Other Highway Assets

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

These categories are:

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

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

Maintenance Strategies and Goals

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

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

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

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

Emergency Preparedness

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

Safety Rest Area Preservation

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

WSDOT prioritizes planned facilities based on locations where collisions due to fatigue are occurring, and where no nearby rest facilities (public or otherwise) are present. Sleepy driving and inattentive driving are among the leading causes for vehicle collisions in Washington State. Together they account for 20 percent of all fatal accidents from 1993 to 2001. Unfocused drivers are a danger to themselves, their passengers, and other drivers.

Photo 12. Toutle River Safety Rest Area (northbound Interstate 5)

Safety rest areas offer an opportunity for sleepy and inattentive drivers to get off the road and rest along highways that otherwise have no good stopping points such as all-night restaurants.

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

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

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

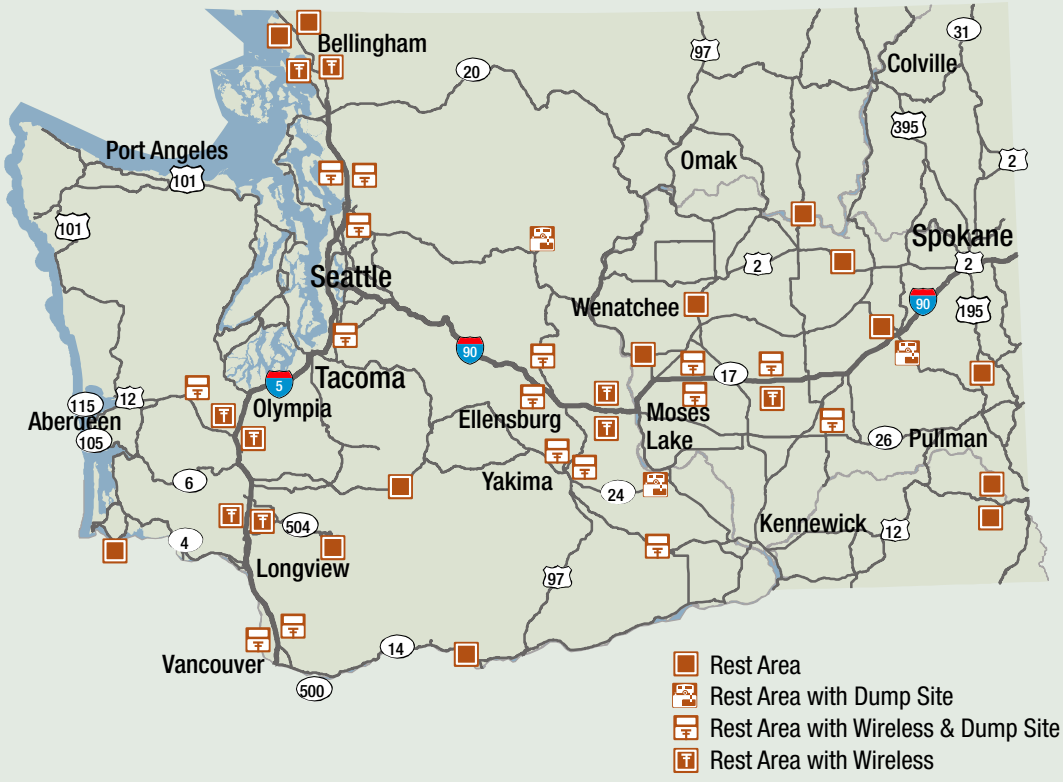
The RV Dump Program provides the traveling public with an environmentally safe repository for RV waste and potable drinking water in WSDOT safety rest areas. WSDOT owns, operates and maintains 19 RV Dump Stations within the 42 safety rest areas statewide (see Figure 22).

Needs

Inventory of Safety Rest Areas

WSDOT is responsible for 42 safety rest areas; 27 of which are located on the Interstate system. These facilities contain a total of 555 acres, 83 buildings, 29 on-site public drinking water systems, 36 on-site sewage treatment/pretreatment systems and 19 RV dump stations.

Figure 22. WSDOT Safety Rest Areas



With the exception of Blue Lake on SR 17 at milepost 89 in Grant County which requires winter closures, all are open 24/7.

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

Strategies

Approaches to Rest Area Preservation

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

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

Preservation of a safety rest area consists of the following:

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

Prioritization Process

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

In addition, maintenance and operational costs and the number of visitors are factors in the prioritization process.

