

WSDOT has established specific provisions for treating stormwater coming from existing pavement in order to maintain the financing intent and capacity of our budget category. In Mobility Projects treating runoff from existing pavement is always allowed. In Safety and Economic vitality projects there is generally a limit of 20 percent of the cost to treat new pavement, although a variance can be requested. Environmental Retrofit projects except for Stormwater Retrofit, are not allowed to treat runoff from any pavement. Paving projects can only consider retrofitting existing impervious surfaces involving the total replacement of existing concrete lanes.

These policies are reviewed periodically by the Strategic Planning and Programming Office to consider any changes that may be necessary due to changes in laws and other legislative directives.

**Stormwater Retrofit Needs**

Most highways were built prior to stormwater regulations and have no runoff treatment or flow control facilities associated with them. All new projects address stormwater, however, a small amount of funds are applied to retrofit old stormwater facilities where no new construction is planned. There is also a lack of information about the number and location of outfalls on the state system. Regulations requiring that highway runoff be treated to remove pollutants and control peak flows took effect for WSDOT in 1995. As most of Washington’s highways predate such regulations, the water running off of these highways is not treated. This lack of treatment results in large amounts of dirty stormwater leaving the highway system in thousands of places called outfalls. The water from these outfalls potentially degrade receiving water bodies used for drinking, recreation, fish habitat, and other beneficial uses.

Because new construction projects only affect limited portions of the highway system, WSDOT programming procedures allow for stand-alone environmental improvements as part of the Environmental Retrofit program. Although authorized, this program has received limited funding for some time despite a requirement of the Washington Administrative Code (Chapter 173-270 WAC) to retrofit deficient outfalls in the Puget Sound Region.
Strategy

While WSDOT is intent on addressing all stormwater deficiencies (see Figure 68), this stormwater strategy priority will be given to developing urban fringe areas. There is a closing window of opportunity associated with preserving and protecting urban fringe areas compared to rural and intensely urbanized areas. As the area develops, land becomes much more expensive. Decreasing land availability and increasing real estate costs in such areas impose a level of urgency to provide stormwater treatment before currently available, cost-effective treatment options are forever lost.

Development in urban fringe areas is transitioning to more intense land uses but the natural systems, while under stress, are still functioning properly and not beyond repair. Retrofitting stormwater here is more likely to make a measurable difference. At a minimum, the retrofits constructed in this environment will eliminate highways as a pollutant-contributing source as the area builds out. There will be a large array of treatment facilities to choose from and more of an opportunity to use low impact development practices.

Retrofitting outfalls in rural area is less urgent because rural waters are less likely to become significantly affected in the near future and retrofit opportunities will not diminish as quickly. Likewise, potential benefits are low in urban areas where extensive development in surrounding areas severely limits the potential for significantly restoring habitat and water quality.

Prioritization

Within these developing areas environmental specialists will apply a rating methodology that takes into account proximity to sensitive surface water bodies, drinking water supplies, and traffic density. WSDOT will use the data to identify areas in the developing urban landscape where retrofits are most likely to have a beneficial impact. Additional detailed inventory can then be scheduled to determine the highest priority outfalls in those areas and the best solutions.

Figure 68. Stormwater Retrofits Projects
Performance

How Do We Characterize Benefit?

» WSDOT can characterize benefit in terms of (1) acres of surface treated or (2) estimate reductions in annual pollutant load. The first can be accomplished in the design and, although the second can be estimated during design, it would be prudent to monitor a variety of treatment facilities constructed for retrofit purposes.

» The level to which the retrofit supports other initiatives, for example protecting Puget Sound, Salmon recovery, etc., or any program that relies on water. Controlling water flow benefits fish habitat, reduces bridge scour, and culvert maintenance. Managing pollutants benefits the health of aquatic animals, drinking water supplies and human recreation activities.

2005 Legislative Action

The 2005 Legislature funded several stormwater retrofit projects ($7.6 million for eight projects).

