

**Washington Transportation Commission**  
**Washington State Department of Transportation**  
**WTP Update Process**

**Future Visions**

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*Source: "The Quality of Mobility" ("Die Qualitaet der Mobilitaet") by Claudia Wandler at the Institute for Design in Pforzheim, Germany, ("Fachhochschule fuer Gestaltung, Pforzheim").*



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## Executive Summary

### **What are the visions of transportation system futures - shared and unshared - that should shape today's transportation planning to help create pathways to the future?**

There are a lot of visions for the future of transportation in Washington that come from all levels and perspectives - some are beyond our grasp (either by just a little or sometimes by a lot), and some are within sight (sometimes clearly, and sometimes more distantly). Some are clearly needed – some are less justified. Given that Washington's population is still growing, it is important to think today about shaping the future, even though current funding is tight.

#### *Adding New Systems*

New types of transportation are being pursued to provide alternatives to driving and to support growth management plans at the local and regional level.

#### **High Capacity Transit**

A high capacity transit vision is starting to unfold in Washington. Sound Transit's *Tacoma Link* light rail is now operating in downtown Tacoma. The first 14-mile segment of the *Seattle Link* light rail is under construction between downtown Seattle and Tukwila, with a second phase being planned. The light rail system vision lays out proposed connections across Lake Washington to Bellevue and Redmond and extensions north to Everett and south to Federal Way. Sound Transit commuter rail is now operating from Tacoma to Seattle and from Everett to Seattle, with expanded service under development. Sound Transit *Express* buses are also operating on major freeway corridors throughout the Puget Sound Region, and a series of direct-access ramps are being constructed to improve transit access to park and ride lots from HOV lanes.

In Portland, the TriMet *MAX* light rail system has four lines operating, two of which approach Clark County in the I-5 and I-205 corridors. The Vancouver area is considering high capacity transit in Clark County and connections across the Columbia River into Oregon. In Spokane, preliminary planning has been done for a light rail line from the Spokane Valley to downtown Spokane.

Supporting this high capacity transit vision is the 300-mile High Occupancy Vehicle (HOV) lane system in the Puget Sound Region, with over 200 miles already constructed within congested freeway corridors. This HOV system is supported by a broad network of park and ride lots, an extensive vanpool fleet, and demand management programs aimed at encouraging transit alternatives. Transit-oriented developments—land uses that provide densities, mixed uses, and pedestrian facilities to build a walk-to-market for transit have been built in Bellevue, Issaquah, Dupont, Vancouver, and throughout the City of Seattle, and are being planned along the light rail and other transit corridors.

#### **Monorail**

Voters approved extension of Seattle's vintage monorail line in November 2002. Phase I will build the *Green Line*, which runs 14 miles from Ballard to downtown Seattle and

from West Seattle to downtown Seattle. Future phases of the monorail are intended to connect other parts of the city.

### **High-Speed Intercity Passenger Rail**

Washington has a vision for high-speed intercity passenger rail in the federally designated Pacific Northwest Rail corridor, which runs from Eugene, Oregon, through Portland and Seattle to Vancouver, British Columbia.

This service is being incrementally implemented through track, signal, and rolling stock improvements to increase speeds and frequencies. The Amtrak *Cascades* currently provides three roundtrips per day between Seattle and Portland, and two roundtrips per day north of Seattle (one to Vancouver, B.C., and one to Bellingham). The lack of a stable source of state multi-modal funding, and to date little federal support, has slowed the implementation of this vision and is leading WSDOT to reassess its high-speed intercity passenger rail plan.

### **Major Roadway Capacity Expansions**

With the population and job growth experienced in the past 20 years, which is projected to continue, Washington's roadway capacity is inadequate to meet the growing demand. WSDOT's highway system plan has identified over \$30 billion of unfunded capacity expansion needs on state highways, and regional plans have identified large additional expansion needs on city and county arterials.

Major corridor expansions have been planned for the I-405 corridor in East King County, SR 167 in South King County, and SR 522 and SR 9 in Snohomish County. A new north/south corridor as part of SR 395 has been planned in Spokane, with the first segment under construction. Highway missing links, including SR 509 south of SeaTac Airport, SR 167 from the Port of Tacoma to Puyallup, and SR 704 Cross-base Highway in south Pierce County, are also part of the state's expansion plan. In Vancouver, there is a need for an expanded I-5 Columbia River Bridge, with planning proceeding jointly between Oregon and Washington.

Capacity needs exist across the state, including SR 28 in East Wenatchee, SR 17 in Moses Lake, SR 101 in Olympia, SR 539 in Bellingham, and SR 240 in the Tri-Cities. In the Puget Sound Region, growing delay is affecting regional highways such as SR 202 east of Redmond, SR 169 in Maple Valley, SR 164 from Auburn to Enumclaw, SR 162 in Pierce County, SR 524 in Snohomish County, and others. Local arterial expansion plans to meet growth needs are numerous, including Myra Road in Walla Walla, Stevens Drive in Richland, Valley Mall Boulevard Extension in Yakima, and Schurman Way Extension at the Port of Woodland.

### **Changes in How Freight is Moved**

#### *Intermodal Logistics Parks*

Freight capacity is being expanded by development of intermodal efficiencies and connections. Burlington Northern and Santa Fe Railroad (BNSF) is developing rail-truck

Intermodal Logistic Parks. Recognizing the shift from a manufacturing economy to a warehouse and distribution economy sparked development of this concept of offering multi-modal transportation choices in major regional markets. BNSF is developing a “four corner” nationwide strategy with one location in the Pacific Northwest.

### *Short Sea Shipping*

Short sea shipping is a future intermodal shipping concept that would transport freight via barge or container ship for short-hauls over water in lieu of highway or rail movements that might be delayed by congestion. The water-borne freight would bypass the most congested land areas and be picked up by truck or rail to complete its journey.

### *Intelligent Transportation Systems—Smart Vehicles and Smart Roads*

Intelligent Transportation Systems (ITS) technology is rapidly evolving and includes such things as smart vehicles and smart roadways. 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. Vehicles outfitted with smart technologies are starting to enter the marketplace, such as the On-Star navigation system.

Smart road technologies are being put into place as quickly as they can be developed and funded. In the future, roads across the state will feature such things as variable speed limits, customized traveler information delivered directly to a traveler’s car or personal digital assistant (PDA), interaction between arterial traffic signals and ramp meters, special time-saving features for transit, and automated maintenance devices that protect worker safety, such as remote control traffic cones.

### *CVISN/WIN System*

There are also ITS technologies designed to meet the special needs of truckers. Roadside weigh stations have traditionally performed a number of inspection and enforcement functions, including weighing of trucks, safety inspections, and license and operator credential checks. But waiting in line at a weigh station adds time (and therefore expense) to the trucker’s trip. The Commercial Vehicle Information Systems and Networks (CVISN) and Weigh-In-Motion (WIM) system embedded in the roadway about a half-mile before a weigh station, weigh each truck as it passes over. At the same time, trucks equipped with an Automatic Vehicle Identification (AVI) transponder electronically transmit essential safety rating credentials, weight, size, and other information to the weigh stations.

The data is instantly checked and if no problems appear, the truck can bypass the station and continue down the highway. Within the next four years all interstate weigh stations should be converted to this technology. Up to now WSDOT has applied an incremental approach to CVISN. The ultimate vision is paperless permitting and tracking, and data sharing within a national system. International border crossing applications of this technology are underway with a pilot project for sealed cargo containers.

## **Tolling Technologies**

System pricing strategies show promise as a way to increase traditional transportation funding, especially in congested corridors. Also known as congestion pricing, these concepts include:

- System-wide tolling, where fees 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, such as traditional, limited-access toll roads or toll express lanes. Advances in electronic toll collection now provide for “at speed” (no tollbooth) collection of tolls.
- Cordon tolling, where all drivers are charged a toll when entering an area, such as a downtown district.
- High Occupancy Toll (HOT) lanes, where single-occupant vehicles can pay to use High Occupancy Vehicle (HOV) lanes when there is available capacity. Almost 20 different projects using or studying HOT lane applications are currently underway in the United States.

## **New Fuels**

Fluctuating world petroleum markets causing price increases and concern about environmental pollution are focusing attention on alternative fuels. Non-petroleum energy sources include biodiesel, ethanol, natural gas, electricity, propane, and hydrogen. Alternative fuel development will likely become a significant factor in the second decade of this century.

Hybrid vehicles are here now. They operate on two fuel sources, most commonly gasoline in an internal-combustion engine and electricity stored in a battery. The Toyota Prius and Honda Civic are two such models already on the market. Other makes and models are scheduled for production within the next three years. Hybrids are efficient in their gasoline consumption because they run on electricity except when additional power is necessary, at which point the internal combustion engine kicks in. Industry experts expect hybrid vehicle sales to accelerate sharply in the next few years. By 2008, it is estimated that hybrids will account for 2 percent of all vehicle sales.

Hydrogen fuel cell vehicles obtain electrical energy from the chemical process of separating oxygen atoms from hydrogen atoms. In its pure form, the only waste product created by the process is warm water. However, most fuel cells currently being developed require another energy source to drive the chemical separation, such as an internal combustion engine. But that may not always be the case. In May 2003, General Motors introduced a drivable, engine-less fuel cell prototype called the Hywire. It runs on compressed hydrogen and transmits energy to the drive train by electrical wire, rather than by mechanical linkages.

## Emerging Directions

- In order to build the new systems and capacity expansions needed to support growth, new financing strategies will be needed. Regional approaches, such as the Regional Transportation Investment District (RTID) of Puget Sound, show promise if voters will support regional funding sources to augment state transportation funding.
- Pricing approaches also show promise to supplement traditional transportation funding, especially in congested corridors.
- As ITS technologies continue to be developed, such as smart vehicles and smart roads, Washington needs to be on the forefront of adapting the transportation system to make sure that the benefits of these innovations are accessible to drivers, including commercial drivers who make their living on the roads.
- The anticipated shift from petroleum-based fuels to alternative fuels requires Washington to adapt the current transportation funding system. Innovative and fair strategies for meeting future system needs must be devised and implemented.

## Introduction

There are many visions for the future of transportation in Washington State. They come from many different perspectives and range from the possible to the nearly impossible, and from the probable to the improbable.

Dreamers and visionaries aren't the only ones thinking about transportation's future. The "personal jet pack" types of ideas exist but many visions being discussed are considered to be fairly conventional ideas both here and around the world. The key is to understand that many of the concepts are within our grasp while others remain more distant and would require significant societal changes.

The validity of these visions will depend on many factors including: travel time expectations, the effects of changing population and land use on travel demand; local, state, national, and international economic factors; the rising costs of fuel, developments in technology; safety expectations; our ability to operate and maintain existing and new complex transportation systems; and many other factors—some within our control, some not. For those issues within our control and influence, it is important to think today about what we might do to shape the future of transportation, as opposed to merely reacting to changes after-the-fact.

## Beyond the Single Occupancy Vehicle

With continuing growth in population, jobs, and increasing congestion on our roadways, most of us agree that we cannot continue to rely on the single occupancy vehicle (SOV) to the extent that we have in the past. In urbanized areas across the state, new types of transportation systems are being pursued to provide alternatives to driving alone and to support growth management plans at the local and regional level.

### High capacity transit

A high capacity transit vision is starting to unfold in the three largest urban areas of Washington.

#### *Central Puget Sound – Sound Transit*

*Central Link*, the first 14-mile segment of the *Seattle Link* light rail, is under construction between Westlake Station in downtown Seattle and Tukwila, with a second phase now in the planning stage. This project is fully funded and should be operational by 2009. This is a future vision that is definitely within our grasp and is on its way to becoming a reality.

The development of this first 14-mile segment fits well with current and planned land uses. For example, along the *Central Link* line in the Beacon Hill section of Seattle, an old public housing project was torn down and in its place the New Holly development was constructed. This development is a mixture of economic housing that is conveniently located adjacent to future transit stations on the light rail line in the Rainer Valley. New Holly is gaining recognition as a housing and community model for the rest of the nation.<sup>1</sup>

*North Link* is the planned light rail extension north from Downtown Seattle's Westlake Station through First Hill and Capital Hill to the University of Washington. This project is partially funded. Beyond the University of Washington, two alternative alignments are being considered for addition, bringing the entire route to a total distance of 8 miles. However, this portion of the project is unfunded at this time.



Map of Sound Transit Link Service  
Source: Sound Transit

<sup>1</sup> New Holly web site: <http://www.sea-pha.org/Development/newholly/newholly.html>

*Airport Link* is the planned 1.6-mile extension from the interim 154<sup>th</sup> Street Station in Tukwila south through Port of Seattle property at Seattle-Tacoma International Airport (includes an elevated station near the main terminal.)

Sound Transit's *Tacoma Link*<sup>2</sup> is a streetcar, which operates 1.5 miles between the Theatre District and the Tacoma Dome Station. The Puyallup Tribe has expressed an interest in extending *Tacoma Link* to their new casino under construction near I-5. The presence of *Tacoma Link* is viewed by some as a placeholder for future extension of Sound Transit's *Central Link* south to Tacoma. Others have viewed *Tacoma Link* as the first step in building a larger Tacoma streetcar/light rail network.



Sound Transit in Downtown Tacoma

Sound Transit commuter rail is now operating from Tacoma to Seattle, and from Everett to Seattle, with expanded service under development. Sound Transit *Express* buses are also operating on major freeway corridors throughout the Puget Sound Region. A series of direct access ramps are being constructed to improve transit access to park and ride lots from High Occupancy Vehicle (HOV) lanes.

*Sound Move*, the 10-year regional transit system plan for Sound Transit, proposes to extend *Central Link* from Northgate Shopping Center to SeaTac with connections north to Everett and south to Fort Lewis. Additional extensions across Lake Washington to Bellevue and Redmond, and along I-90 between Issaquah and Seattle are also being studied.



Potential Future Sound Transit Rail Line  
Source: Sound Transit

<sup>2</sup> Tacoma Link web site: <http://www.soundtransit.org/linkrail/tacoma/tacoma.htm>



## Clark County – TriMet MAX

Vancouver has been exploring a connection with Portland TriMet's MAX light rail system since the early 1990s. Voters rejected a local bond levy to link MAX on the Washington side of the Columbia River in 1995. However, TriMet opened the Interstate MAX (Yellow Line) light rail line in May 2004. The Yellow Line runs parallel to I-5 to a point just south of the Columbia River. The TriMet light rail vision includes extension of the Interstate MAX line north to Vancouver, possibly as part of a new I-5 bridge across the Columbia. TriMet also has proposed a second light rail line in the I-205 corridor crossing upstream of downtown Vancouver. The two lines would join in downtown Vancouver, Washington, allowing direct service between Vancouver and downtown Portland, Portland International Airport, and Clackamas Town Center.

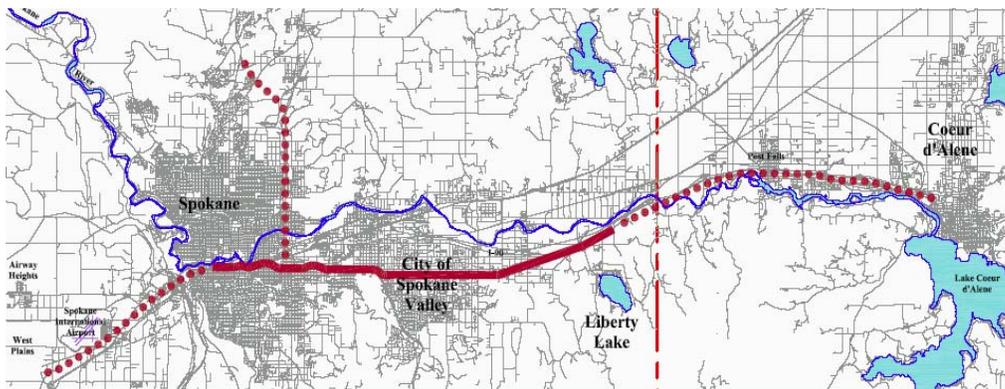


TriMet MAX Service Map

Source: TriMet

## Spokane regional light rail and bus rapid transit

Spokane is in the preliminary planning stage for a light rail line as one option for high capacity transit in the Spokane Valley corridor. The proposed alignment is parallel to I-90 and east of downtown Spokane. The metropolitan area is trying to plan for efficient transportation to guide development in this new growth area. Phase I would connect downtown Spokane to the City of Liberty Lake (15.6 miles).<sup>4</sup> The vision is to build a regional system, which would include a connection west to the Spokane International



Proposed Spokane Regional Light Rail Project

Source: Spokane Transit Authority

<sup>4</sup> See Spokane Light Rail web site - includes maps above: <http://www.spokanelightrail.com/spokanelightrail/>

Airport/West Plains area, a connection to north Spokane along the North Spokane Corridor (US 395), and a connection east to Coeur d 'Alene, Idaho.