Photo 13. Rest Area Projects

Interstate 90 Indian John Hill Safety Rest Area – Sewer Rehabilitation Work

Interstate 5 Custer Safety Rest Area – Sewer Rehabilitation Work

Performance Measurement

WSDOT has maintained Interstate safety rest areas at a rating of "good condition" since 1999. A safety rest area is considered in good condition if all features (such as soap dispensers or RV dump stations) are in working order, landscaping is trimmed, with only a small amount of litter, weeds, or minor defects in sidewalks or parking areas.

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

Major Drainage System Rehabilitation

A drainage control system is a complex system which may include:

- Culverts or other drainage structures
- Connected streams in the watershed
- Wetlands
- Ditches
- Manmade detention or retention basins
- Pervious and impervious surfaces
- Other means of controlling and mitigating stormwater runoff and impurities from roadway surfaces.

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

Needs

Inventory of Drainage Systems at Risk of Failure

WSDOT is early in the process of developing a statewide inventory of drainage system conditions. This information will enable WSDOT to ore effectively manage drainage system preservation.

Approaches to Preventing Drainage System Failure

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

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

Photo 14. Pipe Inspection by Rovver©

Envirosight Inc. Rovver© 900 pipe inspection crawler with lights and camera as purchased by WSDOT.

The first culvert to be inspected using the new crawler and camera.

Crew with motorized cable reel which is attached to the crawler and camera, supplying video feed to the monitor and recorder.

Figure 23. Future Drainage Rehabilitation Needs

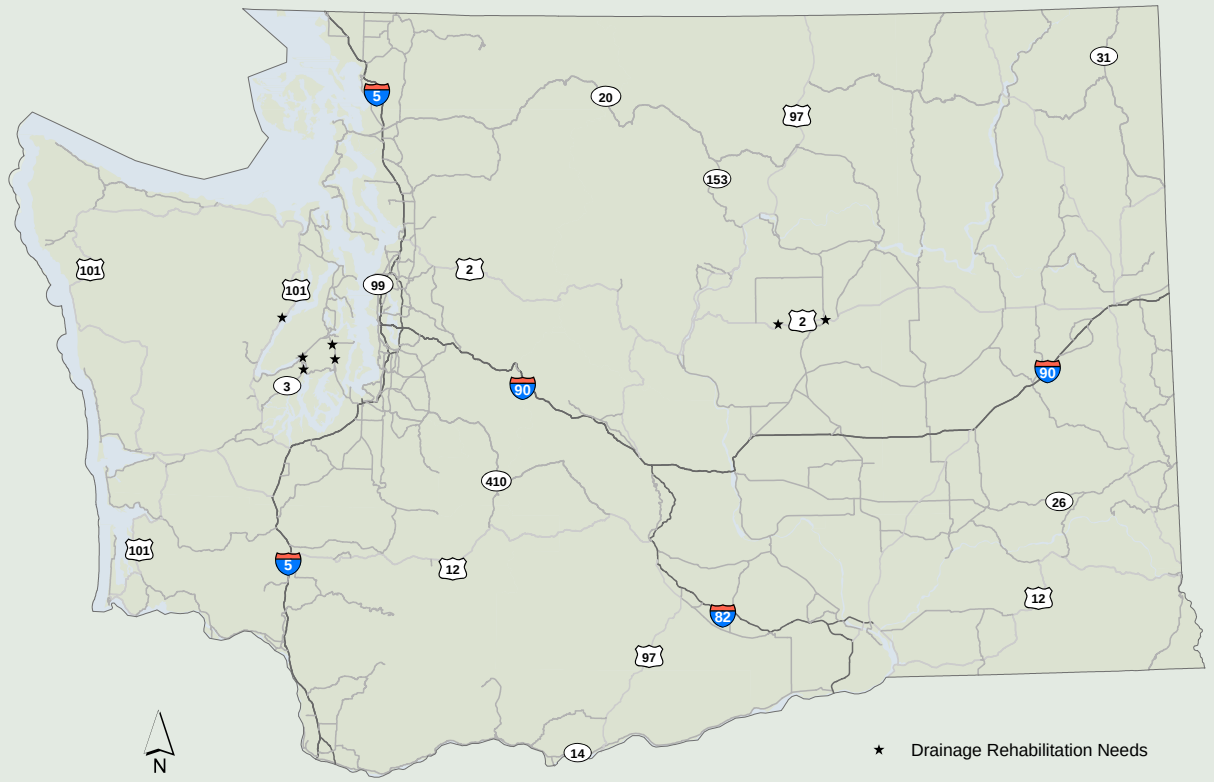
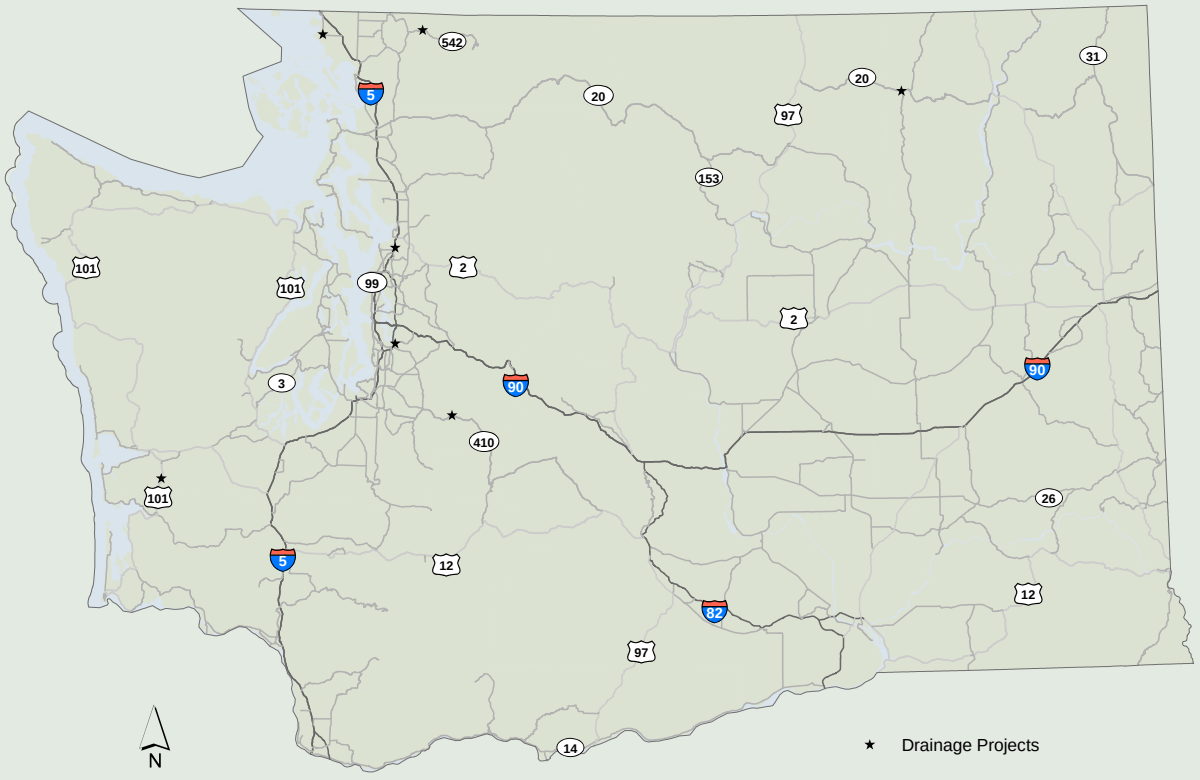