The proposal is to increase the funding for the stormwater retrofit program to complete the outfall inventory and fund more retrofit projects.

Description of Benefits/Impacts of Implementing the Proposal

Improving the performance of highway drainage facilities will improve water quality and reduce damage to the highway system and downstream areas from stormwater.

A complete inventory of outfalls and treatment facilities will help WSDOT better plan, execute and maintain an effective stormwater program.

The estimated cost to develop a strategic implementation plan, to complete the inventory of stormwater facilities on the state highway system, and begin retrofit installations at selected locations is $340 million.

This dollar request is derived from the following:

Stormwater retrofit (capital) and maintenance/operating unfunded priority needs including:

» Funding projects on five percent of outfalls to install stormwater treatment statewide,

» Completion of an inventory of stormwater facilities (to track and prioritize),

» Stormwater facility maintenance and inspection to comply with new permits.

Related Investments Proposed by the Commission in the WTP

Roadside Maintenance – Retrofit of existing state highway shoulders and medians as part of the Integrated Vegetation Management program to improve filtration of stormwater runoff and establish desired grass stands.

Benefit of this change of practice would be decrease in herbicide use, weeds and invasive species and maintenance costs. Grass shoulders filter contaminants – benefiting water quality.

Noise Barrier Retrofit

What is the Noise Wall Retrofit Program?

Noise barrier retrofit is a voluntary program established by WSDOT to improve livability at locations where traffic noise exceeds certain levels and negatively impacts residential areas and other noise-sensitive areas; and that were not considered when highways and freeways were initially built. Retrofit locations are only identified if sensitive uses like homes, schools, and parks were permitted for construction on or before May 14, 1976. This date is important because federal traffic noise regulations came into effect in 1976. Highways built prior to that date are not subject to federal noise regulations unless they are widened or their alignments change.

A Short Summary of How, When and Why WSDOT Builds Noise Walls

Noise barriers (see Figure 69) are free-standing earth berms or walls built parallel to a highway. Walls are usually made of concrete and are found near public areas (such as parks) and residences. The barriers range in height from 6 to 30 feet, but are typically 12 to 15 feet tall. Around the Seattle area, examples of noise walls can be seen on Interstate 5 just north of the Ship Canal bridge, on Interstate 90 just west of the Mount Baker Ridge tunnel, and on Interstate 405 between Totem Lake and Bellevue. Most noise walls are installed as part of large construction projects that add new highway lanes, which increase vehicle capacity.
Long before construction begins, acoustical engineers evaluate sources and patterns of noise in neighborhoods near the project limits. The findings are used to determine if noise walls would be feasible and cost-effective. This evaluation takes into account many factors, only one of which is actual highway noise. Among other things, acoustical analysts look at area topography, population density, cost, and expected levels of noise reduction a barrier would provide. If, for example, homes near a project are widely-spaced or built high on a hill, WSDOT often will not build noise barriers because the cost to reduce noise for each resident is usually quite high and the barrier does not noticeably decrease noise.

WSDOT also builds noise walls in high-noise neighborhoods that existed before the freeway. These walls, known as “retrofit” walls, are submitted to the Legislature for programming consideration along with other important programs like safety improvements and pedestrian accommodations. To be equitable to everyone, retrofit noise walls are ranked and built according to a neighborhood priority list. WSDOT builds on average one retrofit wall every two years. That means even if a neighborhood qualifies for a noise wall, it may be several years before it is actually built.

WSDOT receives many requests from citizens to build noise barriers, but not everyone wants them. Sometimes finished barriers obscure scenic views from residents’ homes. And, in almost every case, WSDOT must remove trees and shrubs within state right-of-way to make room for a barrier. Because of these differing viewpoints regarding noise barriers, WSDOT holds open houses during the design phase of a project to solicit public comments.

What is the Problem?
The impact of traffic noise on neighborhoods throughout the state was not considered before May 1976, when federal noise regulations were put in place. WSDOT has developed a prioritized retrofit program to construct noise barriers in these locations, but it has received limited funding.