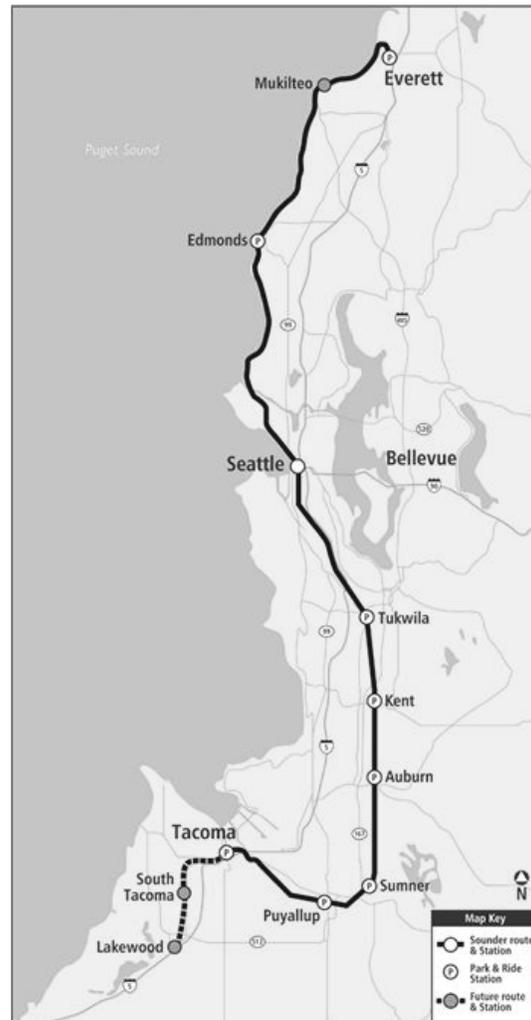
## Commuter and intercity passenger rail

The state of Washington has a vision for high-speed intercity passenger rail in the federally designated Pacific Northwest Rail corridor that runs from Eugene, Oregon, through Portland and Seattle to Vancouver, British Columbia. Sound Transit has a vision for commuter rail service in the central Puget Sound Region.

### Sounder commuter rail

Sound Transit Commuter Rail, or *Sounder*<sup>5</sup> is an 82-mile planned route from Everett to Lakewood, with 74 miles currently in use. The map to the left shows its current route from Tacoma up to Everett with stops in Puyallup, Sumner, Auburn, Kent, Tukwila, Seattle, and Edmonds. There are plans to extend the southern route down to Lakewood with a stop in South Tacoma. Future stops in Mukilteo, Shoreline, Ballard, and Georgetown are under consideration although not currently funded.

When fully developed, 18 trains (nine in the morning and nine in the evening) would serve the Lakewood-Tacoma-Seattle segment, and eight trains (four in the morning and four in the evening) would serve the Everett-Seattle segment. Headways (the time between trains) are planned to be approximately 30 minutes. Trains would run in both directions.



Sounder Route Map

Source: Sound Transit

<sup>5</sup> Sound Transit's *Sounder* web site: <http://www.soundtransit.org/sounder/sounder.htm>

**Amtrak Cascades service**

WSDOT’s intercity passenger rail program, commonly known as the Amtrak *Cascades*, is being incrementally implemented through track, signal, and rolling stock improvements to increase safety, speeds, and frequencies. Amtrak *Cascades* currently provides three roundtrips per day between Seattle and Portland and two roundtrips per day north of Seattle (one to Vancouver, B.C., and one to Bellingham). Amtrak *Cascades* service is financed and operated in partnership with the state of Oregon, Amtrak, the Burlington Northern and Santa Fe (BNSF) Railway, and local jurisdictions.



**Amtrak Service Map for Pacific Northwest**

Source: Amtrak

The Washington State Transportation Commission and WSDOT started this service in the 1990s to offer a new mode of transportation service designed to meet the anticipated growth in demand for regional intercity travel. Previously, there were only long-distance trains. While WSDOT is currently revisiting the policy for higher speed passenger rail in our state, the *Passenger Rail Plan* recommends up to 13 daily roundtrips between Seattle and Portland at 2-1/2 hours travel time with up to four daily roundtrips between Seattle and Vancouver, B.C., for a total travel time of 2 hours, 40 minutes.

WSDOT’s recent projections suggest that the service could carry as many as three million passengers per year with little or no public operating subsidy once all capital projects necessary to achieve WSDOT’s service goals are put in place. As stated in WSDOT’s *Draft Amtrak Cascades Plan for Washington State: 2003-2023*, the latest capital cost estimate is approximately \$5.4 billion for full program implementation, in 2003 U.S. dollars. WSDOT assumes that these capital costs would be split between Oregon, the BNSF Railway, the Province of British Columbia, and the United States and Canadian governments. However, WSDOT assumes that public subsidies will be necessary to operate Amtrak *Cascades* until the full level of service is achieved. Current subsidies amount to about \$12 million per year.

**Amtrak Cascades Daily Roundtrip Trains**

Total Trains	1994	2003	Mid-point	2023
Portland, OR to Seattle, WA	1	3	8	13*
Seattle, WA to Vancouver, BC	0	2**	3	4

\*Includes three trains which travel north, beyond Seattle to Vancouver BC  
 \*\*Amtrak *Cascades* #513/516 travels between Seattle and Bellingham

### Amtrak long-distance services

Amtrak provides two long-distance service routes to the state of Washington. The *Coast Starlight* is a daily train that connects Seattle to Los Angeles. The other service is an east west service called the *Empire Builder*. The *Empire Builder* runs daily from Seattle and Portland through Spokane to Chicago.



**Amtrak Service Routes**

Source: Amtrak

Service reliability is an issue for Amtrak long-distance trains. Increasing freight train congestion has the potential to negatively impact on-time performance. In the future, we will need to closely monitor the relationship between the growth in freight and passenger rail usage. (See the Freight Mobility issue paper for more on this topic.)

### High-speed passenger rail

In the early 1990s, Washington State's *High-speed Ground Transportation Study* looked at the potential for high-speed rail (operating at speeds over 125 mph) in Washington. As a result of that study, the Washington State Legislature directed WSDOT to take an incremental approach towards implementing higher speed passenger rail. As a first step, WSDOT began funding rail capacity expansion projects and train operations for one daily round trip train between Seattle and Portland (1994) and one daily round trip train between Seattle and Vancouver, British Columbia (1995). Additional daily round trips were added in 1998 and 1999 as strategic rail capacity expansion projects were completed. WSDOT, in conjunction with Amtrak, also purchased new, passive tilt trainsets for the intercity service in 1999 and 2003.

Today, WSDOT continues to take an incremental approach toward high-speed passenger rail development, as directed and funded by the Legislature. WSDOT and Amtrak will begin offering a fourth daily round trip between Seattle and Portland in 2006. The second daily round trip between Seattle and Bellingham that was introduced in 1999 will be extended to Vancouver, B.C. if Canadian funding can be secured for a rail capacity project north of the international border.

## Supporting high capacity options

Other strategies will be needed to support high capacity transportation systems and reduce dependence upon the single occupancy vehicle. Transit-oriented solutions incorporating land use and travel efficiency strategies are needed to increase transit use and promote the use of multiple forms of travel. Transit-oriented solutions include: Transit-oriented developments (TODs), efficient transportation strategies (sometimes referred to as transportation demand management), and programs to integrate transit with biking and walking.

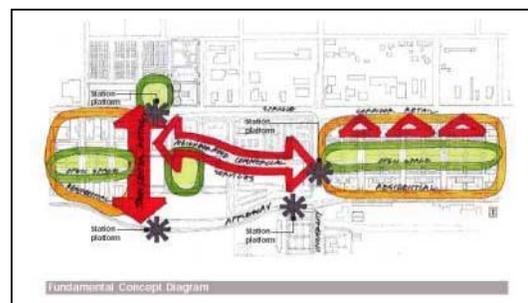
### Transit-oriented development

Transit-oriented developments (TODs)—land uses that provide high densities, mixed-uses, and pedestrian facilities that help to build a market for transit—have been built in Bellevue, Issaquah, Dupont, Vancouver, and throughout the City of Seattle. They are being planned along the light rail line and other transit corridors. The basic concept of transit-oriented development is to provide enough population and employment density within walking distance around transit hubs so that many of the trips taken to access transit at those hubs are walking trips. Creating retail and residential markets around transit hubs in turn supports more walking trips.

TODs reflect a new way of thinking in the United States. This planning approach contends that if people can live closer to where they want to go (via transit, walking and biking), then we may be able to avoid the need to build new roads. Transit-oriented development has a growth management benefit also because it supports population growth in urban areas, thereby reducing demand on undeveloped rural areas at the urban fringe, lowering infrastructure costs. Residents within the TOD frequently have lower transportation costs. In recognition of this, some financial institutions are beginning to reduce income levels required to qualify for mortgages in transit-oriented developments. This is because the income needed to own and operate private vehicle(s) is eliminated or reduced.

University City, in Spokane is an example of a TOD where the community is trying to plan development to create connections and high densities around transit stations. Preliminary planning by Spokane Light Rail proposes developing a new town center retail street to provide primary focus for transit supportive development.

As of the writing of this paper, there are nine transit-oriented developments in King County.<sup>6</sup> TODs are frequently built near park and ride lots. They often involve some kind of mixed-use development, with some degree of subsidized housing. A TOD in Northgate with mixed-use development will be built on the south parking lot to go with



Concept Diagram for Spokane's University City Transit-oriented development

Source: Spokane Transit Authority

<sup>6</sup> King County's Transit-oriented development web site: <http://www.metrokc.gov/kcdot/transit/tod/>

the transit center and park and ride lot. There is another one planned in Overlake on the Eastside.

Other U.S. cities are initiating these links between transportation and land use. Some states (New Jersey and Pennsylvania for example) are looking to avoid the need for road expansion through land use decisions that move people closer to where they want to go on a daily basis. Although land use decisions are made in this state at the local level, WSDOT is adding transit-oriented development philosophy to the mix for future vision of how we might deal with transportation issues.

### **Addressing future service demands**

In the past, many transportation efficiency strategies were called transportation demand management (TDM),<sup>7</sup> but investigation and study groups have revealed that this term can be confusing and bureaucratic. In plain English, transportation demand management looks at means and methods to reduce or spread out transportation demand (typically roadway traffic). As Washington's population continues to grow, it will become even more important to make sure our transportation system functions at its maximum efficiency. Determining which efficiency strategies to pursue and to what degree, requires us to consider what will be needed to support these functions successfully.

Although highway improvements may accommodate additional travel demand and target existing bottlenecks and chokepoints, alternative travel modes will need to play a larger role in the future in order to accommodate anticipated demand. Research shows that land use and urban design characteristics can influence how people travel, and there is increasing interest in land use planning and design as important ways to meet or support transportation objectives.

### **Strategies to maximize roadway capacity**

Public and private organizations use a variety of strategies to reduce the number of single occupancy vehicles (SOV) on our roadways. These are described below.

- *Vanpools*  
Washington State's Vanpool Program, at over 20 years old, was one of the first of its kind in the nation. Vanpools can significantly reduce SOV traffic. When the I-405 Corridor Study examined the possibility of doubling the number of vanpools in that corridor, results showed there is a market on that corridor to sustain such a proposal. This type of approach is in use and will continue to be considered as a lower cost approach for adding future capacity.

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<sup>7</sup> WSDOT's TDM Office web page: <http://www.wsdot.wa.gov/tdm/>  
WSDOT's Central Puget Sound TDM Resource Center's web page: <http://www.wsdot.wa.gov/mobility/TDM/default.htm>

- *Carpools*  
Transit and businesses have developed Internet tools to assist with matching carpool partners. In the future this could be expanded to match regional or long-distance travelers.
- *Car sharing*  
Shared-use cars are usually placed in designated neighborhoods where members may reserve them to use on an hourly basis. Car sharing may be run through small co-ops, nonprofits, public agencies or for-profit businesses. This option shows the most promise in urbanized areas.
- *Telecommuting and working out of the home*  
The number of employees working out of their home and/or telecommuting at least part-time has risen and is expected to continue to rise in the future. Nationally, these workers have grown from an estimated 3.4 million in 1990 to 44.4 million in 2004.<sup>8</sup>
- *Alternative schedules*  
Alternative work schedules can reduce or redistribute commute trips away from the peak commuting hours and make it easier for employees to take advantage of rideshare and transit opportunities. Compressed workweeks, such as 4-day/40-hour or 9-day/80-hour schedules are examples of this strategy. Simply allowing flexibility in work start and end times can also accomplish similar goals.
- *Guaranteed ride home*  
A guaranteed ride home ensures that workers who take transit or rideshare have a way home in the event of illness, personal emergencies, or unscheduled overtime. Employers can provide taxi scrip, car service, or contracted service with a transit agency to provide the employee a means of getting home. “Guaranteed ride home” is a complement to other strategies to reduce driving alone.
- *Parking cash-out*  
With parking cash-out, parking is considered a workplace benefit, and those who do not use it (or share it with others via ridesharing) can receive its monthly value in their paychecks, thereby providing an incentive to use transit, rideshare or bike/walk to work.
- *Parking charges*  
Transferring the cost of parking to employees is among one of the most effective ways to reduce the number of single occupancy vehicles for commute trips. Parking charges may be the same rate for all vehicles (which effectively makes carpools cheaper) or may implement a graduated fee system where carpools/vanpools pay less or park for free. In order to be effective, parking

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<sup>8</sup> 2004 ITAC Interactive Consumer Survey

charges must be high enough to provide a financial incentive for behavioral change.

- *Priority parking for vanpools and carpools*  
In areas where parking is tight, giving rideshare vehicles priority through designated spots (especially if those spots are close to the building entrance) can be an excellent incentive to rideshare.
- *Fare subsidies for transit/ vanpools/ carpools*  
Fare incentives can be either partially or fully covered by employers to give employees a financial incentive to take transit or rideshare to work.
- *Education and marketing*  
Although education and marketing are often overlooked, they are vital elements of any plan to increase transportation system efficiency. Lack of awareness or little knowledge about how transit or ridesharing works can inhibit participation: efforts to educate and build awareness around alternatives to driving alone can increase the effectiveness of these options.

## Supporting rural and suburban needs

High-capacity transportation options that are available in urban areas are often lacking or impracticable in rural and suburban areas. WSDOT is working with public transit agencies, non-profit associations, and others to create new strategies and services to meet existing and future transportation needs specific to these areas. For example, we work with groups around the state to create new vanpools to serve workers who could not otherwise access employment locations, using Federal Transit Administration's Job Access and Reverse Commute grants. The following are issues being worked on and needing additional attention to better serve rural and suburban areas in the future:

- *Integrate rural and suburban transportation planning and services*  
Evaluate the appropriate level of intercity connections and provide business opportunities for private companies to meet the intercity transportation needs within those corridors. Create toolkits to increase the effectiveness of local long-term public transportation planning in rural and suburban areas. Expand the agencies involved in rural and suburban transportation planning to include social service programs and educational institutions.
- *Expand rural and suburban public transportation services*  
Identify institutional structures that can provide a forum for identifying needs and local decision-making, and use or create new legal authorities for stabilizing funding for rural and suburban transportation programs.
- *Eliminate administrative and legal barriers to coordination*  
Identify opportunities to facilitate efficient public transportation by continuing to emphasize coordinating and collaborating.

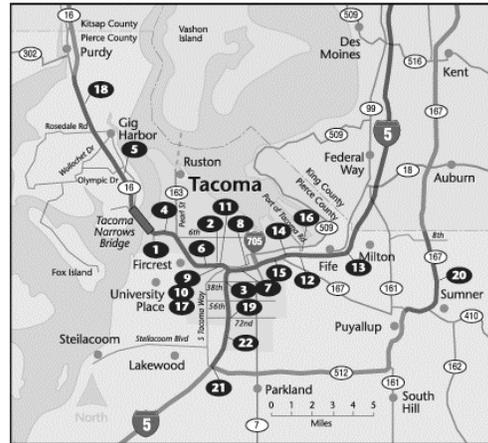


This proposal would create a seismically sound and safe new Portage Bay Bridge and Evergreen Point Bridge with full shoulders, with a bike and pedestrian path running through the entire project corridor.