Figure 24. Drainage Projects



Strategies

As drainage systems age, routine inspection and eventual replacement must be planned to ensure these systems remain in good working condition. Drainage system rehabilitation may also be addressed by other highway construction projects.

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

Prioritization Process for Selecting Projects

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

Performance

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

Highway Slopes and Embankments

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

Slope instability is classified into five categories:

- **Rock fall** is the fall of newly detached segments of bedrock of any size from a cliff or steep slope. The rock fall descends mostly through the air by free fall, bouncing or rolling. Movements are rapid and may not be preceded by minor movements.
- **Landslides** are the vertical and horizontal displacement of soil mass within a slope or embankment. Generally landslides can be divided into two categories, circular and sliding block failures. The rate of movement of landslides can vary from very slow moving to very rapid and vary in size from small cut slope failures to large failures many miles in area.
- **Debris flows** are a rapidly moving fluid mass of rock fragments, soil, water, and organic material with more than half of the particles being larger than sand size. Generally debris flows occur on steep slopes or in gullies and can travel long distances. Debris flows may result from unusually high rainfall, or rain on top of snow events and are characterized by fluid mixtures of water, soils and vegetative matter including trees.
- **Settlement** is the vertical displacement of a soil mass not associated with a horizontal movement within a slope or embankment. Generally movement is slow. Soil piping occurs when erosion of the subsurface soil, associated with groundwater flow, causes failure of the soil. (Soil piping is a particular form of soil erosion that occurs below the soil surface. It is associated with levee and dam failure as well as sink hole formation.)

Photo 15.

A large wedge failure involving up to 500 cubic yards occurred on September 11th, 2005 on Interstate 90 west of Snoqualmie Pass resulting in debris covering all three lanes and a single vehicle – triple fatality accident. In addition to the slope area from where the wedge failure initiated, similar wedge features in the adjacent slope areas were stabilized with slope scaling and rock anchors.

