

Road Safety Audit (RSA)

Mt. Hood Highway, Mile Post 47.0 – 54.3

Clackamas County, Oregon

Prepared For:

Oregon Department of Transportation (ODOT)

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September 2009



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Mt. Hood Highway Road Safety Audit (RSA) Mile Post (MP) 47.0 – 54.3

Project Title: Mt. Hood Highway Road Safety Audit

Date: Jun 16-18, 2009

RSA Team and Participants:

Carl Deaton, P.E. - Senior Roadway Designer, Oregon Department of Transportation (ODOT)
Hermanus Steyn, Pr.Eng., P.E. - Associate Engineer, Kittelson and Associates, Inc.
Jack Freeman, P.E., PTOE – Senior Principal, Kittelson & Associates, Inc.
Robert Tolman - Transportation Maintenance Manager (TMM), ODOT

Project Characteristics:

Audit Type: Planning Stage
Land Use Development Proposal: No
Units of Measure: US
Adjacent Land Use: Rural
Design Speed (US): 55 mph
Opposite Flow Separation: Undivided
Service Function:
 Highway Number: 26
 Route Number: US 26
 Functional Classification: Rural Principal Arterial, National Highway System (NHS) Route
 Oregon Highway Plan (OHP) Highway Designation: Statewide Highway
Terrain: Mountainous
Climatic Conditions - Temperature: Cold Winter (freezing, icing possible)
Climatic Conditions - Snow: Snow in Winter

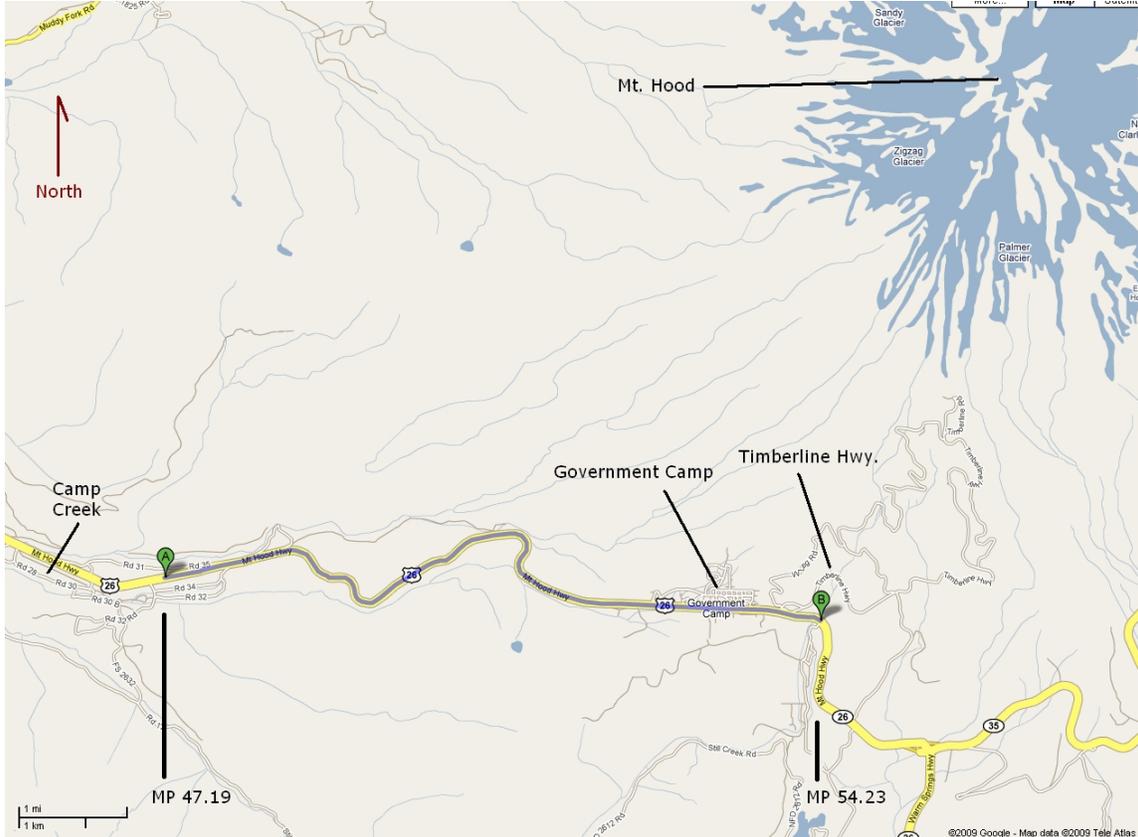
Background:

This Road Safety Audit (RSA) is for Mt. Hood Highway (US 26) on the western slope between Portland and the Mt. Hood recreational ski areas. Oregon Department of Transportation (ODOT) has designated much of this corridor to be a "Highway Safety Corridor" meaning there is a focus on engineering, enforcement and education, and that violations will have double fines.