*Estimated cost: \$2.2 billion<sup>10</sup>*

**The Tacoma/Pierce County Core HOV Program**

This program entails a series of highway projects that would be operational improvements on I-5 and SR 16 to complete the next portion of HOV lanes in the Puget Sound Region. This is the biggest piece of the system that remains to be constructed. The program consists of 22 projects. While many of these pieces were funded by the 2003 legislative transportation funding package, some are incorporated into other current projects, and some are yet to be funded.



Tacoma/Pierce County HOV Program  
Source: WSDOT

*Estimated cost: \$1.4 billion<sup>11</sup>*

**I-5 – Pierce County line to Tukwila HOV lanes**

This multi-phase project, underway in south King County, adds HOV lanes in both directions between Tukwila and the Pierce County line. It also extends I-5 traffic camera and flow map coverage by 13 miles.

*Estimated cost: \$280.4 million<sup>12</sup>*



I-5 – Pierce County to Tukwila HOV Lanes  
Source: WSDOT

<sup>10</sup>WSDOT’s SR 520 Bridge Replacement & HOV Project web page: <http://www.wsdot.wa.gov/projects/SR520bridge/>

<sup>11</sup> WSDOT’s Pierce County Line Core HOV Program web page: <http://www.wsdot.wa.gov/projects/piercecountyhov/>

<sup>12</sup> WSDOT’s I-5 Pierce County to Tukwila HOV Lane project web page: <http://www.wsdot.wa.gov/projects/I5HOVPiercetoTukwila/>

### *I-5 – Everett, SR 526 to US 2 HOV lanes*

This project would add a new carpool lane in each direction on I-5 between SR 526 and Marine View Drive. The project would also add a new merge lane in both directions on I-5 between 41<sup>st</sup> Street and US 2. The project would also include installing retaining walls and a detainment and treatment area for freeway water runoff.

*Estimated cost: \$222 million<sup>13</sup>*

Altogether these projects would go a great distance toward connecting and completing the entire Puget Sound HOV system. But there will still be missing links. In some portions HOV lanes will be more expensive to install because the existing shoulders are substandard or there are other design constraints. These portions remain unfunded.



I-5 – Everett, SR 526 to US 2 HOV Lanes  
Source: WSDOT

<sup>13</sup> WSDOT's I-5 Everett, SR 526 to US 2 HOV Lane project web page: <http://www.wsdot.wa.gov/projects/sr526us2hov/>

### Vancouver HOV lane<sup>14</sup>

As congestion has grown in Southwest Washington, residents and other highway users have asked WSDOT to better manage the use of the area freeways. An extensive planning and public involvement effort led by the Southwest Washington Regional Transportation Council identified adding a new HOV lane as an affordable and efficient way to improve traveling conditions on I-5.

Vancouver's first HOV lane on I-5 heading south is the initial phase of a bi-state plan that includes adding a southbound lane in Oregon during the morning commutes. Future extensions are currently under discussion.

The diagram to the right displays existing HOV lanes (black with diamonds), newer HOV lanes that were opened on October 29, 2001, (grey with diamonds, south of 99<sup>th</sup> and north of Mill Plain,) and where future HOV lanes are still only envisioned (gray with diamonds, south of Marine Drive and north of 99<sup>th</sup> Street).

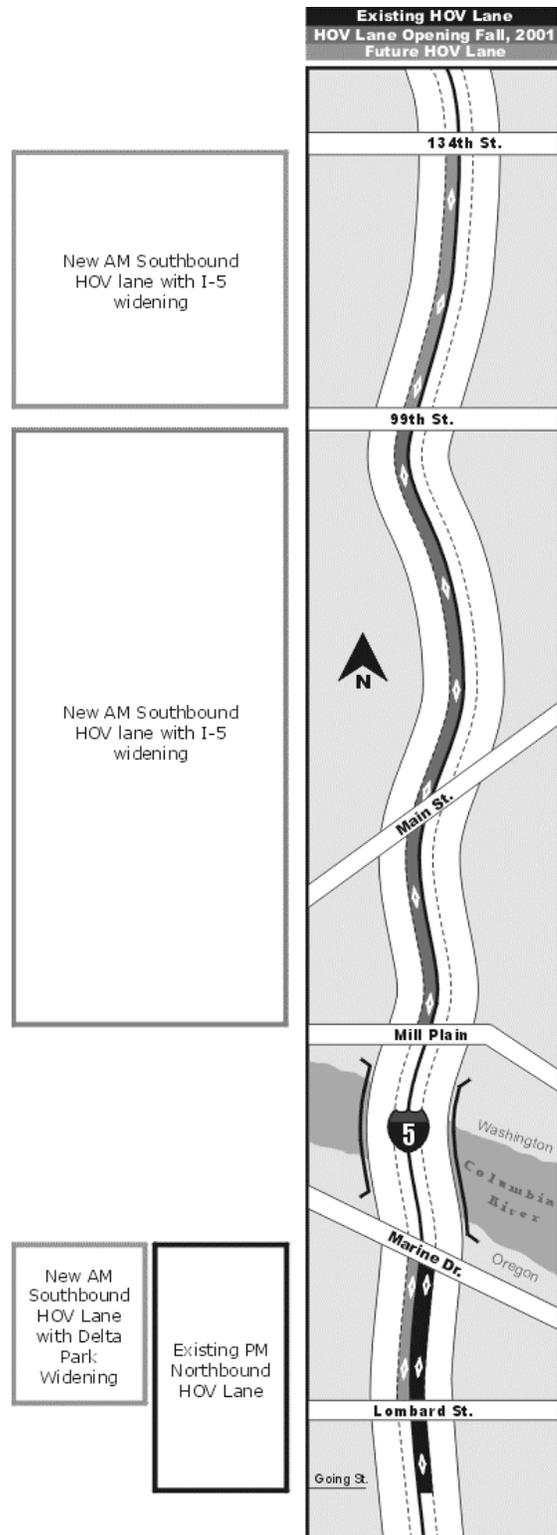


Diagram of Vancouver's HOV Lane Program  
Source: WSDOT

<sup>14</sup> RTC's Vancouver HOV Lane project web page: <http://www.rtc.wa.gov/hov/>

## Direct access ramps

Part of the broad support system of state HOV lanes is the state's network of park and ride lots, an extensive vanpool fleet, and demand management programs aimed at encouraging transit alternatives. Direct access ramps are a tool to assist flow and safety when transferring into and out of HOV lanes. A direct access ramp is for the exclusive use of transit and HOVs. The ramp provides direct movement between the roadway entrance and the HOV lane without crossing or being delayed by crossing general-purpose lanes.



I-90 at Eastgate Direct Access Ramps

## Locations of proposed direct access ramps

1. Connection to South Industrial Way/E3 bus way
2. Northeast 50<sup>th</sup> Street Interchange
3. SR 523 (Northeast 145<sup>th</sup>) Interchange
4. SR 512 Interchange vicinity
5. Connection to 48<sup>th</sup> Street (Tacoma Mall)
6. Connection to Tacoma Dome
7. SR 167
  - a. SR 167 and I-405 to SW 27<sup>th</sup> Street
8. SR 522 (funded)
  - a. Bothell UW Campus Access

## Using pricing mechanisms to increase roadway efficiency

A distinction should be drawn between tolls intended to fund roadways (road pricing) and tolls intended to increase system efficiencies and help reduce congestion (congestion or value pricing) as they have different objectives and impacts. Road pricing tolls are a common way to fund highway and bridge improvements while value pricing is used to influence travel patterns and reduce congestion.

Value pricing is a market or demand-based strategy designed to encourage shifting peak period trips to off-peak periods, to routes away from congested facilities, or to increase alternative mode use (HOVs or transit) during the peak demand periods. Value pricing proposes to account for the transportation "costs" of delay and accidents associated with congestion by charging motorists for using a particular stretch



Direct Access Ramps in Washington State Highway System Plan

Source: WSDOT

of highway or bridge, or for entering a particular area. The “costs” of delay and accidents are largely unaccounted for in the current transportation system. Value pricing strategies show promise as a means to maximize transportation system efficiency, especially on congested corridors.

### *System-wide tolling*

System-wide tolling bases fees on actual roadway use. Charges accrue over all roads—from driveway to highway. Fees are based on actual use of the road. “Dynamic pricing” (variable pricing based on demand) may be applied in this form of congestion pricing. Minnesota and Oregon are currently studying and testing these systems. In addition, the Puget Sound Regional Council is studying a Global Positioning System (GPS) incentive-based system. It is intended to assess pricing as a means to modify driving behavior.



GPS unit for PSRC Traffic Choices Study tolls all highways in the system depending on congestion

### *Segment tolling*

Segment tolling is typically used on limited access facilities and can use dynamic pricing based on varying traffic volumes and delay. Until the late 1980s, federal policies discouraged toll roads or imposing tolls on existing highways. However, with diminished transportation funding, advances in tolling technology, and more open federal policies, there has been a resurgent interest in using road pricing to increase system efficiencies.

### *Cordon tolling*

Cordon tolls are fees paid by motorists to drive in a particular area, usually a city center. Some cordon tolls only apply during peak periods, such as weekdays. This type of toll can be done by simply requiring vehicles driven within the area to display a pass or by tolling at each access point to the area. Singapore initiated a cordon tolling system in 1975, and transitioned to an electronic system in 1998. Cordon tolling controls access to the Central Business District and many ring roads. It effectively reduced the number of solo drivers. London initiated a cordon system in 2003 for their Central Business District. Their system uses photo tolling with 688 cameras at 203 sites. It helped reduce vehicles within the cordoned areas by 17 percent.



### *High occupancy toll (HOT) lanes*

High occupancy toll (HOT) lanes are high occupancy vehicle (HOV) lanes open to carpools, vanpools, transit, and motorcycles, and toll-paying solo drivers. HOT lanes differ from regular toll roads, which may offer discounts to high occupancy vehicles, in that they give drivers of lower occupancy vehicles a choice: stay in the free but potentially congested lanes or pay a fee and enjoy a faster, more reliable and potentially less stressful trip in the HOT lane.

Tolls for HOT lanes can be set to assure that these lanes keep traffic flowing even when regular lanes are congested. HOT lanes can be specifically built for this purpose or can be converted from high occupancy vehicle (HOV) or general-purpose lanes.

In addition to providing another travel option in highly congested corridors, HOT lanes improve efficient utilization of existing HOV lanes. HOT lanes are a very recent experiment nationally, evolving out of a federal program initiated under the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.

The concept of HOT lanes offers significant potential, especially for underutilized HOV lanes.<sup>15</sup> There are currently about 20 different projects using or studying HOT lane applications in United States, including a proposal to consider HOT lanes on SR 167 in King County:

Operational or under construction:

- I-10 and US 290 (Houston, TX)
- I-15 (San Diego, CA)
- SR 91 (Orange County, CA)
- I-394 (Minneapolis, MN)
- I-25/US 36 (Denver, CO)

System-wide HOT lane studies are ongoing:

- Minneapolis, MN
- Atlanta, GA
- Washington, DC Beltway

### **Tolling technology**

#### *Collection of tolls via transponders*

Advances in electronic toll collection now provide for “at speed” (no tollbooth) collection of tolls.<sup>16</sup> Transponders, simply act as an electronic barcode reader. A vehicle with a transponder displays an electronic pattern containing user-specific information. When the vehicle moves past a fixed scanner, the scanner collects the vehicle’s information. The communication is not one-way, however, as both the transponder and the scanner share data.

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<sup>15</sup> Feasibility information at <http://tti.tamu.edu/documents/7-4915-S.pdf>

<sup>16</sup> For more on at speed tolling, see [http://www.forbes.com/2001/07/31/0731transponders\\_print.html](http://www.forbes.com/2001/07/31/0731transponders_print.html)

### *In-vehicle-based billing*

In a pilot program currently underway in the Puget Sound area,<sup>17</sup> in-vehicle meters have been placed in participants' vehicles to simulate imposed variable travel fees depending upon the location and time of the trip. Drivers are informed of the pricing both through maps (and other printed material) and a real-time read-out displayed on the in-vehicle meter.



The location and time of travel of the vehicle will be determined by an integrated GPS antenna/receiver. Preliminary analysis suggests that in-vehicle meters can be built from off-the-shelf components for less than \$300-\$400 per vehicle (excluding software or firmware development costs).

### **Integrating high capacity transport, biking, and walking**

Walking is probably the most important "development" for the future of transportation.<sup>18</sup> Walking is the basis behind transit-oriented development. The more people are able to walk to school, to the market, to work, the more these walking trips can substitute for vehicle trips and less capacity is needed for vehicles.



Bicycle racks on buses makes the transit / bicycle connectivity.

Additionally, such integration improves the quality of life for our society's members who cannot or do not wish to drive. Not all trips can be made by foot or on a bicycle, but some shift to increase our walking and biking in the future could have a significant effect on the type and cost of transportation facilities we may need. Examples of ways to integrate transit, biking, and walking include:



Medians in streets promote safety for pedestrians and transit users.

- Installing bike racks on buses and vans.
- Locating transit stops in safe locations for pedestrians.
- Improving bicycle and pedestrian accommodations on ferries and at terminals as well as at transit stations (e.g., storage lockers and showers.)

<sup>17</sup> <http://www.psrc.org/projects/pricing/demo.pdf>

<sup>18</sup> WSDOT's Walking in Washington web page: <http://www.wsdot.wa.gov/walk/>  
WSDOT's Bicycling in Washington web page: <http://www.wsdot.wa.gov/bike/>

- Adding medians, refuge islands, and other traffic calming features, to improve road-crossing conditions, particularly in transit corridors.
- Implementing safe and creative solutions for sharing limited right of way in urban areas (i.e., bus/bike-only lanes and pedestrian bridges.)
- Completing regional bike stations and connecting them with bicycle and pedestrian networks.
- Providing on-line travel aides to transit users that track bus locations in real-time.<sup>19</sup>



Suspended pedestrian bridge is a creative solution to sharing right of way and can help complete bicycle and pedestrian networks.

## Experimental high capacity systems

### Magnetic Levitation

High-speed rail is being looked at for a number of corridors across the country and around the world. Magnetic Levitation (MagLev) is a recent technology that shows some promise for the future. Although no MagLev system has yet been successfully deployed in the United States, research and development have been ongoing for over 30 years in Japan, Germany, Korea, and the United States with systems tested and deployed in Japan (mid-1970s) and China (German designed and built in 2004). Currently California, Colorado, Florida, and Maryland are studying potential MagLev investment.

Interestingly enough, the Chinese, after building a portion of MagLev railway, were ready to pursue a route between Beijing and Shanghai, but decided to use the less expensive wheel-track high-speed rail. The Chinese government stated that although magnetic levitation technology is very advanced, the investment is still too large and the engineering requirements are too high for the proposed 1,300 kilometer (780 mile) route between Beijing and Shanghai.

### Magnetic Levitation

Proponents see Magnetic Levitation (Maglev) transportation as a potential high capacity transport solution. Advocates point to the benefits of this non-petroleum based, higher speed travel.

However, some opponents point to its comparatively high price per mile and the unusually loud noise while traveling.

Cost Comparison of High Speed Ground Transportation

Technology	Type of Corridor	Estimated Cost*
Tilt and Conventional Trains	Existing Rail Right of Way	\$10 million / mile
Electrification	Existing Rail Right of Way	\$20 million / mile
Maglev	New Corridor	\$30 million / mile

\*In 1993 dollars

Source: High-Speed Ground Transportation: Issues Affecting Development in the United States, U.S. Government Accounting Office, November 1993.

<sup>19</sup> For an example, see [http://busview.org/busview\\_launch.jsp](http://busview.org/busview_launch.jsp)

The Chinese also disclosed that although the magnetic levitation trains will not be used between Beijing and Shanghai, MagLev would be used for the more than 170 kilometer (102 mile) rail link between Shanghai and Hangzhou. After completion, it should take only 26 minutes to cover the distance between Pudong airport in Shanghai and Hangzhou.

### **Personal Rapid Transit**

A rapid transit form that has also received notice in recent years, but has no actual systems developed, is the concept of Personal Rapid Transit (PRT). PRT would be a transit system made up of numerous small “pod-like” vehicles that could carry two to four people. The three main ways to differentiate PRT from light rail or heavy rail are:

- *Type of track* (usually PRTs are discussed as being elevated systems with cars running on a track or suspended from the track.)
- *Cars size* (would have smaller cars for 2-4 passengers only.)
- *Non-stop trips* would take passengers directly to their destination.

PRT has a small but ardent group of supporters. Initial attempts to develop PRT systems in Detroit, Michigan,<sup>20</sup> Jacksonville, Florida,<sup>21</sup> Miami, Florida,<sup>22</sup> and Morgantown, West Virginia<sup>23</sup> have not been successful. Each of these systems ended up diverging from one or all of the above-mentioned discernable criteria.