» **Slope erosion** is the wearing away of a soil mass by the actions of running water. On slopes this process can result in the overland flow of water in an unconcentrated sheetwash, or the development of rills (e.g., small grooves or channels in soil slopes). Along streams or rivers the process can cause the near vertical undercutting of the adjacent stream or river bank.

Needs

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

Inventory of Unstable Slopes

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

Strategies

Approaches to Slope Stabilization

Mitigation measures vary for each type of failure:

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

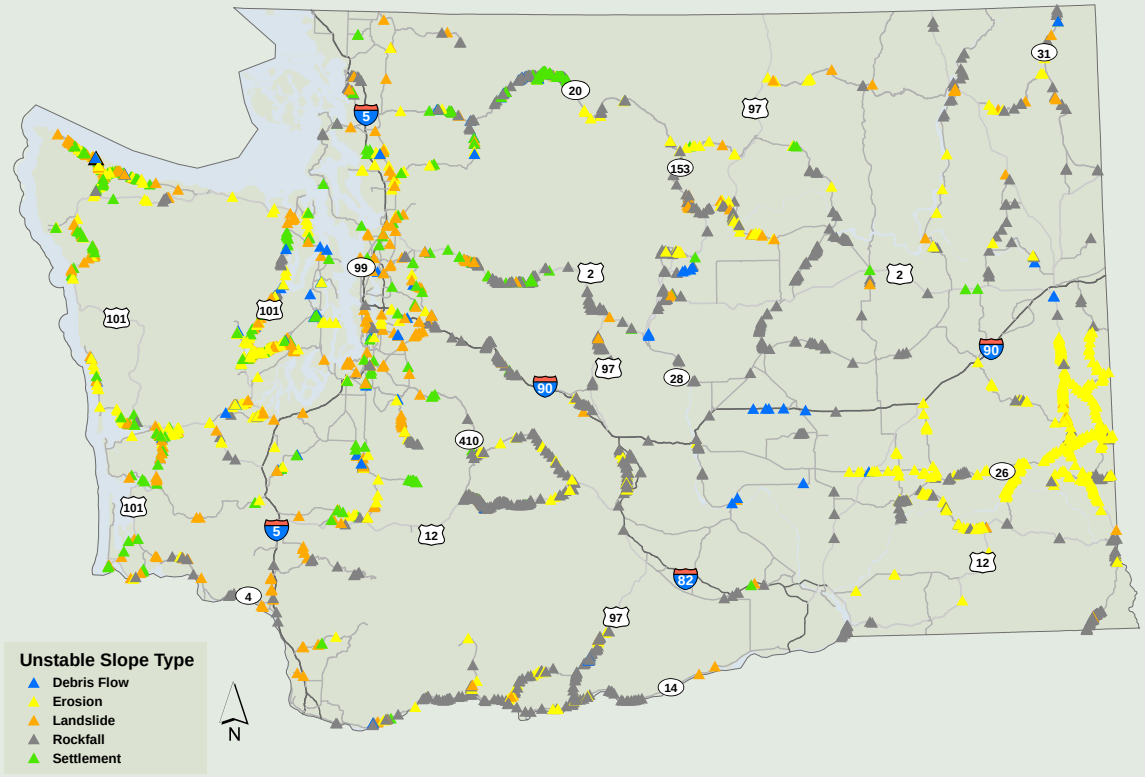
» **Landslide** – Reducing driving forces by removing material from the upper portion of the unstable slide mass (slope flattening by regrading) and replacing with lightweight materials. Increase the resisting forces at the bottom of the slide by constructing buttresses, berms or retaining walls with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

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

Table 8. Unstable Slope Numerical Rating System

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

Figure 25. Unstable Slope Locations



- **Settlement** – Excavate the fill material and replace with low density lightweight materials such as cellular concrete or polystyrene blocks or avoidance by realignment of the roadway.
- **Slope Erosion** – Problems are not presently addressed within the unstable slope program but are included in the database. Bioengineering methods of mitigation (planting vegetation) are being implemented through research projects.

Prioritization Process

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

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

WSDOT's senior geotechnical staff review a "first cut" slope to make sure the order of slopes makes sense and that no slopes were left out, and that any slope omissions are corrected. If necessary, WSDOT conduct new field reviews to update slope ratings and refine the list of slopes.

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

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

Performance

Since 1985 the state highway system has experienced 21 slope failures that resulted in roadway closures in excess of one week. The minimum closure was one week with the maximum closure of one year. Landslides typically cause the longest

closures. The longest closure by a rock slide (two months) was the SR 20 – Newhalem occurrence in 2003.