Figure 69. Noise Barriers
II. Improvement > Health and the Environment

Health
A threshold noise level at 67 decibels (dBA), for consideration of noise barriers, is based on annoyance curves from previous studies and has no actual relationship with health. Noise and health is an extremely complex relationship because it affects many people differently. Annoyance may lead to health concerns/stress like high blood pressure, anxiety, and difficulty concentrating or sleeping in some people but not in others. Some people have a high tolerance for loud noises and others are less comfortable with quiet. Some people will put up with traffic noise if there is a scenic view at stake – but not without one. Other people are upset because they cannot control their noise environment, yet that lack of control is not an issue.

Permanent hearing loss can occur when people are exposed to continuous high sound levels according to the US Occupational Safety and Health Administration (OSHA). The OSHA regulated levels range from 90 dBA for eight continuous hours to 115 dBA at ¼ hour or less. Typical continuous noise exposure for drivers and passengers inside standards cars may range from 65 to 85 dBA. Noise from traffic measured on the roadside ranges from 55 to 85 dBA based on a 15 minute time-weighted average.

Property Values
WSDOT provides noise mitigation when it is reasonable and feasible to do so (including a cost/benefit analysis). WSDOT’s determinations are not related to property values in any way. If property values were taken into account, WSDOT would not be in compliance with environmental justice and non-discrimination values. The effects of noise mitigation on property values (like health), is so subjective that WSDOT can not make specific determinations. For example, if WSDOT places a noise wall that blocks a scenic view – property values may go up or down depending on the values of the property owner. For some locations, property values may temporarily dip during construction phases (because people do not generally like construction delays), but then come back up again once the project is complete. In some cases, properties values may increase more without a barrier because of better access to transportation facilities. When WSDOT places noise barriers, the property value may go down because to some people the wall is too imposing, but others may value it more because of the noise reduction.

2005 Legislative Action
The legislature provided about $38 million to address several of the highest priority locations.

Description of Proposal
WSDOT is looking to dedicate consistent funding for the noise retrofit program. The retrofit priority list currently consists of 61 locations in 20 different counties. This proposal will address the continued backlog of noise projects which will benefit established neighborhoods and help to meet noise reduction goals in an environment of increasing traffic volumes.

The WTP identifies funding of noise retrofits as a medium priority. Based on an updated cost assuming an inflation rate of approximately four percent, the anticipated total need is estimated at $220 million in 2007 level dollars.

*No policy recommendations are made in the final WTP for addressing noise issues other than the specific retrofit of 60 locations.

Source WSDOT WTP Presentation-6/15/05

Noise Barrier Inventory
Source Prioritization Process
How are noise retrofit locations prioritized on the list and how will they perform?
Washington State Department of Transportation Directive D22-22 outlines the procedures for placing locations on the ranked retrofit list and provides a detailed methodology on how to prioritize locations. Locations on the list are prioritized in an order that reflects traffic noise levels, number of homes benefiting, planning level cost, and achievable reductions.

Each noise barrier project is designed to achieve noticeable reductions in traffic noise for benefiting residents. Typical reductions range from 3 to 15 dBA depending on the location of the listener in relation to the barrier. The department performs detailed noise studies prior to construction of a noise barrier to determine the amount of noise reductions that we anticipate a barrier to achieve.
Bicycle Transportation, Pedestrian Walkways and the Environment

Bicycling and walking are two modes that signify a dynamic transportation system. They provide not only environmental and health benefits, but also a strategy to reduce traffic congestion and have a positive economic impact across the state.

Description of the Issues

WSDOT is committed to working with private and local governmental entities to develop a plan which identifies bicycle and pedestrian needs and cost effective strategies. This plan will be consistent with the Legislature’s stewardship goal and satisfy requirements of RCW 47.06.100 as well as the federal requirement for a long range bicycle transportation and pedestrian walkway plan.