## **Intelligent Transportation Systems (ITS)**

Rapidly evolving technology in this area holds promise for the future. As technology continues to evolve, it is becoming clearer that technology will continue to be integrated into the transportation system. ITS applications focusing on the roadway tend to be more for urban areas while applications focusing on automobiles are being developed for both urban and rural use.

### **Intelligent Vehicle Initiative**

To help improve driver performance and safety, the U.S. Department of Transportation (USDOT) and the Intelligent Transportation Systems (ITS) Joint Program Office at the Federal Highway Administration established the national Intelligent Vehicle Initiative. This is a cooperative effort between the motor vehicle industry and four agencies of the USDOT: the Federal Highway Administration, the Federal Motor Carrier Safety Administration, the National Highway Traffic Safety Administration, and the Federal Transit Administration.

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<sup>20</sup> Detroit People Mover webpage: <http://www.thepeoplemover.com/>

<sup>21</sup> Jacksonville Skyway webpage: <http://www.jtaonthemove.com/services/skyway.aspx>

<sup>22</sup> Miami Dade Metro Mover webpage: <http://www.co.miami-dade.fl.us/transit/metromover.asp>

<sup>23</sup> Morgantown PRT webpage: <http://www.wvu.edu/~facserv/prt.htm>

This initiative is designed to accelerate developing and applying vehicle-based driver assistance products that warn drivers of dangerous situations, recommend actions, and even assume partial control of vehicles to avoid collisions.

### **Vehicle Infrastructure Integration (VII) Initiative**

The VII Initiative is a cooperative effort between federal and state departments of transportation and vehicle manufacturers to evaluate the technical, economic, and social/political feasibility of deploying a communications system to be used primarily for improving the safety and efficiency of the nation's road transportation system. This communications system could also be used for other applications to the extent that they would not interfere with the primary purpose of enhancing transportation safety and movement.

The primary benefit of this initiative's deployment would be traveler safety. There are also expected to be significant benefits to operations and maintenance of the transportation network due to the real-time performance feedback that the initiative's deployment could be expected to provide. In addition, other commercial and business applications may be enabled by a high-bandwidth data connection between vehicles and the infrastructure.

### **Smart vehicles**

Products currently in testing that are expected to appear soon in passenger cars include rear-end collision avoidance systems and roadway departure warning systems. Vehicles on the road may one day become traffic probes gathering data about travel behavior and traffic conditions. They may also make that information available to an ITS network instantaneously.

Vehicles may someday have the capability to alert drowsy drivers to help prevent crashes. Vehicles could also send road surface condition information from anti-lock/traction control systems to a data network. Global position and mapping systems in cars could become more sophisticated and start to integrate real-time traffic and weather conditions into route planning. These products and others promise to continue putting the "auto" into the automobile.

Smart vehicle products already in the marketplace include automated collision notices, lane-departure warning systems, adaptive cruise control, as well as mayday systems and rear-end collision warning systems for trucks.

### **Collision avoidance and roadway departure alarms**

Smart vehicles could help reduce collisions in many ways: drowsy driver alerts, roadway departure alarm systems, and side scanning radar/video are a few examples. Drowsy driver alerts monitor and measure the driver's pupil and eyelid position and relative motion. When there is a significant departure from the measured norm of an alert driver, the system notifies the driver (usually via a sound).

Roadway departure alarm systems have been offered for years in Japan and will likely be offered for the first time in the U.S. with the introduction of the 2005 Infiniti M45 model. Other systems now under development should be available soon. Systems typically monitor longitudinal highway markings and compute the vehicle's path. Warnings are given to the driver when calculations indicate that vehicle departure from the roadway is imminent. Side scanning radar/video is a means of preventing or reducing sideswipe collisions, although heavy snow and fog may reduce the system's effectiveness. Volvo and others are currently offering these systems.



### **Adaptive cruise control**

Adaptive cruise control automatically adjusts speed to keep a selected distance from the vehicle ahead. Systems typically use forward-looking radar mounted at the front of a vehicle to detect the speed and distance of the vehicle ahead of it. It then automatically adjusts speed accordingly. Adaptive cruise control maintains a safe, comfortable distance between vehicles without the need for driver interventions. The cruise control maintains a consistent performance in poor visibility conditions, continuous performance during road turns and elevation changes, and alerts drivers when following too closely to other vehicles by way of automatic braking.

### **Improving unsafe driver behavior**

Driver behavior is a contributing factor in up to 90 percent of the crashes on America's highways.<sup>24</sup> A variety of intelligent technologies could be used to address this problem. Of particular interest are in-vehicle technologies that alert drivers to their unsafe behaviors. The driver could then use this feedback to reduce or eliminate the unsafe behavior and to minimize the risk of being involved in a crash. Some research in this area is underway in the United States as well as in other countries. WSDOT will continue to compile the existing research and look at new ITS applications that can help to improve unsafe driver behavior. We will also carefully examine potential privacy, policy, and legal issues.

### **Teen driver learning tool**

Traffic crashes are the number one killer of today's teenagers. Teenage drivers are most vulnerable to crashes during their first year after licensure. Contributing factors include inexperience, immaturity, low rate of safety belt use, and driver error. One approach that might help novice drivers hasten developing skills and safe behaviors is to integrate vehicle-based technologies into a device that can operate in real-time to sense, record, evaluate, and provide feedback on driving practices. This driving "tutor" could serve as a learning tool and motivator to help teens identify and modify their unsafe actions.

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<sup>24</sup> USDOT. Federal Highway Administration. *Public Roads* Jan/Feb 2004.

The tool could be incorporated into parental supervision, driver education, graduated licensing, and insurance policy. The goal of this program would be to develop and evaluate the usability, effectiveness, and acceptability of a vehicle-based teen driving “tutor” to prevent crashes, and to accelerate the learning curve and safety consciousness of teenagers.

### **Mayday systems**

Primarily intended for less congested, rural areas, “mayday” systems have been and are continuing to be developed. For example, if a vehicle crashes, the mayday system automatically would send a signal to the state police or a rescue unit. The object is to reduce emergency response time to rural crash sites. Mayday systems have been shown to reduce emergency responders’ arrival times by up to 30 minutes, thereby saving lives.

### **Trucks with “brains”**

A trucker advisory system has been developed that can provide drivers unfamiliar with an area an advance alert about upcoming hazardous roadway features such as extra-tight access ramp curves or when they are approaching work zone. In cooperation with several state departments of transportation, the developers identified more than 500 “trucker advisory zones” in ten states, determined the latitude and longitude of the zones, and created a database of these areas.

*“These days, truck drivers are traveling fewer set routes and increasingly are traveling in unfamiliar territory to pick up freight. TAS familiarizes drivers with these unknown areas and decreases the risk of crashes in locations known for rollover hazards, steep grades, or other dangers.”*  
**Jim Kennedy, McKenzie Maintenance Director**

Trucks participating in a test were equipped with an onboard computer, the database, and global position systems. Using this equipment, the Trucker Advisory System (TAS) let drivers know when they were in close proximity to any of the hazardous driving areas via an alert message on an in-vehicle display that indicated the type and location of the hazard.

### **Wireless truck and bus inspection**

On average, 15 people are killed or injured in America each hour in truck and bus-involved crashes. The 2.7 million roadside inspections conducted annually by 10,000 roadside safety inspectors save an estimated 400 lives annually. Despite this level of activity and the safety benefit, a typical truck driver or truck is not likely to be inspected more than once every three years. Crashes could be prevented through improved roadside inspections using wireless technologies that would enable more efficient and effective truck and bus inspections. Inspectors’ efforts would be maximized and lines at inspection stations reduced. As part of an exploratory study by USDOT, wireless inspection operational concepts will be developed, and the feasibility of these operational concepts will be evaluated.

### **Vehicle assist and automation systems**

Operating buses in extremely narrow lanes is difficult and can be dangerous. Vehicle assist and automation systems allow precise operations of buses in such circumstances. They support precision docking, vehicle guidance, vehicle platooning, and automated

operations. They have the potential to improve system efficiency, improve bus rapid transit amenity and accessibility, and increase overall efficiency and productivity of bus operations. While the primary focus of a federal initiative looking at these systems is transit vehicles, this technology has implications for commercial vehicles as well. A Federal Highway Administration initiative effort will explore the concept and feasibility of these systems in various environments to determine if additional research and development is warranted.

## Smart Roads—increasing capacity and safety without adding lanes

The potential promise of “smart road” technology is to safely reduce vehicle headways (the spacing required between vehicles) and thus increase lane capacity; in other words, to allow the same roads to carry more vehicles. This could significantly delay the need to expend large amounts of taxpayer dollars to build more capacity as well as help reduce the frequency and severity of congestion related collisions.



A few European countries are testing an advanced application that allows vehicles to communicate directly with each other to coordinate collision avoidance measures, vary speeds, and increase system efficiency through vehicle spacing and groupings for desired destinations. These clusters of cars (also called pods) could be run in a special lane, traveling just a few feet apart. Both automated highway lanes and intelligent vehicles would require special sensors, controllers, and communication devices to coordinate traffic flow.<sup>25</sup>

### Variable-message signs

Variable-message signs are large, illuminated signs that are adjacent to or span the freeway. Messages displayed on these signs can be controlled either on-site by field personnel or remotely by WSDOT traffic systems management center operators. These messages help alert drivers to issues that affect their travel and improve efficiency and driving safety by providing advance notice of special conditions.

### Variable speed limits

The concept of variable speed limits involves setting maximum and minimum speed limits on the basis of real-time monitoring of prevailing traffic and roadway conditions using changeable information displays to inform motorists of the appropriate limits.

Since some locations with traditional posted speed limits experience highly variable traffic, weather, or other conditions, traveler compliance with these speed limits can be an issue. Variable speed limits can offer a more accurate and responsive means of alerting motorists to changing conditions. Allowing the speed limit to change according to

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<sup>25</sup> Accessed from <http://www.memagazine.org/backissues/may98/features/smarter/smarter.html>

specific conditions should prove more credibility and may improve compliance, safety, and increase system efficiency.

The Washington State Department of Transportation (WSDOT) deployed a variable speed limit system to improve safety and reduce winter-weather related accidents on a 40-mile stretch of Interstate 90 over Snoqualmie Pass. The system consists of radar detection, six weather stations, nine variable message signs (VMS), and radio and microwave transmission systems. The weather stations monitor temperature, wind, humidity, precipitation, and road surface conditions. Current traffic speed and weather condition data are collected and transmitted by packet radio and microwave communication to the Travel Aid control center. The system calculates safe speeds, which are confirmed by WSDOT staff and transmitted to the dynamic message signs.

The variable message signs were installed on the mainline downstream of each on-ramp, and the signs display either the maximum legal speed limit or an enforceable reduced speed limit when conditions warrant lower speeds. Speed limits are changed in 10 mph increments. If traction tires are advised, the speed limit is reduced to 55 mph; if traction tires are required, the speed limit is reduced to 45 mph; and if chains are required, the speed limit is reduced to 35 mph. The system has been operating since the winter of 1997-98. There is no current accident data available to compare accident rates and severity with the area before the signs were activated

### **Traffic signal synchronization**

Traffic signal synchronization, when properly implemented, can provide significant decreases in travel time, fuel consumption and emissions, as well as some increases in driving safety. The effectiveness of the control system depends heavily on the quality of the prediction model used. Signal synchronization often reduces the number of stops required, which in turn reduce the chances of rear-end collisions<sup>26</sup> and lowers emissions.

### **Improving transit reliability through signal preemption**

Another type of traffic signal operation is using preemptive signaling to improve the reliability of transit vehicle schedules. Preemption is transferring normal signal operations to a special control mode. Preemptive signaling is most commonly used by emergency response vehicles, but can also be used by transit operators to assist in maintaining bus schedules. Many transit systems are looking at this option with interest for their future operations. However, using signal preemption for transit or emergency purposes adds up to three signal cycles to re-synchronize the signals: This causes additional delay for traffic on the roadway and can substantially negate the advantages of signal synchronization.

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<sup>26</sup> See also [http://www.calccit.org/itsdecision/serv\\_and\\_tech/Traffic\\_signal\\_control/trafficsig\\_summary.html](http://www.calccit.org/itsdecision/serv_and_tech/Traffic_signal_control/trafficsig_summary.html)

## **Using ITS technologies to reduce pedestrian injuries and fatalities**

Pedestrians represent about 11 percent (4,808) of all roadway fatalities. In general, half of pedestrian fatalities are caused by pedestrian inattention/error, and half are caused by driver inattention/error. Experience with various ITS-based pedestrian safety systems such as pedestrian detection devices, lighted crosswalks, and countdown pedestrian signals has shown that such devices generally improve pedestrian safety and save motorists time. They are especially helpful for slower moving pedestrians. But while some of these examples have been developed and deployed, there has been no focused effort to understand how technology could be applied in a coordinated and integrated manner to address this critical safety problem. USDOT is exploring the feasibility of developing and field-testing pedestrian detection and warning systems to incorporate these technologies into a comprehensive infrastructure and/or vehicle-based pedestrian detection and warning system.

## **Ramp metering**

Ramp metering helps reduce congestion by managing vehicle flow entering highways from local access on-ramps. Entrance ramps can be equipped with a traffic signal that allows vehicles to enter the freeway at predetermined intervals. Ramp metering, contributes to system efficiency when it is used to maintain traffic loading to maintain as close to maximum throughput as possible. This helps preserve optimum freeway flow, reduce accidents, and reduces pollution.

Although ramp metering is highly effective in improving system efficiency, it can cause problems when trucks are unable to reach mainline speeds on the ramp because of a steep grade or insufficient ramp length. The implementation of ramp metering in areas with a large amount of freight movement should include geometric ramp design considerations for trucks.

## **511 customized traveler information**

Real-time traffic and weather information is now available by simply dialing 5-1-1 from most phones. Customized traffic information is delivered via state-of-the-art speech recognition technology, which allows callers to either verbally or numerically indicate the information they want, such as "traffic" or "mountain pass" information. The requested information is then "spoken" back to the user. Callers can use key words to quickly navigate the system to the specific road segment for the information they seek.

The new 511 system builds upon the highly successful Washington state highway hotline that now manages 4.6 million calls each year. Updated every few minutes, 511 allows callers to get a variety of information, such as:

- Puget Sound traffic conditions
- Statewide construction activities and delays
- Incident information
- Mountain pass conditions
- State ferry system information
- 800 numbers for passenger rail, airlines, and weather

WSDOT will update the type of information available on the 511 system based upon customer demand and feasibility.

### **Automated maintenance**

Automated road maintenance can improve safety by getting workers off the road. Minimizing interference between traffic and maintenance crews can reduce fuel consumption and user costs. Automated maintenance enables nighttime maintenance operations and ensures consistency in the quality of work. Reductions in labor costs are also potentially high. A number of promising technologies exist related to this topic.<sup>27</sup>

Controls for the equipment are similar to video games with ergonomic joysticks, graphical interfaces and sensory alarms. Furthermore, the global positioning system, the Internet and wireless technology enhances the situational awareness of the operator while controlling the remote equipment within various features and obstacles of the worksite.



Prototype Crack Sealing Unit

One example is the full-scale roadworthy crack sealing system that now operates at “crew speed” or better that was developed at the University of Texas. Computer vision and operator input combine to map the location of roadway cracks. A computer-controlled mechanism is used to clean, seal and squeegee cracks in one pass. This unit will reduce the sealing crew by three persons, resulting in considerable improvements in user costs, safety, and productivity. Work with the system can occur at night, and the system facilitates improved project control by recording the length of cracks sealed. Images of work performed can also be automatically recorded.