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

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

Major Electrical Preservation

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

Major Electrical System Items

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

Photo 16. South 317th HOV Direct Access & I-5 (continuous high mast and 50-foot light standard illumination system)

Photo 17. SR 520 Floating Bridge in Seattle (midspan opening)

The following section will briefly define each of the Major Electrical System items.

Traffic Signal Systems

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

Ramp Meter Systems

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

Illumination Systems

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

Tunnel and Bridge Electrical Systems

Tunnel Electrical Systems

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

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

Photo 18. Traffic Signal and Ramp Meter Systems

Vehicle Signal Display (LED)

Signal Controller Cabinet

Typical Ramp Meter – Seattle Area

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

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

Bridge Systems

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

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

Movable and Floating Span Bridges

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

Bridges With Navigation Lights

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

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

Dynamic Message Signs (DMS)

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

Photo 19. Dynamic Message Sign (DMS) Displaying Travel Times

Highway Advisory Radio (HAR) Systems

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

Closed Circuit Television (CCTV) Camera

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

Photo 20. Closed Circuit Television (CCTV) Camera Systems

Data Station Systems

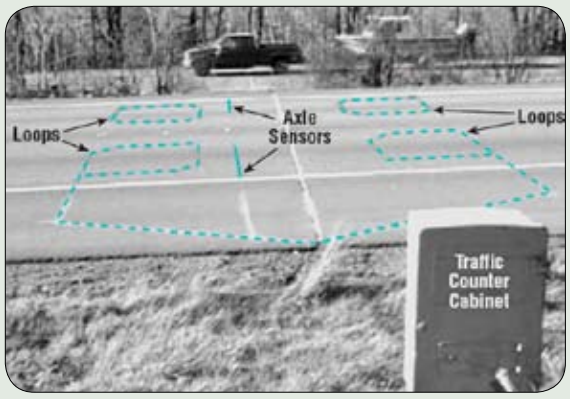
TMCs also depend on field devices such as the 479 traffic data stations which include video, radar and loop detectors. Data stations provide critical volume, speed, and occupancy data which are used for planning, design, operations, construction, and maintenance activities. This information is also used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

Permanent Traffic Recorder (PTR) Systems

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

Due to Federal reporting requirements for PTR system collected data, the data quality standards for these systems are much higher than for data station systems. As a result, the life expectancy for a PTR system is estimated at 10 years.

Photo 21. PTR Site on SR 16 Near Burley



Animal Warning Systems

WSDOT maintains six animal warning systems (AWS) installed or planned statewide. These systems are designed to inform drivers of animals (see Photo 22) entering or in the roadway along select rural roadway section. In general, the life expectancy of an AWS system is 10 years.

Photo 22. Roadside Animal Warning Systems (AWS)

Automatic Anti-Icing System (AAIS)

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

Fiber Optic Communication Systems

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

Installation of High Density Polyethylene (HDPE) Conduit for Fiber Optic Cable *(see Photo 23)*

Communication Hubs

Statewide there are approximately 30 communication Hubs that support the ITS communication systems. Communication Hubs are basically an above or below ground structure where ITS communications systems from multiple systems interconnect as information from field devices is brought back to the TMC and vice versa. These hubs house large amounts of electronic equipment and allow for fiber optic cable and other communication media to be spliced. Temperature and humidity control are critical for extending system life expectancy which is estimated at 20 years, although this kind of field environment is prone to periodic replacement of some electronic equipment due to failure.

Photo 23. Installation of HDPE Conduit for Fiber Optic Cable

Other Communication Systems

(Emergency Telephone, Ethernet, DSL, T1)

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

Wireless Communication Systems

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

There are over 125 communication sites included in the system statewide. The facilities used are a variety of state owned, shared with sister agencies, and leased from private companies. These facilities

Figure 26. CVISN / Weight in Motion (WIM) Deployment Site Map

Photo 24. Wireless Communication Systems

Microwave Tower and Communications Building Equipment Inside Skyline Lake at Skyline Lake, 1.5 miles above Stevens Pass Communications Building

have a life expectancy of 50 years. Within the facilities is a combination of support equipment that has a life expectancy of 15 years.