The goal is to improve bicycle and pedestrian safety while increasing the number of people who bicycle and walk. The strategies for accomplishing these goals include: maximizing funding through partnerships; raising awareness of the needs for bicycle and pedestrian safety; and sharing information on bicycle and pedestrian issues between agencies, jurisdictions, and organizations in Washington State.

The rapid increase in obesity, diabetes, and asthma among children and adults in Washington State is a growing concern. Statistics from the Centers for Disease Control show that obesity trends among adults in Washington State have increased from less than 10 percent in 1991 to over 20 percent today. Personal transportation choices, the perceived limitations on personal mobility, and in some cases the lack of transportation alternatives have been implicated as contributing factors to these disturbing trends.

Needs

In response to these trends and research, several Washington communities have identified and benchmarked community health indicators that often include transportation measures such as the number of people walking and bicycling. Pedestrian and bicycling activity is a common measure of community health because this measure reflects many different aspects including safety, security, economic vitality, public health, and the quality of the natural environment. Other indicators of healthy communities include:

* available and affordable housing;
* mixture of land use;
* strong community leadership;
* innovative neighborhood design;
* interconnected pedestrian and bicycle facilities;
* creative stormwater management;
* healthy wetland areas;
* and improved air quality.

Strategies

Collaborative partnerships to develop and implement transportation systems are improving the way people live and work together by increasing access to transportation services and the way we share information about travel. A comprehensive approach to designing transportation systems considers the compatibility of each project with community character and values, the environment, and the unique needs and desires of the community.

The ability to plan, participate in planning efforts, or develop a community’s transportation future depends on having trained planning staff. This is a key issue for many of Washington State’s tribes, small cities, and counties that lack funding for such planning capacity.

Healthy Communities

WSDOT should coordinate with the Growth Management Services Division of the Department of Community, Trade and Economic Development. The two departments should convene a task force to identify sources and ways of pooling funds in order to support local governments seeking assistance in addressing the Growth Management Act requirement to include a pedestrian and bicycle component in comprehensive plans. Pedestrian and bicycle facilities and network constructed to provide for safe and healthy transportation options through walking and biking.
Washington Provides Grant Funding for Pedestrian and Bicycle Projects

The Washington State Legislature funded $74 million over the next 16 years to support pedestrian and bicycle safety projects, such as pedestrian and bicycle paths, sidewalks, safe routes to school, and transit.

The Pedestrian & Bicycle Safety program will address the nearly 400 statewide fatalities and injury collisions involving pedestrians and bicyclists each year. The purpose of the Pedestrian and Bicycle Safety program is to aid public agencies in funding cost effective projects that improve pedestrian and bicycle safety through engineering, education, and enforcement. Eligible projects may address the following:

A. Engineering Improvements – Projects may include items such as:
   - Improving intersections by providing: curb extensions, lighting, raised median, crosswalk;
   - Enhancements, signs, signals, and mid-block crossing treatments;
   - Completing bicycle lanes and sidewalks;
   - Constructing bicycle and pedestrian paths;
   - Providing safe routes to transit;
   - Providing pedestrian and bicycle safety improvements for at-risk groups (children, the elderly, and people with disabilities).

B. Education Efforts – Projects may include items such as:
   - Implementation of educational curricula;
   - Distribution of educational materials;
   - Development of promotional programs for walking and biking.

C. Enforcement Efforts – Projects may include items such as:
   - Additional law enforcement or necessary equipment for enforcement activities;
   - Vehicle speed feedback signs;
   - Neighborhood watch programs;
   - Photo enforcement.

<table>
<thead>
<tr>
<th>Environmental Quality and Health: Funded vs. WTP Unfunded Targets</th>
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<tbody>
<tr>
<td><strong>Funded</strong> (in millions)</td>
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<tr>
<td>Environmental Quality and Health Total</td>
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<tr>
<td>Highway System Plan Total</td>
</tr>
</tbody>
</table>

16.7% funded, 83.3% unfunded.