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<sup>27</sup> For more on this topic, see the following: [http://www.ce.utexas.edu/prof/haas/a\\_text\\_armm.pdf](http://www.ce.utexas.edu/prof/haas/a_text_armm.pdf) and <http://gulliver.trb.org/publications/circulars/ec017.pdf>

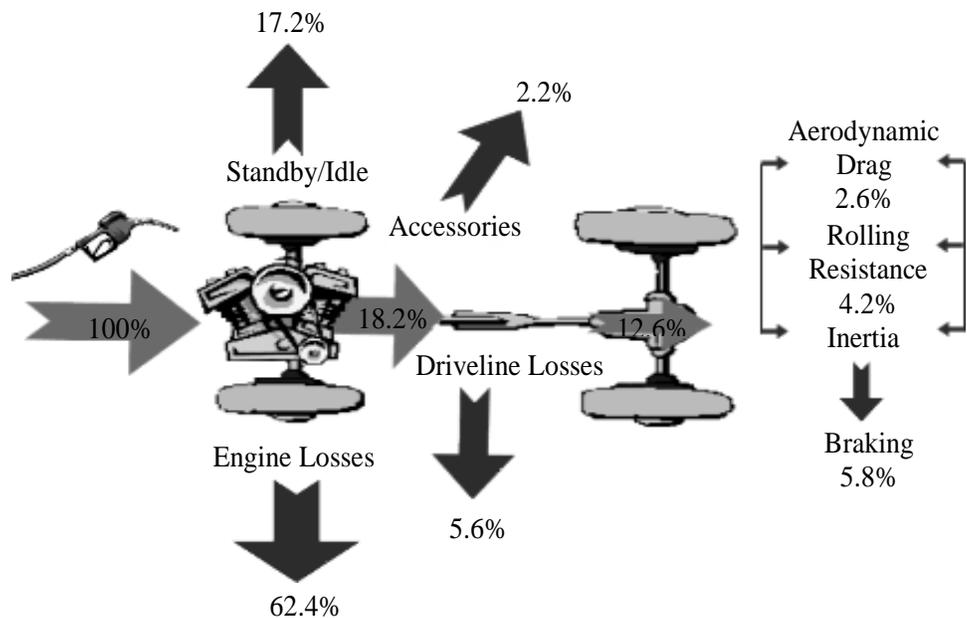
## Future Vehicles: Technology, Energy, and Impacts on Transportation Funding

Fluctuating world petroleum markets and concern about environmental pollution are helping to motivate an ever-increasing body of research that should lead to more efficient energy use for transportation purposes. Until a few years ago, the environmental community was almost exclusively interested in policies that promoted renewable energy, conservation, and natural sinks. More recently, they have begun to explore alliances with traditional energy supply industries on the grounds that to establish the pace required to achieve environmental goals, parallel action on many fronts is required.

In general, the most promising technologies incorporate electronic motors and batteries,<sup>28</sup> while using new design techniques and advanced materials to reduce resistance, cut vehicle weight, and better conserve energy. However, many technologies are still in various stages of development and have not yet proven marketable to most consumers. The three key issues for the marketing of advanced technology vehicles will be cost, infrastructure, and performance. Consumers must be willing and able to purchase the vehicles, so initial and overall life-cycle costs must be competitive. Refueling (whatever the energy source) and servicing must be relatively convenient. Finally, performance—in terms of fuel economy, drivability, safety, and emissions—must be acceptable.

### Technology—better use of existing fuels

Only about 15 percent of energy in the fuel used to power vehicles is actually used to move them down the road or run useful accessories like air conditioning, power steering, or generators for hybrid electric motors and drive systems. Most of the energy is lost to heat, friction, and



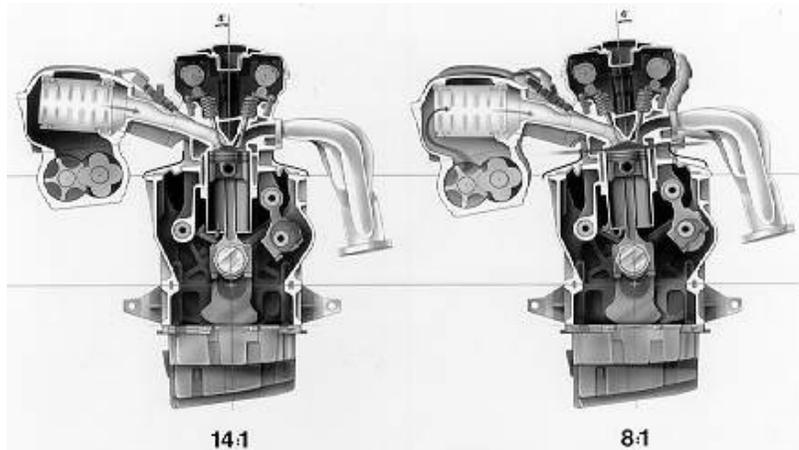
other forms of resistance. The figure above illustrates the paths of energy through a typical gasoline-powered vehicle in city driving. The laws of physics will not permit all of these losses to be entirely eliminated but improvements are possible at every step.

<sup>28</sup> For more discussion, see <http://www.ncseonline.org/NLE/CRSreports/04Jan/RL30484.pdf>

Because the potential to improve fuel economy with advanced technologies is enormous, a great deal of research in this arena is currently being conducted. Some examples of advancements in automotive technologies include: computer controlled solenoid powered valves, higher pressure direct injection, low sulfur diesel engines, continuously variable transmissions, hybrid drive trains, lower rolling-resistance tires, variable compression/displacement engines, more aerodynamic undercarriages, lighter vehicles, fuel additives, and many other technologies.

### **Variable compression/displacement engines**

At the 2000 Geneva Motor Show, Saab Automobile AB unveiled the Saab Variable Compression (SVC) engine, a new engine concept that enables fuel consumption to be radically cut (up to 30 percent) while increasing engine performance per liter of engine displacement.<sup>29</sup>



The combination of reduced engine displacement, high supercharging pressure, and a

unique system for varying the compression ratio enables the SVC engine to use energy in fuel far more efficiently than today's conventional automotive engines. SVC offers an entirely new concept for combining high performance with low fuel consumption and low exhaust emissions.

### **Lighter vehicles**

Lightweight materials including aluminum, plastics, magnesium, carbon fiber, and metal matrix composites, can be used to build more fuel-efficient vehicles without sacrificing safety, durability, or comfort. For every 10 percent of weight eliminated from a vehicle's total weight, fuel economy improves by 7 percent. Researchers are aiming to cut vehicle weight by up to 40 percent—about 1,200 pounds—compared to today's average mid-sized sedan. Some manufacturers are already using aluminum to cut about half of the weight of a conventional automobile body structure.



Research must find cost-effective ways to mass-produce vehicles constructed with lightweight materials.

<sup>29</sup> See <http://www.saabnet.com/tsn/press/000318.html>

## **Computer controlled camless valves**

Camshafts have served internal combustion engines since the beginning of the 20th century. They enable engines to draw in an air-fuel mixture for the combustion cycle and then dispose of the exhaust afterward by precisely synchronizing the opening and closing of an engine's valves to the movement of its pistons. Current variable valve timing technology is capable of only slight adjustments in valve timing.

In an attempt to consign the fixed camshaft to the history books, every major auto and truck maker in the world is now said to be considering a switch to electronically controlled valve timing. Electronic timing offers vehicle manufacturers a myriad of advantages, the main ones being better performance and lower emissions. Unlike the fixed camshaft, electronic control enables engines to change valve timing on the fly and to a greater degree.

## **Higher-pressure direct injection**

Both gas and diesel engines are benefiting from high-pressure direct fuel injection. Though many manufacturers are offering this technology in 2005, more will likely follow. Unlike standard fuel injection that simply sprays gasoline inside the engine's intake port, high-pressure direct injection (up to 23,000 pounds per square inch (psi)) gas and diesel engine technologies allow for the injection of an optimum air-fuel droplet mixture directly into the combustion chamber.<sup>30</sup> This increases burn efficiencies, minimizes exhaust particulates, lowers emissions, reduces fuel consumption, reduces noise, and enhances power output.

Diesel produces 20 to 30 percent lower carbon dioxide emissions and significantly lower carbon monoxide than gasoline engines, but has historically produced more oxides of nitrogen and soot or particulates. However, with high-pressure direct injection and the low-sulfur diesel that will become available in 2006, engineers are optimistic that these new diesels will be able to meet emissions standards in all 50 states.

## **Continuously variable transmission**

Continuously variable transmissions (CVTs) have been around since 1886 but only recently a number of automakers have begun bringing CVT-equipped vehicles to market—with more on the way. Although there are different variations on this theme, most passenger cars use a similar setup. Essentially, a CVT transmission operates by varying the working diameters of the two main pulleys in the transmission. The action is similar to the way a mountain bike shifts gears, by "derailing" the chain from one sprocket to the next—except with a CVT the action is infinitely variable, with no "steps" in between.<sup>31</sup> The "stepless" nature of its design is CVT's biggest draw for automotive engineers. Because of this, the transmission can work to keep the engine in its optimum power range, thereby increasing efficiency and gas mileage.

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<sup>30</sup> For more, see <http://www.yenra.com/mercedes-cdi/>

<sup>31</sup> See also <http://www.edmunds.com/ownership/techcenter/articles/45104/article.html>

## **Maximizing efficiency through tire pressure/ lower rolling resistance tires**

A vehicle's fuel economy is very much related to its total resistance to movement. Total resistance includes such things as overcoming inertia (Newton's Law,) driveline friction, road grades, tire rolling resistance, and air drag.

The easiest way to reduce rolling resistance to enhance fuel economy is to inflate tires properly. Therefore, maintaining the vehicle manufacturer's pressure recommended for light load and heavy load conditions may almost be as important as whether or not lower rolling resistance tires are used, although these can also improve fuel efficiency.

## **Energy—new automotive sources**

While various forms of energy, including alternative fuels, are being used or undergoing testing worldwide, it is unknown when or if research on non-petroleum alternative energy sources may result in a significant shift for powering vehicles.

Alternative fuels often reduce harmful pollutants and exhaust emissions. In addition, most of these fuels or energy sources can be domestically produced and derived from renewable sources. Alternative fuels, as defined by the Energy Policy Act of 1992, include ethanol, natural gas, propane, hydrogen, biodiesel, electricity, methanol, and p-series fuels.

### **Biodiesel**

Biodiesel is one of the only alternative fuels usable in any conventional diesel engine with little or no modification to the engine or fuel system. More than 40 federal and state fleets are already using biodiesel blends in their existing diesel engines.<sup>32</sup> Substantial investments are being made to research and produce biodiesel.

Biodiesel blend (B20) and pure biodiesel (B100) offer the following changes relative to conventional diesel:

- Reduce carbon monoxide emissions 10 percent (B20) and 50 percent (B100)
- Reduce particulate emissions 15 percent (B20) and 70 percent (B100)
- Reduce total hydrocarbon emissions 10 percent (B20) and 40 percent (B100)
- Reduce sulfate emissions 20 percent (B20) and 100 percent (B100)
- Increase nitrogen oxide emissions 2 percent (B20) and 9 percent (B100)
- No change in methane emissions using either B20 or B100

### **Fischer-Tropsch**

The majority of heavy-duty vehicles on our nation's highways today are powered by diesel fuel. This presents enormous opportunities for clean-burning diesel substitutes such as Fischer-Tropsch liquids. Although they have been used to some degree since the 1920s, Fischer-Tropsch fuels are not widely used today—but this could change.

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<sup>32</sup> <http://www.epa.gov/otaq/consumer/fuels/altfuels/420f00032.pdf>

Fischer-Tropsch technology converts coal, natural gas, and low-value refinery products into a high-value, clean-burning fuel. The resultant fuel is colorless, odorless, and low in toxicity. In addition, it is virtually interchangeable with conventional diesel fuels and can be blended with diesel at any ratio with little to no modification. Fischer-Tropsch fuels offer important emission benefits compared with diesel, reducing nitrogen oxide, carbon monoxide, and particulate matter.<sup>33</sup>

## **Ethanol**

Ethanol-fueled vehicles date back to the 1880s when Henry Ford designed a car that ran solely on ethanol. Subsequently, the popular Model T was designed to operate on either ethanol or gasoline. Four generations later, ethanol-blended gasoline accounts for more than 10 percent of total gasoline sales in the United States.

Essentially 100 percent pure grain alcohol made unfit to drink, fermenting plant sugars produces ethanol. It can be made from corn, potatoes, wood, waste paper, wheat, brewery waste, and many other agricultural products and food wastes. Anything containing sugar, starch, or cellulose can be fermented and distilled into ethanol.

More than 90 percent of U.S. ethanol production comes from corn. Pure ethanol is rarely used for transportation; usually it is mixed with gasoline. The most popular blend for light-duty vehicles is known as E85, which has 85 percent ethanol and 15 percent gasoline. The technology to produce ethanol is well established, and all the resources needed to produce it can be supplied domestically.

## **Methanol**

For more than 30 years, methanol has been the fuel of choice at the Indianapolis 500. Today, non-race car drivers can benefit from methanol's high performance and safety benefits, as well. Most methanol-fueled vehicles use M85, a mixture of 85 percent methanol and 15 percent unleaded gasoline. Methanol is also available as M100 (essentially pure methanol), typically to substitute for diesel.

Most methanol-powered vehicles are fuel-flexible, meaning they can use 100 percent gasoline if methanol is not available. Because it is produced as a liquid, methanol is stored and handled like gasoline. Most methanol fuels are currently made from natural gas, but they can also be made from a wide range of renewable sources, such as wood or waste paper. Commonly known as "wood alcohol," methanol is a toxic, colorless, tasteless liquid with a very faint odor.

Methanol also offers important emission benefits compared with gasoline—it can reduce hydrocarbon emissions by 30 to 40 percent with M85 and up to 80 percent with M100 fuels. Emissions are considerably lower when methanol is used in a fuel cell vehicle—automobiles that convert the chemical energy of a fuel into electricity and heat without combustion.

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<sup>33</sup> EPA fact sheet, see <http://www.epa.gov/otaq/consumer/fuels/altfuels/420f00036.pdf>

## **Compressed natural gas**

Natural gas is one of the most widely used forms of energy today. It is commonly used to heat and cool homes and businesses nationwide. In addition, more than 85,000 compressed natural gas (CNG) vehicles, including one out of every five transit buses, are operating successfully using this fuel today. Two types of CNG fuel systems are on the market: dedicated vehicles, which operate exclusively on natural gas, and dual-fuel vehicles, which can use both natural gas and gasoline. Auto manufacturers offer a variety of both dedicated and dual-fuel vehicles, including compacts, trucks, vans, and buses.

This fuel's popularity stems, in part, from its clean-burning properties. In many cases, CNG-powered vehicles generate fewer exhaust and green house gas emissions than their gasoline- or diesel-powered counterparts. This fuel is odorless, colorless, and tasteless. It consists mostly of methane and is drawn from gas wells or in conjunction with crude oil production. CNG vehicles store natural gas in high-pressure fuel cylinders at 3,000 to 3,600 psi. An odorant is normally added for safety reasons.

The United States has vast natural gas reserves distributed across the country through extensive pipeline systems extending from the wellhead to the end-user. As a result, CNG is currently available at approximately 1,300 refueling stations in 46 states, and this number continues to grow. Additionally, CNG vehicle owners can refuel their cars by installing small compressors connected directly to the home's natural gas supply.

## **Liquefied natural gas**

For decades, natural gas has provided clean power to thousands of households and businesses nationwide. Today, more than 1,000 vehicles traveling our nation's roads are powered by natural gas that is cooled to a liquid—liquefied natural gas (LNG.)

LNG is odorless, colorless, non-corrosive, and nontoxic. When extracted from underground reserves, natural gas is composed of approximately 90 percent methane. During the liquefaction process, oxygen, carbon dioxide, sulfur compounds, and water are removed, purifying the fuel and increasing its methane content to almost 100 percent. As a result, LNG-fueled vehicles can offer significant emission benefits compared with older diesel-powered vehicles, and can significantly reduce carbon monoxide and particulate emissions as well as nitrogen oxide emissions.

To date, fleet managers have been the primary user of LNG-powered vehicles. Therefore, most LNG refueling stations are located at heavy-duty vehicle fleet operations not open to the public. LNG's complex onboard storage system does not make it a viable fuel for light-duty vehicles. It is, however, replacing diesel in many heavy-duty trucks and buses and many new gas-fueled locomotives. The number of LNG-fueled transit buses is expanding rapidly as many cities work to reduce air pollution levels.

## **Propane**

More than 60 million Americans use propane gas for everything from heating and cooling their homes and businesses to powering their barbecue grills. Propane is also used to fuel more than 350,000 vehicles on our roads today, from taxicabs and school

buses to police cars. In fact, with more than 5,000 fueling stations nationwide, propane is the most widely used alternative fuel to date.

Propane (otherwise known as Liquefied Petroleum Gas or LPG) is a byproduct of natural gas processing and petroleum refining. In its natural state, propane is a colorless, nontoxic gas—at least 90 percent propane, 2.5 percent butane and higher hydrocarbons, with the balance ethane and propylene. An odorant is added to the gas so it can be detected for safety reasons.

Under moderate pressure, propane gas turns into a liquid mixture, making it easier to transport and store in vehicle fuel tanks. Compared with gasoline, propane can lower carbon dioxide, carbon monoxide, and other toxic emissions.