Roadway/Weather Information Systems (RWIS)

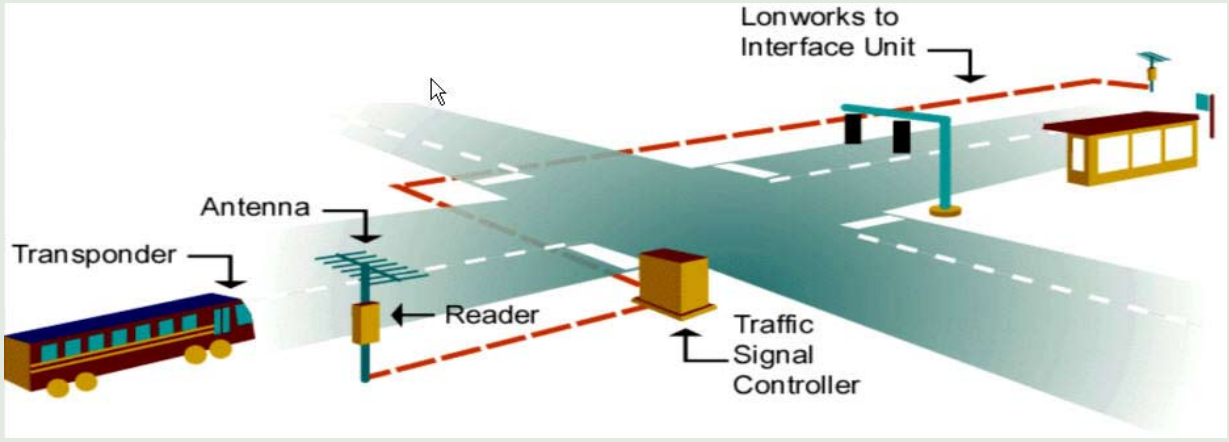
WSDOT maintains and operates 94 RWIS. These systems are installed along the roadway with instruments and equipment that provide weather and road surface condition observations. This information is used to facilitate decisions on maintenance strategies and to provide information to drivers.

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

Transit Signal Priority (TSP) Systems

Transit Signal Priority (TSP) (see Figure 27) is a traffic signal control strategy to provide incremental benefits to public transit for the purpose of improving transit speed and reliability. Traffic signal timing is slightly modified to provide a benefit to the transit vehicle. Transit vehicle arrival times are estimated from on-street detection or from a Global Positioning System (GPS) based Automatic Vehicle Location (AVL) system.

Figure 27. Transit Signal Priority System



Transit Signal Priority System (Integration With City of Lynnwood Advanced Traffic Management System (ATMS))

WSDOT current operates and maintains 10 TSP systems in the greater Seattle Area. In general, the life expectancy of a TSP system is 10 years with periodic electronic component replacement.

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

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

Photo 25. Typical WIM Installation (Enlargement of Transponder in Truck)

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

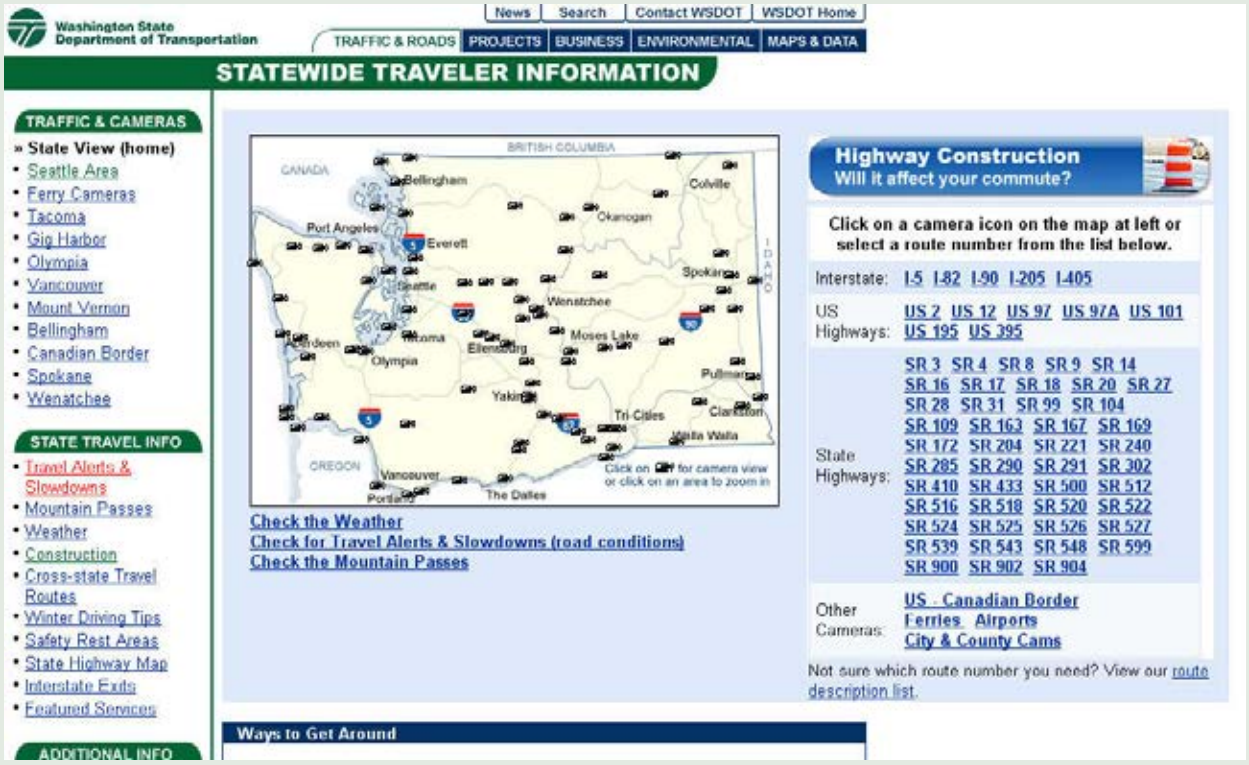
The Washington State Department of Transportation (WSDOT) continues to provide valuable on-line traveler information to the public in creative and effective ways.