### **Hybrid-Electric Vehicles (HEVs)**

Hybrid-electric vehicles typically combine the internal combustion engine of a conventional vehicle with the battery and electric motor of an electric vehicle. The combination offers low emissions, with the power, range and convenient fueling of conventional (gasoline and diesel) vehicles—and they never need to be plugged in. The inherent flexibility of these vehicles makes them well suited for fleet and personal transportation.

HEVs are powered by two energy sources—an energy conversion unit (such as a combustion engine or fuel cell) and an energy storage device (such as batteries or ultracapacitors.) Gasoline, methanol, compressed natural gas, hydrogen, or other alternative fuels may power the energy conversion unit. Hybrid-electric vehicles have the potential to be significantly more fuel-efficient than conventional vehicles.

### **Electricity**

Although some Electric Vehicles (EVs)<sup>34</sup> are found nationwide, California has the greatest concentration of this alternative vehicle. EVs do not produce tailpipe emissions, but generators producing the electricity used to charge EV batteries do emit pollutants.

Electricity for EVs is produced by power plants, which send the power to substations through transmission lines and then to homes and businesses through distribution systems. An EV's electric motor converts electricity, usually from a battery pack, into mechanical power that runs the vehicle. After a vehicle is driven a certain distance, however, EV batteries must be recharged. Also, earlier anticipated demand for these vehicles has been reduced by increased electricity prices.

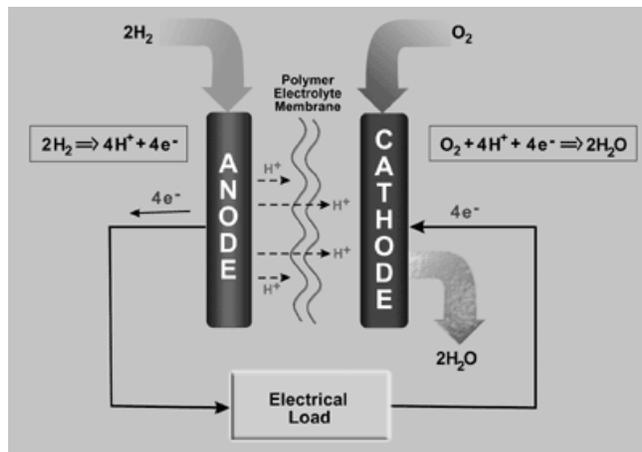


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<sup>34</sup> EPA fact sheet <http://www.epa.gov/otaq/consumer/fuels/altfuels/420f00034.htm>

## Hydrogen

Hydrogen fuel cell vehicles (FCV) generate power through an electrochemical process, much like a battery. They can achieve 40 to 70 percent efficiency, substantially greater than the 30 percent of the most efficient internal combustion engines. The most promising of these technologies is the gas-electric hybrid vehicle, which uses both an internal combustion engine and an electric motor, switching seamlessly between the two to optimize gas mileage and engine efficiency. The Environmental Protection Agency (EPA) is playing a leading role in the federal government's growing efforts to accelerate the development of fuel cell technology, especially for vehicle applications.



## Batteries

Several of the new technologies noted above depend upon batteries. Hybrid electric and fuel cell vehicles are electrically driven, albeit with dramatically different ways of producing the electricity. In both cases these advanced vehicles require high-power electric battery packs for optimal performance. Current battery challenges include limited driving range, cost, limited life cycles, space requirements, weight, and production and disposal issues related to their heavy metals. Battery technology itself is rapidly developing and advances in battery technology hold the promise of one day allowing us to use less polluting forms of energy.

The following types of batteries have the potential to power electric vehicles:<sup>35</sup>

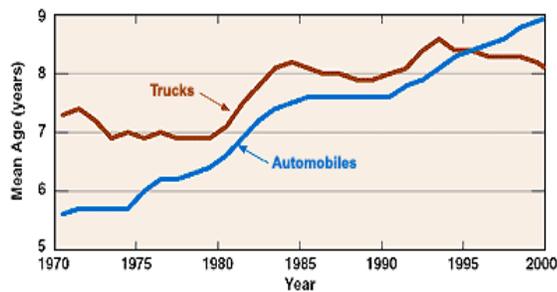
- **Lead-Acid**—Provides a low-cost, low-range (less than 100 miles) option with a 3-year life cycle.
- **Nickel-Metal Hydride**—Offers a greater driving range and life cycle, but is currently more expensive than lead-acid batteries.
- **Nickel-Cadmium**—Offers a range of 100 miles, a long life, and faster recharges than lead-acid batteries, but is more expensive and has lower peak power and recharging efficiency.
- **Lithium-Ion**—Offers the potential for a long driving range and life cycle, but is currently very costly.
- **Zinc-Air**—Currently under development. Provides superior performance compared to current battery technology.
- **Flywheels**—Currently under development. Could be capable of storing a larger amount of energy in smaller, lighter weight systems than chemical batteries.

<sup>35</sup> IBID

## Impact of new technology on transportation funding

If vehicles become significantly more fuel-efficient while vehicle miles of travel continue to increase (or even remain at current levels,) revenues received from the state's current gas tax will likely decrease. However, with the average age of vehicles in the U.S. fleet increasing to over eight years, it is less likely that new technology will immediately and significantly impact tax or use-fee base revenues.

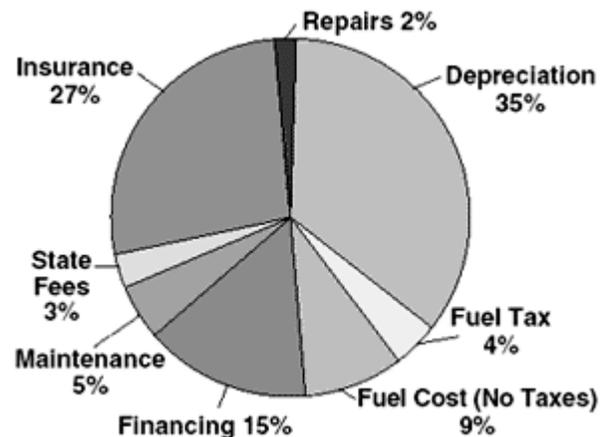
*The average age of automobiles has continued to increase, to a high of 9.0 years in 2000. The average age of trucks actually declined from an all time high of 8.6 in 1993, to 8.0 years by 2000. The increasing popularity of pickups, vans, and sport utility vehicles as personal vehicles may be influencing the average age of trucks.*



Source: Ward's Communications, Ward's Motor Vehicle Facts and Figures 2001. (compiled from The Polk Company data). <http://www.fhwa.dot.gov/ohim/onh00/onh2p3.htm>

Further, while some passenger cars have increased in fuel efficiency, the popularity of SUVs and pick up trucks has caused overall fuel efficiency to decline—from the “light duty automotive fleet” average of 22.1 miles per gallon in 1987 to 20.8 miles per gallon in 2004.<sup>36</sup>

A study by the WSDOT Financial Planning and Economic Analysis Office indicates that hybrid vehicles are expected to comprise only about 4 percent of Washington's vehicles by the year 2020. This is perhaps due to the public's perception that 1) periods of higher fuel prices will be temporally shorter than the duration that they intend to own their vehicles, and 2) that fuel costs are but a small percentage of overall vehicle ownership costs (see right.)



Source: Ward's Communications, Ward's Motor Vehicle Facts and Figures 2001 (compiled from The Polk Company data).

In 2005, however, Washington passed a new law that requires new vehicle compliance with California motor vehicle emission standards beginning in 2009 (conditional upon adoption of

<sup>36</sup> Environmental Protection Agency 2004 report

the same standards by the state of Oregon.) This is projected to increase fuel efficiency and reduce WSDOT's fuel tax revenues by approximately 11 percent by the year 2021. This will equate to the equivalent of a 3-cent per gallon drop in the gas tax.

Significant shifts in fuel costs, inflation, and or vehicle fuel efficiency may eventually prompt many questions such as:

- *How will future maintenance and operation of roadways be funded if gasoline consumption is reduced?*
- *Should factors such as annual vehicle miles traveled be incorporated into future tax or fee structures?*

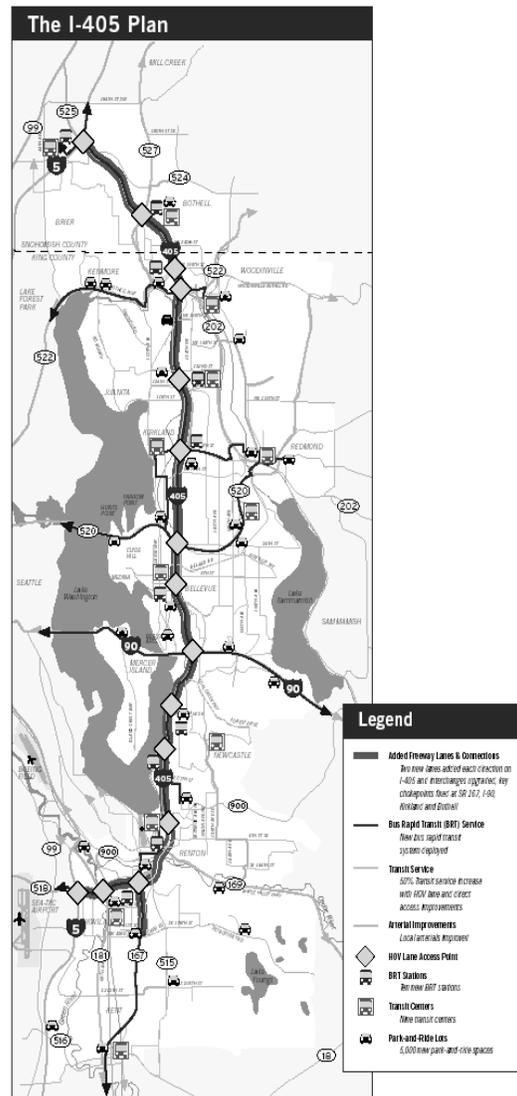
## Major roadway expansions

Although high capacity transportation options can increase the efficiency of our roadways, undoubtedly the future transportation system will include expanding the roadway system. There are many more proposals for highway expansion than could be produced in the upcoming Washington Transportation Plan update or the next. The Highway System Plan has \$39 billion in capacity expansion projects that are not funded. This reflects updated project estimates in 2004 dollars and includes the Alaskan Way Viaduct replacement and SR 520 bridge replacement. The following are all projects that are within our sight, if not quite within our grasp: except where noted, estimated costs are not yet funded.

### I-405 Master Plan

The I-405 Master Plan is a long-range 20-year vision of multi-modal improvements to the freeway, transit system, and arterials along the I-405 corridor stretching from Tukwila to Lynnwood. The plan proposes adding up to two lanes in each direction of I-405, developing a bus rapid transit line with stations, is projected to increase total transit service by 50 percent, and would create eight new pedestrian/bicycle crossings over I-405.

Some funding from the 2003 Legislative Funding Package and the 2005 Transportation Partnership Account will be used to start on



master plan high priority targeted investments. The first of these targeted investments will expand I-405 with two lanes in each direction through many parts of the corridor.

*Estimated Cost: \$11 billion (2002 dollars)*<sup>37</sup>

**SR 509/I-5 freight and congestion relief project**

This project is proposed as a freight and congestion relief project in south King County. It adds over three miles of new six-lane freeway, and more than six miles of new lanes on I-5 between Sea-Tac and Federal Way. The project addresses multiple modes by extending Des Moines Creek Park pedestrian and bike paths over one mile.

This project would complete the missing link between State Route 509 at SeaTac and I-5. It also would expand I-5 to accommodate additional traffic. Included would be a new access route from the south to SeaTac airport to curtail some of the northbound airport traffic currently traveling through the City of SeaTac.

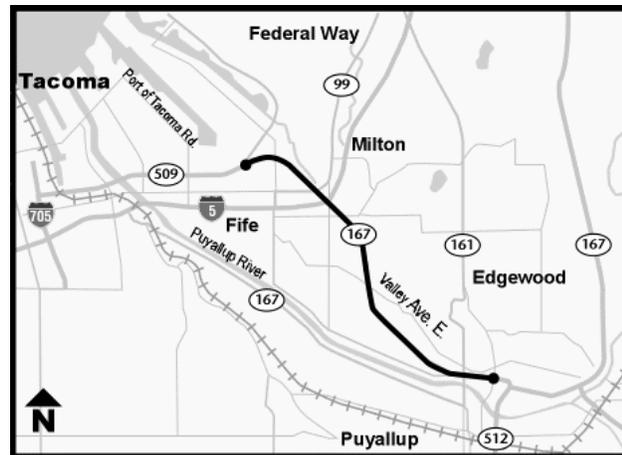


It is proposed as a complete airport/freeway connection similar to the current north side access. The airport/freeway connection is a long-range vision with partial funding in the '03 and '05 biennia.

*Estimated Cost: \$997 million*<sup>38</sup>

**SR 167 extension (Tacoma to Edgewood)**

A new four-lane freeway would help relieve congestion in the lower Puget Sound Region by offering commuters, travelers, and shippers an alternative to I-5. This project would provide a key link to move freight between the Port of Tacoma, I-5, -405, and I-90.



The project would extend SR 167 along the north side of the Puyallup River in Pierce County from its junction with SR 161 in Puyallup to SR 509 in the Port of Tacoma area.

<sup>37</sup> I-405 Master Plan Progress Report – Winter 2004 pdf file: [http://www.wsdot.wa.gov/projects/I-405/resource/i405\\_0104\\_ProgRept\\_rev.pdf](http://www.wsdot.wa.gov/projects/I-405/resource/i405_0104_ProgRept_rev.pdf)

<sup>38</sup> SR 509 project webpage: <http://www.wsdot.wa.gov/projects/I5DesMoinesWaySouth188St/>

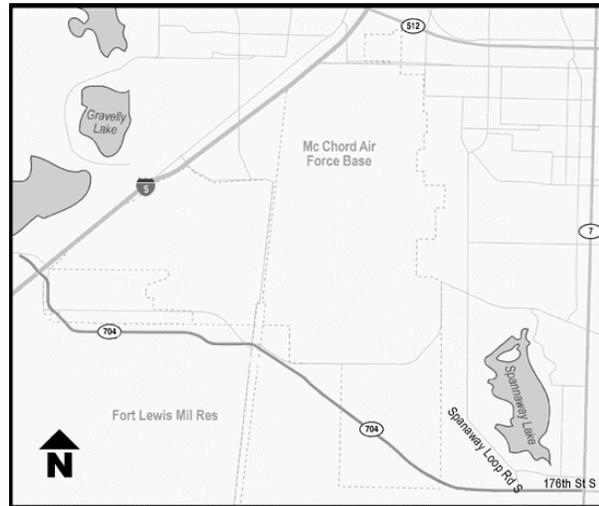
When constructed, the facility would be a divided highway, providing two general-purpose lanes in each direction and HOV lanes from I-5 to SR 161. Access is planned for the following key locations: SR 509—54<sup>th</sup> Avenue (partial interchange,) I-5—Valley Avenue East, and SR 161. This would be another important freight project for connecting the Port of Tacoma to the freeway network and is, as yet, only partially funded in the '03 and '05 biennia.

*Estimated Cost: \$1.7 billion*<sup>39</sup>

### **SR 704 the proposed cross-base highway**

This project is intended to improve transportation system linkages and capacity in Pierce County and destinations along the I-5 corridor to more efficiently move people and goods.

When complete, the highway (SR 704) would provide regional travelers with a new six-mile-long, multi-lane divided highway beginning at the I-5 Thorne Lane Interchange at the west end, and connecting to 176th Street at SR 7 at the eastern terminus. This new alternate east west route would ease congestion on I-5, SR 512, SR 7, Spanaway Loop Road, and 174th Street, by providing a more direct travel route though the Fort Lewis and McChord military bases. The proposed design would accommodate future HOV lanes and include a roadway/railway separation at Thorne Lane. This is partially funded in the '03 and '05 biennia.



*Estimated Cost: \$167.7 million*<sup>40</sup>

<sup>39</sup> SR 167 Extension project webpage: <http://www.wsdot.wa.gov/projects/SR167Extension/>

<sup>40</sup> SR 704 project webpage: [http://www.wsdot.wa.gov/projects/SR704\\_CrossBase/](http://www.wsdot.wa.gov/projects/SR704_CrossBase/)

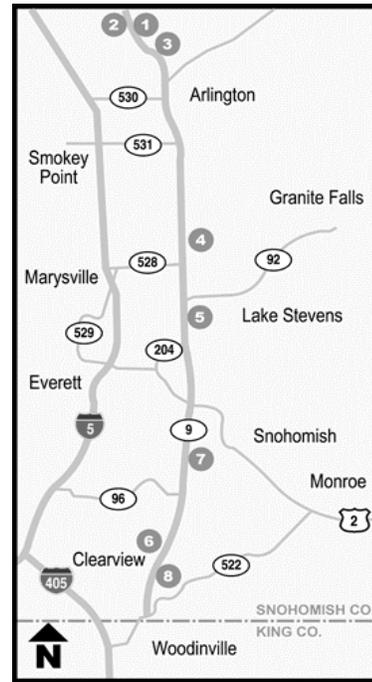
### SR 9 widening

Highway 9 is a crucial north south route connecting Woodinville and Arlington and all destinations in between. It is the only major north south roadway on the east side of Snohomish County and the only major alternative to I-5.

This project would widen 31 miles of two-lane roadway to four and five lanes, provide access control as needed by installing raised medians and turn lanes at key intersections, and would improve several intersections. More vehicles could then travel the highway in less time while increasing safety due to reduced accident potential with turn lanes.

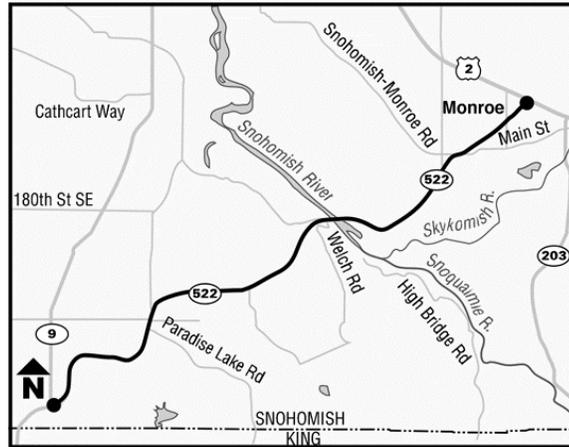
Initial improvements are funded through the state's "Nickel Account." The '05 Legislative Funding Package includes \$127 million for this project.

*Estimated Cost: \$463,426 million<sup>41</sup>*



### SR 522 widening

State Route 522 is an important east west route between I-5 in Seattle and US 2 in Monroe. Significant population growth has caused severe congestion on SR 522, especially during the morning and afternoon commute periods. SR 522 improvement projects should enhance safety and decrease drive times.



If all planned projects on SR 522 were completed, drivers would have two lanes in each direction (including widened bridges), two new interchanges, and numerous safety improvements. The environment would also benefit from new drainage facilities that would help improve water quality. This had partial funding of \$110 million in the '03 biennium.

*Estimated Cost: \$266.7 million<sup>42</sup>*

<sup>41</sup> SR 9 Widening project webpage: [http://www.wsdot.wa.gov/Projects/SR9\\_widen/default.htm](http://www.wsdot.wa.gov/Projects/SR9_widen/default.htm)

<sup>42</sup> SR 522 project webpage: <http://www.wsdot.wa.gov/projects/SR522widen/>

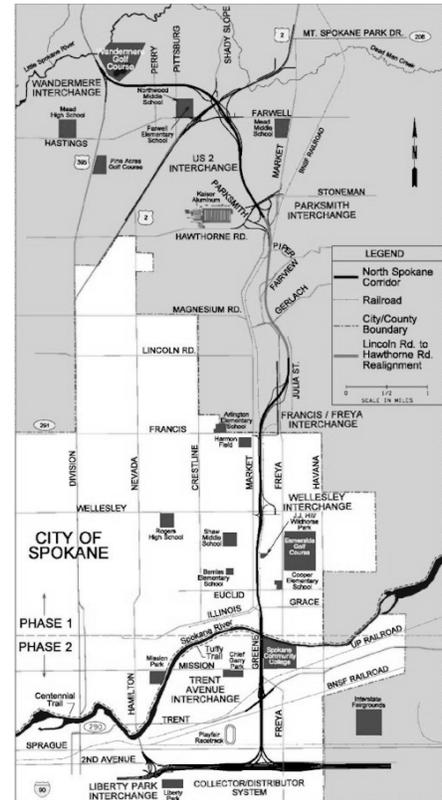
## US 395 North Spokane Corridor Project

This project would address the need to allow motorists and freight to move through metropolitan Spokane along the North Spokane Corridor (NSC) from I-90 to US 395 at Wandermere. The length of the planned North Spokane Corridor is approximately ten miles and would include up to seven interchanges. The project is only partially funded.

The project would provide facility improvements to serve several transportation modes. These would include park and ride lots to support transit and vanpooling operations, and an expanded and enhanced pedestrian/bicycle facility. Right of way would also be reserved for possible future light rail use.

When completed, the North Spokane Corridor would be a 60-mile per hour, limited access highway with a direct connection to I-90 just west of the existing Thor/Freya interchange. This project is planned for development in two phases and is partially funded in the '03 and '05 biennia.

*Estimated Cost: \$1.5 billion*<sup>43</sup>



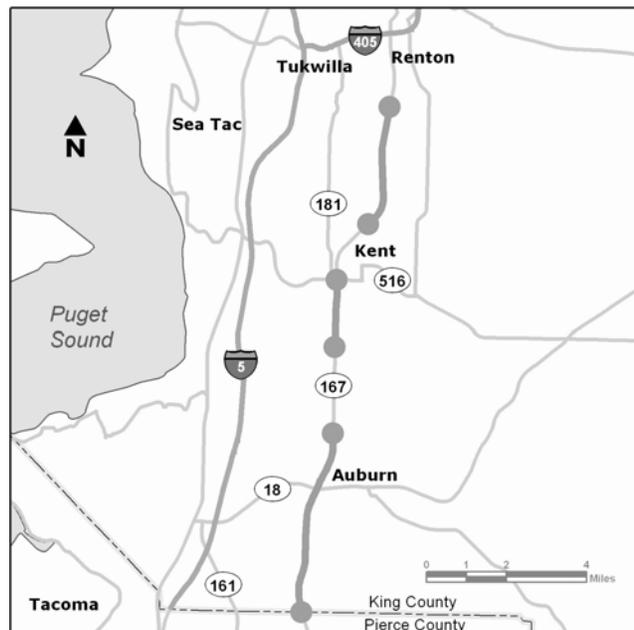
## Projects just beyond our grasp

The following projects are all being discussed, but are still just out of our grasp. This is not meant to be an exhaustive list as there are many ideas for capacity expansion throughout the state.

### SR 167 Valley Freeway

Traffic volumes on SR 167 through the Kent Valley have grown steadily in the last few years. Significant congestion currently exists, especially in the southern end, due to heavy development in the Puyallup and Bonney Lake areas. This proposal would target particular hotspots along the route, although there are many proponents of projects that would prefer to widen the entire route. The *Sounder* commuter rail parallels this corridor.

This project would improve congestion



<sup>43</sup> US 395 project webpage: <http://www.wsdot.wa.gov/projects/US395NorthSpokaneCorridor/>

in the SR 167 corridor by addressing three critical transportation "chokepoints." First, the remaining "missing" sections of HOV lane would be completed from their current terminus in the vicinity of SR 18 in Auburn at approximately the King/Pierce County line and would be extended to SR 410 / SR 512. Second, a single lane would be added in each direction from S. 180th Street (matching the I-405 Corridor improvements) to 84<sup>th</sup> Avenue South. And third, the project would add an auxiliary lane to SR 167 in each direction between SR 516 (Kent-Des Moines Road) and S. 277<sup>th</sup> Street.

*Estimated Cost: \$419 million (2004 dollars)*<sup>44</sup>

#### *US 395 Spokane to the Stevens County line*

US 395 is a major north south transport link that helps move people and goods between the United States, Mexico, and Canada. Southern Stevens County is a bedroom community for people who work in Spokane County and has not increased in population until recently.

This project would widen US 395 to improve traffic flow and safety—from the current two lanes to a four-lane divided highway with a 60-foot wide median. Also included in the project would be new grade-separated interchanges.

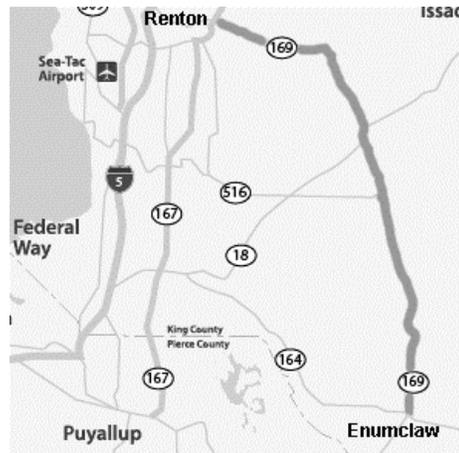
*Estimated Cost: \$91.5 million*



<sup>44</sup> <http://www.wsdot.wa.gov/projects/SR167/ValleyFreewayExt/>

***SR 164 Corridor Study—(Auburn to Enumclaw)***

Located in southeast King County, State Route 164 serves urban, suburban, and rural areas from the City of Auburn through the Muckleshoot Tribal Reservation to the City of Enumclaw. The area's population has grown considerably in recent years and consequently SR 164 is now experiencing increasing traffic congestion and accidents.

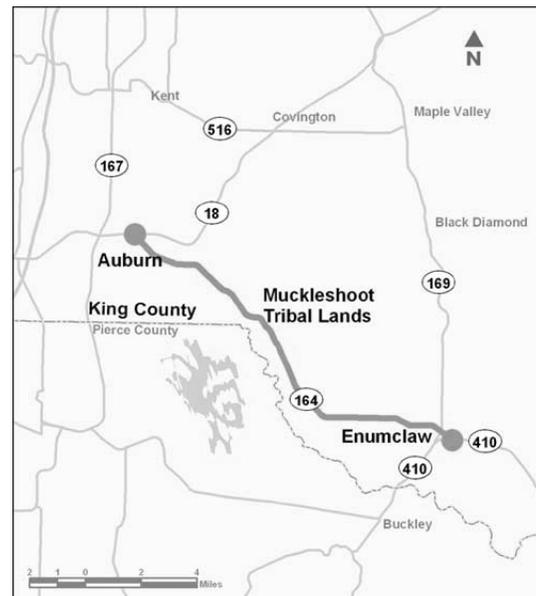


Along with being an important regional highway for southeast King County, SR 164 is also a "main street" for Auburn, Enumclaw, and the Muckleshoot Reservation. It is the sole point of access for Enumclaw Plateau residents. This 15-mile highway also provides access to Mt. Rainer National Park, and the White River Amphitheater. Some proposals have sought to create a bypass around the City of Auburn, one of the major bottlenecks on this commuter corridor having high levels of peak-period directional congestion. A study is needed to analyze proposals and evaluate alternate ways to address the growing problems with congestion and accidents.

*Estimated Cost: Cost estimate cannot be made until specific improvements are identified in the Route Development Plan—the Corridor Study's final product.*

***SR 169 Corridor Study—(Renton to Enumclaw)***

Another route needing further study is SR 169. This route serves urban, rural, and farming areas from Enumclaw to Renton. It is an important rural and commuter corridor, a city main street, and a freight connector. Because of rapid growth, it has experienced increased traffic congestion, and has a number of high accident locations.



The corridor has a consistent flow of large trucks transporting gravel from nearby gravel pits. One proposal calls for a bypass to divert some of the gravel truck-traffic away from the Enumclaw residential and downtown portions of the corridor. The corridor suffers bottlenecks during the morning and evening peak period commutes.

*Estimated Cost: Cost estimate cannot be made until specific improvements are identified in the Route Development Plan—the Corridor Study's final product.*

## New bridges and crossings

Regions throughout the state are distinguished by their unique geology, including water bodies, habitats, and climates. These features make Washington a land of great diversity. This diversity however, makes providing many desired transportation facilities a great challenge. The following are some examples of those challenges Washington has overcome in the past to inspire us as we face future challenges for needed new bridges and crossings:

- Washington is home to four of the world's eight floating bridges. These include the Albert D. Rosellini Bridge over Lake Washington (SR 520) boasting the longest floating span in the world (7,518 feet,) the Lacey V. Murrow Memorial/Homer Hadley Bridges (I-90 across Lake Washington,) and the Hood Canal Bridge (SR 104) on the Olympic Peninsula.
- The Ed Hendler Bridge (Tri-Cities Area) spans the Columbia River between Pasco and Kennewick. At 2,503 feet long it is the world's second longest concrete cable-stayed bridge.
- Fred Redmon Memorial Bridge (on I-82, between Ellensburg and Yakima) is the longest single-span concrete arch bridge in North America (13th longest in the world) with a total span of 1367 feet. It contains an arch span of 550 feet and is 330 feet high.
- Astoria-Megler Bridge near the mouth of the Columbia spans the river between Washington and Oregon. With truss spans of 616 feet, 1232 feet and 616 feet, it is the longest continuous steel span truss bridge in the world. Total length is 4.1 miles.

Washington has met other unique design and operational challenges successfully:

- The Port of Everett is the second largest marina on the West Coast. With the state's ports handling the ever-present and economically important shipping trade, much work is required to facilitate the massive amount of freight coming from and distributed to all points north, east, west, and south in the United States, Canada, Mexico, and around the world.
- Boeing's Everett assembly plant has the largest building by volume in the world; it covers 62 acres and is 11 stories high. The railroad spur that delivers parts to the plant climbs 600 feet in just over three miles and is the second steepest standard gauge railroad in the world.<sup>45</sup>

Though these and other challenges may have seemed insurmountable, hard work, ingenuity, and vision led to transportation improvements that met the challenges—some

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<sup>45</sup> <http://www.travel-in-wa.com/TRAVEL/facts.html>

of which serve as model solutions for the rest of the nation and the world. But what does the future hold?

### Challenges within our grasp

The following projects having unique design and funding challenges have some level of funding.

#### *New I-5 Columbia River crossing*

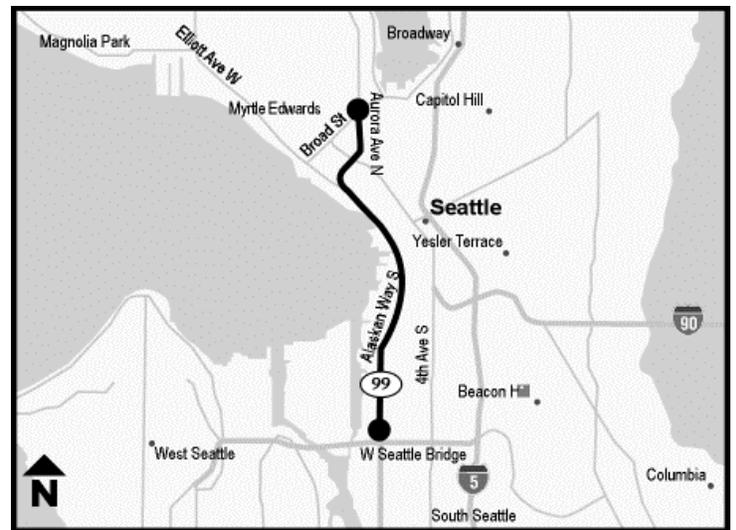
In Vancouver, Washington a new bridge is needed to provide additional capacity to cross over the Columbia River. Replacing the current I-5 Columbia River Bridge is just one of several transportation improvement options that will be examined in an Environmental Impact Statement (EIS) which is currently underway. The '03 Legislative Funding Package provided funds to complete the EIS and begin design work.



*Estimated Cost: cost cannot be estimated until the EIS and preliminary design work are complete.*

#### *SR 99 - Alaskan Way Viaduct and seawall replacement project*

The longer we wait, the more we risk in unacceptable loss of life and property. The viaduct and its support structure, the Seattle seawall, are at risk of failure from earthquakes as well as continuing damage due to age and deterioration.



The viaduct plays a major role in sustaining our economy and maintaining our ability to move to and through Seattle. One-quarter of all north south traffic traveling through Seattle uses the viaduct every day (103,000 vehicles). Extreme congestion on I-5 and in the downtown city grid following temporary closures of the viaduct (due to the 2001 Nisqually Earthquake) made it clear that this is a critical route that needs replacing.

This proposal would address the urgent need to replace both the 51-year old viaduct and 70-year old waterfront seawall. It would create a two-for-one solution: a tunnel replaces the viaduct, and along the central waterfront the tunnel's west wall, replaces the seawall.