Statewide Traveler Information Web Page www.wsdot.wa.gov/traffic

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

- **CCTV Camera Images** – Camera Images are updated every minute providing travelers with a visual or roadway conditions at most critical locations around the state.
- **Travel Alerts and Slowdowns** – which combines incidents, construction, events, and anything else that might impede or slow travel on the roads.
- **Consolidated Mountain Pass Information** – with each major pass, such as Snoqualmie and Stevens passes, occupying its own page. These pages allow visitors to view camera images spanning the length of the pass, traction advisories, highway radio messages, and current and forecasted weather information.
- **Dedicated Weather Pages** – WSDOT's weather page has led the country in using intelligent transportation systems data to provide travelers with real-time road and weather information.
- **Construction** – provides travelers with information about ongoing construction activities around the state that may impact their travel plans.
- **511** – an automated telephone information system that provides real-time traffic and weather information by simply dialing 5-1-1 from most phones. Updated every few minutes, 511 allows callers to get a variety of information:
- Puget Sound Traffic Conditions
- Statewide Construction Impacts
- Incident Information
- Mountain Pass Conditions
- Ferry System Information
- 800 numbers for passenger rail and airlines
- Weather
- **Traffic TV** – Traffic camera images and the vehicle speed flow map for the Seattle area are available on select local cable channels.

Figure 28. WSDOT Statewide Traveler Information Page



Traffic Management Centers (TMC)

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

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

TMCs are the nerve centers for WSDOT's operations activities. Real-time information is gathered 24 hours a day, 7 days a week from many sources including traffic detectors, CCTV cameras, ramp meters, the Washington State Patrol (WSP), road crews, WSDOT's incident response teams, and media traffic reporters. WSDOT uses this information to coordinate responses to clear blocking collisions, deal with other problems that occur, and notify the public and the media of these events.

Photo 26. TMC Seattle at Regional Headquarters

Although the TMC facility itself is outside the scope of the P3 program, the extensive electronic equipment, media and software that is required to communicate with and operated the field ITS equipment is a critical component of the Major Electrical System portion of the preservation program. The life expectancy of these items is estimated at 10 years in order to maintain current performance and maintain pace with technological advancements.

Tolling and Electronic Payment Systems

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

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

ITS Systems for Freight Mobility

(Ports / Border Crossings / On Board Trucks)

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

Reversible Roadway System

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

WSDOT maintains two reversible roadway systems (see Photo 27); one from downtown Seattle to the north along I-5; and one from downtown Seattle to the east along I-90. The reversible roadway system consists of 129 gates, 17 gate control systems, and a large number of mechanical overhead signs that help regulate the flow and direction of traffic at different times each day. In general, the life expectancy of these systems is 25 years with periodic electronic equipment replacement.

Figure 29. Tolling and Electronic Payment Systems

Sample Windshield Pass (Electronic Tolling Systems)

Tacoma Narrows Bridge Tolling Plaza (*Good To Go!* – Pass Holders Bypass Plaza)

SR 167 HOT Lanes

Photo 27. Reversible Roadway – Center Lanes (I-90 Floating Bridge, Seattle Area)

Major Electrical Preservation Needs

Continuous use of these major electrical systems; aging equipment; difficulties in acquiring older parts due to evolving technology; reduced safety of degrading insulation; and corrosion due to environmental factors presents WSDOT with the dilemma of how to plan for ongoing rehabilitation and the ultimate replacement of these systems as they approach their life expectancy. The traveling public and nearly every component of WSDOT planning, design, construction, operations and maintenance relies heavily upon the information and services these systems provide.