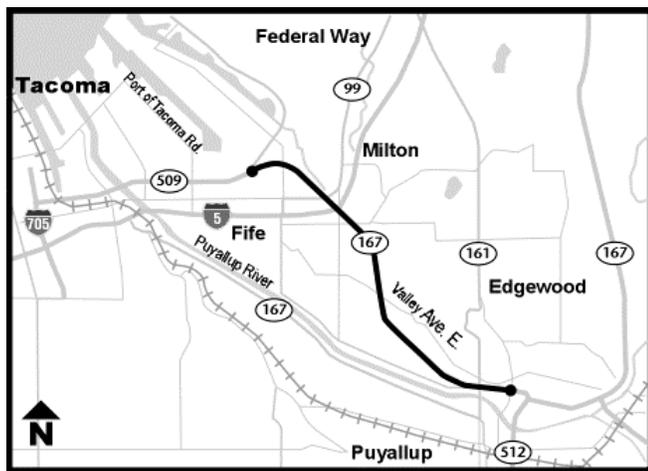
WSDOT, the Federal Highway Administration (FHWA), and the City of Seattle have selected the tunnel alternative as the preferred alternative to replace the Alaskan Way Viaduct following three years of environmental and engineering review, 76 initial concepts, over 200 community meetings, and over 4,500 public comments.

With important questions, including funding, remaining to be resolved, it is important that analysis of the rebuild alternative<sup>46</sup> continue through the final stages of environmental analysis as a contingency, so that the final EIS will adequately provide a foundation for future decision-making. The '03 Legislative Funding Package included \$2 billion for this project.

*Estimated Cost: \$4.2 billion.*

***New SR 167 extension***

As previously noted, this proposed new four-lane freeway would help relieve congestion in the lower Puget Sound Region by offering commuters, travelers and shippers an alternative to I-5. The crossing of large expanses of wetlands in the area provides a unique and difficult engineering challenge, however. This project has received partial funding in the '03 and '05 biennia.



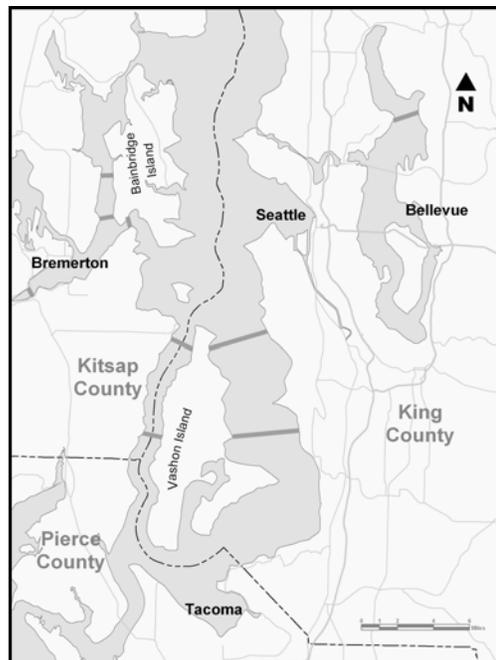
*Estimated Cost: \$1.7 billion.*

**Outrageous or merely visionary?**

The projects that follow are not associated with funding but have been the subject of ongoing discussion and, in some form, and could perhaps become more probable in the future.

***Cross-sound bridges***

Over the years there have been various proposals to connect the Kitsap Peninsula with West Seattle. Feasibility studies to examine this issue were discussed by nearly every legislature between 1949 and about 1967. Since the 1970s, however, most communities along the water, having seen the effect of bridges connecting Mercer Island, have been vocally against such a bridge.

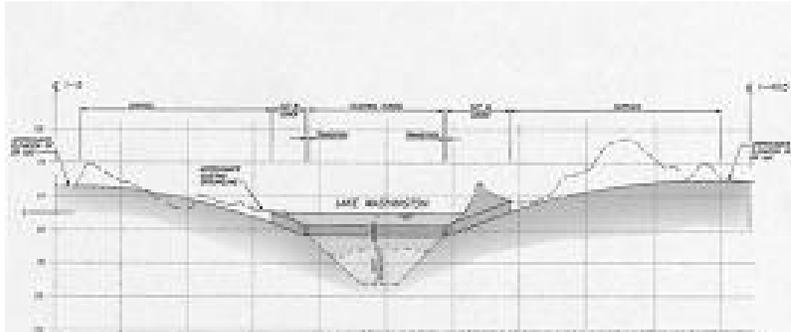


<sup>46</sup> <http://www.wsdot.wa.gov/Projects/Viaduct/Rebuild.htm>

Additionally, North Kitsap County has seen a lot of growth in the last few decades and there is much more ferry travel between Edmonds/Kingston and Mukilteo/Clinton today than between Seattle and Bainbridge. The new Tacoma Narrows Bridge would make a Seattle/Bainbridge type of bridge crossing redundant.

**Lake Washington crossing—a submerged floating tunnel?**

One suggestion WSDOT received for an additional way to cross Lake Washington is a submerged floating tunnel. Although currently no such tunnel exists, the idea is being studied worldwide. The technology is available but there are still significant safety issues that need to be studied in detail.



Dye, Parker, & Reilly 03-17-04

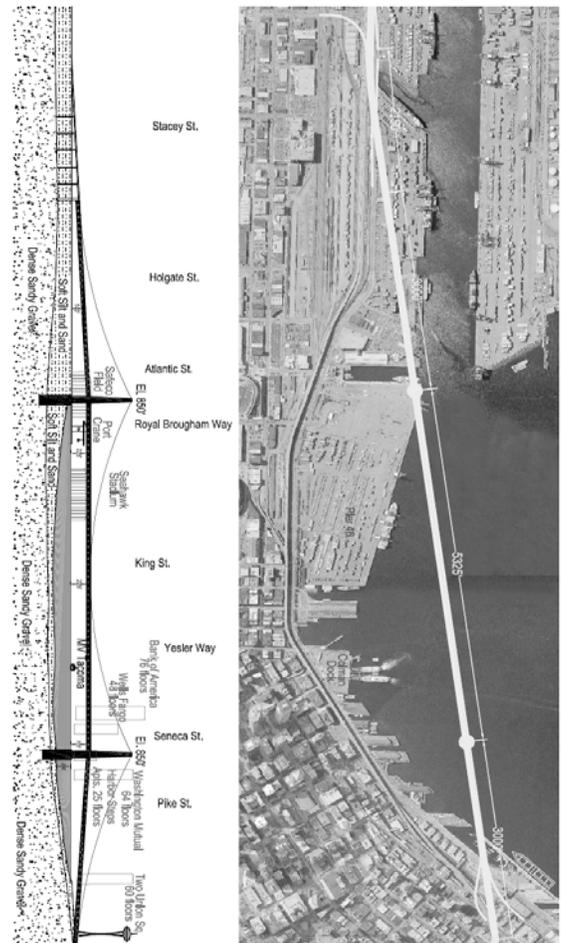
Concept for a floating tunnel across the bottom of Lake Washington

Cost is also an issue with estimates approximately triple that of a floating bridge. In addition to cost and safety, there are concerns for this suggestion regarding geological stability, ventilation, lighting, fire, flooding, and security.

**Elliott Bay bridge concept**

This idea for a cross-sound bridge was submitted through our public comment solicitation for ideas on replacing the Alaskan Way Viaduct. The proposal calls for a bridge from the base of Queen Anne Hill near Elliott Avenue to the south side of Safeco Field near Holgate Street. The intent would be to create a signature bridge that would become our waterfront icon, similar to San Francisco’s Golden Gate, or Sydney, Australia’s Sydney Harbor Bridge.

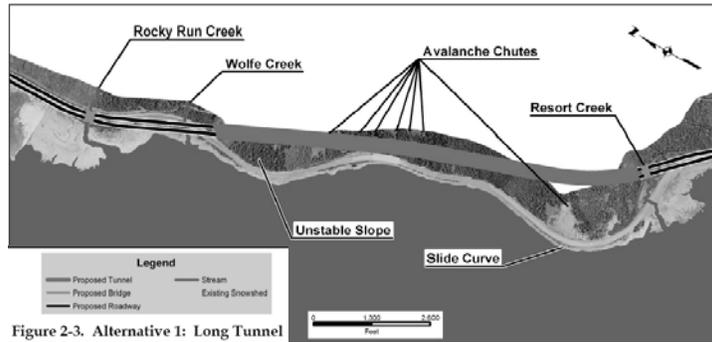
Although highly unlikely under current environmental regulations, there was even one advocate for filling in portions of Elliott Bay and creating new docks farther out into the bay. The suggestion was then to create a five- to eight-lane roadway on the newly “reclaimed” Bay Shore.



## An all-weather Cascade crossing

Another idea that has been around for a while is the concept of an all-weather route through the Cascade Mountains. The need is to avoid avalanche closures and meet projected traffic demands while improving public safety. One proposal would provide six lanes from Hyak to Easton with tunnels and/or other

mitigation measures to protect against avalanches and rock fall to minimize road closures. This idea has also been presented with a Naches Pass tunnel configuration off of State Route 410 near Mt. Rainier. While reducing weather-related road closures is a real need, there have been significant differences in opinion regarding the scope for an actual project.



I-90 All-Weather Cascade Tunnel from Hyak to Easton

*Estimated Cost: \$315 to \$730 million for 15-mile corridor.*

## The Future of General Aviation Airports in Washington

The Small Aircraft Transportation System (SATS) vision for the future is for a safe travel alternative to help free people and products from surface transportation system delays by creating access to more communities in less time via air travel.<sup>47</sup>

The National Aeronautics and Space Administration (NASA), in partnership with the U.S. Department of Transportation/Federal Aviation Administration (FAA,) and state and local aviation and airport authorities, leads a research and development program focused on maturing technologies needed for SATS. The program's initial focus is to prove that four operating capabilities would enable safe and affordable access to virtually any runway in the nation in most weather conditions. These four operating capabilities would require on-board computing, advanced flight controls, "Highway in the Sky" displays, and automated air traffic separation and sequencing technologies.

The SATS Program is being conducted through a public-private partnership and is jointly managed by NASA, FAA, and the National Consortium for Aviation Mobility.

<sup>47</sup> For more information on SATS, see the [SATS Overview](#).

View the SATS Program Explained [Microsoft Word document](#) or [PDF document](#) by: Dr. Bruce J. Holmes, NASA Langley Research Center, and Hampton, Virginia.

## Conclusion

- In order to build the new systems and capacity expansions needed to support growth, new financing strategies will be needed. Regional approaches, such as the Regional Transportation Investment District (RTID) of Puget Sound, show promise if voters will support regional funding sources to augment state transportation funding.
- Pricing approaches also show promise to supplement traditional transportation funding, especially in congested corridors.
- As ITS technologies continue to be developed, such as smart vehicles and smart roads, Washington needs to be on the forefront of adapting the transportation system to make sure that the benefits of these innovations are accessible to drivers, including commercial drivers who make their living on the roads.
- The anticipated shift from petroleum-based fuels to alternative fuels requires Washington to adapt the current transportation funding system. Innovative and fair strategies for meeting future system needs must be devised and implemented.

## Glossary of Terms

**Arterial** - A major street carrying the traffic of local and collector streets to and from freeways and other major streets. Arterials generally have traffic signals at intersections and may have limits on driveway spacing and street intersections spacing.

**BNSF** - Burlington Northern and Sante Fe

**Biodiesel** - A fuel capable of running a diesel engine produced from a variety of renewable sources, including soybean oil, canola oil, sunflower oil, cottonseed oil, and animal fats.

**FAA** - Federal Aviation Administration

**HOV lanes** - High Occupancy Vehicle lane—a lane where use is restricted to vehicles meeting a minimum occupancy level. This level may change based on the time of day or the congestion levels.

**HOT lanes** - High Occupancy Toll (HOT) lane—signifies a lane (typically on a freeway) that is managed to restrict use by different modes through the use of time-of-day tolls.

**ITS** - Intelligent Transportation System: the application of advanced electronics and computer technology to automate highway and vehicle systems to enable more efficient and safer use of existing highways.

**Light rail** - Carries a light volume of traffic. “Light” refers to the number of riders that the train can carry, not the weight. Light rail may share right of way on a roadway or operate on an exclusive right of way and can have multi-car trains or single cars.

**SATS** - Small Aircraft Transportation System

**Telecommuting** - Working at a site other than the regular worksite—typically a home office—and remaining accessible to the regular worksite through internet/telephone/fax.

**TDM** - Transportation Demand Management (TDM): Actions and strategies intended to modify travel behavior. TDM addresses traffic congestion by focusing on reducing travel demand rather than increasing transportation supply to increase transportation efficiency. Travel demand is reduced by measures that either eliminate trip making or accommodate person trips in fewer vehicles and may include incentives, disincentives, and the provision of transportation alternatives such as vanpooling and carpooling.

**TOD** - Transit-Oriented Development: land uses that provide high densities, mixed-uses, and pedestrian/biking facilities around existing or planned transit hubs.

**WIM** - Weigh-in-Motion: systems used to measure commercial vehicles, most importantly axle length and truck weight while the truck is moving. Refers to systems

used to measure the physical data of commercial vehicles, most importantly axel length and truck weight while the truck is moving.

**WSDOT** - Washington State Department of Transportation

**WTP** - Washington Transportation Plan

## Appendix I

### Estimated Fuel Tax Revenue Impact HB 1397 / SB 5397 California Motor Vehicle Emission Standards

	Biennia					
	2009-11	2011-13	2013-15	2015-17	2017-19	2019-21
	----- Dollars in Millions -----					
<b>Motor Vehicle Account</b>	(\$1.5)	(\$13.4)	(\$33.2)	(\$54.6)	(\$76.8)	(\$97.1)
<b>Special Category C Account</b>	(\$0.1)	(\$1.0)	(\$2.4)	(\$4.0)	(\$5.6)	(\$7.1)
<b>Transportation 2003 (Nickel) Account</b>	(\$0.7)	(\$6.5)	(\$16.3)	(\$26.7)	(\$37.6)	(\$47.6)
<b>Subtotal</b>	<b>(\$2.3)</b>	<b>(\$20.9)</b>	<b>(\$51.9)</b>	<b>(\$85.3)</b>	<b>(\$120.0)</b>	<b>(\$151.8)</b>
<b>Washington State Ferries</b>	(\$0.2)	(\$1.4)	(\$3.5)	(\$5.8)	(\$8.1)	(\$10.3)
<b>Transportation Improvement Board</b>	(\$0.4)	(\$4.0)	(\$9.9)	(\$16.3)	(\$22.9)	(\$29.0)
<b>Cities</b>	(\$0.4)	(\$3.2)	(\$8.0)	(\$13.1)	(\$18.5)	(\$23.4)
<b>Counties</b>	(\$0.8)	(\$7.2)	(\$17.7)	(\$29.2)	(\$41.0)	(\$51.9)
<b>Total</b>	<b>(\$4.1)</b>	<b>(\$36.7)</b>	<b>(\$91.0)</b>	<b>(\$149.7)</b>	<b>(\$210.5)</b>	<b>(\$266.4)</b>
<b>Current Fuel Tax Revenue Forecast</b>	<b>\$2,086.1</b>	<b>\$2,174.3</b>	<b>\$2,252.3</b>	<b>\$2,321.5</b>	<b>\$2,391.8</b>	<b>\$2,461.8</b>
<b>Estimated Fuel Tax Revenue Reduction</b>	<b>(\$4.1)</b>	<b>(\$36.7)</b>	<b>(\$91.0)</b>	<b>(\$149.7)</b>	<b>(\$210.5)</b>	<b>(\$266.4)</b>
<b>Revised Fuel Tax Revenue Forecast</b>	<b>\$2,082.0</b>	<b>\$2,137.6</b>	<b>\$2,161.3</b>	<b>\$2,171.8</b>	<b>\$2,181.3</b>	<b>\$2,195.4</b>
<b>Percent Reduction</b>	<b>-0.2%</b>	<b>-1.7%</b>	<b>-4.0%</b>	<b>-6.4%</b>	<b>-8.8%</b>	<b>-10.8%</b>
<b>Equivalent Fuel Tax Rate Reduction</b>	<b>-0.1¢</b>	<b>-0.5¢</b>	<b>-1.1¢</b>	<b>-1.8¢</b>	<b>-2.5¢</b>	<b>-3.0¢</b>

California Air Resource Board (CARB) estimates of reduced motor vehicle fuel consumption resulting from implementation of their motor vehicle emission standards for passenger cars, vans, sport utility vehicles and light trucks vary by type and size of vehicle. Actual fuel consumption reductions will depend upon the mix of new vehicles added to the fleet over time.

The California motor vehicle emission standards would be phased in over six years and would be fully implemented by 2016. Motor vehicle fuel consumption is estimated to decline over time as new vehicles subject to the California emission standards replace older vehicles in the fleet. Actual fuel consumption reductions will also depend upon the on-road fuel economy achieved by new vehicles in comparison to their EPA rated fuel efficiency.