Major Electrical Preservation Strategies

Preventative Maintenance

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

Major Electrical Preservation Performance

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

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

Maintenance Accountability Process (MAP) Performance Measures

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

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

Weigh Station Replacement and Rehabilitation

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

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

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

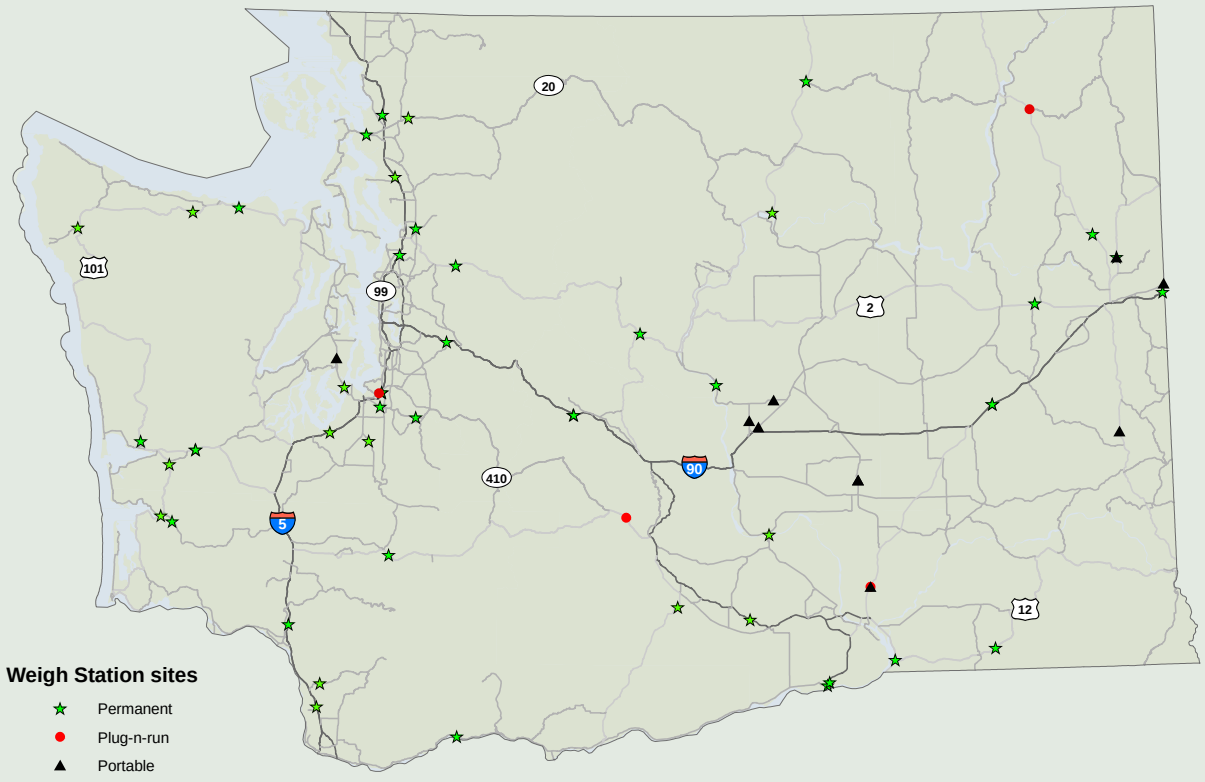
Photo 28. Weigh Stations

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

Weigh Station on Interstate 90 Tokio Road (milepost 231)

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

Figure 30. Locations of Permanent and Plug-n-Run Sites



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

Needs

Inventory of Weighing Facilities

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

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

Strategies

Approaches to Preserving Weighing Facilities

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

Prioritization Process

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

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

Performance

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

Other Highway Assets: Funded vs. WTP Unfunded Targets

	Funded ($ in millions)	WTP Unfunded Targets ($ in millions)
Other Highway Assets Total	$723	$6,246
Highway System Plan Total	$15,625	$33,114

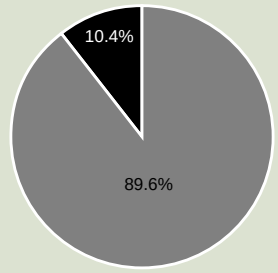


Figure 31. Weigh Station Siting Criteria

Average Daily Truck Traffic
Forecast Average Daily Truck Traffic
Weigh Station Site Bypass Potential
Vehicle Inspection Violation History
Weigh Station Site Traffic Conflicts
Accident History
Hazardous Materials Transported
Potential Environmental Impacts
Right-of-Way Availability
Availability of Electricity
Telephone Availability
Fiber Optic Cable Availability
Redundant Weigh Station Facilities
Pavement Conditions
Roadway Operating Speeds
Topography
Sight Distance
Land Use Compatability
Climate
Availability of Water/Sewage Utilities
Proximity to WSP Offices
Seasonal Movements
Origin and Destination Characteristics
Highway Improvement Opportunities