The specific limits of the RSA are from the vicinity of the entrance to Camp Creek Campground (vicinity of MP 47.0) to the intersection of Mt. Hood Highway and Timberline Highway (vicinity of MP 54.25). The RSA study area is totally within the Mt. Hood National Forest. The corridor is a designated truck route and moderate truck traffic was observed.

The corridor has two distinct sections. The western part from MP 47 to the western entrance to Ski Bowl (vicinity of MP 52.6) is a 55 mph posted speed mountain highway that is generally two lanes eastbound to provide a climbing lane and one lane westbound. There are very few access points for this section and most are trails into the National Forest. This is referred to as the *Mountain Highway Section*.

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Project Vicinity Map

Between the western entrance to Ski Bowl and the Timberline Highway intersection the land use surrounding the roadway and its characteristics change. Located in this area is the community of Government Camp. This community has seen growth in recent years and continues to grow. The RSA Team observed two significant projects under construction that will add short stay rental property in the area. There are new residential developments under construction. The RSA Team was informed of two other developments in the planning stage that could bring an 1,000 to 1,200 additional units to the area. Both ODOT Maintenance staff and US Forest Service staff noted that local businesses want to increase the amount of Snow Park parking in the Government Camp area. Mt. Hood Highway is the major road serving this area and there are multiple intersections in this two-mile section. Clackamas County recently rebuilt the Multorpor Bridge to improve access to the south side of Mt. Hood Highway into Government Camp. The posted speed in this section remains 55 mph. This is referred to as the *Government Camp Summit Section*.



Occurring Developments

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RSA Process:

The RSA Team initiated work on Monday, June 15, 2009 with a meeting at ODOT Region 1 in Portland, Oregon. Attending this meeting was Jason Tell, ODOT Region 1 Manager. Mr. Tell provided some thoughts regarding the safety issues on Mt Hood Highway, and they are summarized below:

- There are ongoing and future developments in the Government Camp area and concerns regarding access management.
- There is a great deal of safety data for the corridor available to the RSA Team.
- ODOT has some funding designated for the corridor and they want to know where they can get the most “bang for the buck.” He suggested considering not only engineering solutions but also education and enforcement solutions for the corridor. He noted the Highway 26 Safety Corridor Citizens Advisory Committee (CAC) as a potential group to aid with educating the public. Staffing of law enforcement in the corridor has had some shortages in the past, but this may be improving.
- He asked the RSA Team to be creative in the thought process and to put all options on the table for potential consideration. ODOT needs a good plan for the corridor.
- ODOT is working with a group to consider multi-modal solutions for the corridor that will support ski operations. The lack of parking in the Government Camp area was noted.
- ODOT is planning some Intelligent Transportation System (ITS) improvements along the route that include the installation of Variable Message Signs (VMS) with temperature sensors.
- During the months of July and August, congestion is an issue.

Following Mr. Tell’s comments, Jim McNamee, Transportation Maintenance Manager (TMM) for District 2C in Region 1 covered the RSA study area and his observations are summarized below:

- Information is currently provided to motorists by a VMS located at Rhododendron at about MP 43.76 regarding road conditions ahead and the need for chains or traction tires.
- Oregon laws regarding the use of traction tires and chains are complex with sign information needing to be regulatory (black lettering on white background). Traction tires are allowed between November 15th and April 1st for vehicles less than 10,000 GVW.
- The past two winters have had over 400 inches of snow at Government Camp. Snow can accumulate to 4 to 6 feet deep.
- ODOT has 24 hours to clear the road after the storm. They work 24 hours a day with three 8-hour shifts. He said that the road has never been closed due to snow since he has been the TMM. The snow plows often work with two to three plows in tandem covering the area from MP 42 to MP 62.
- Some ski areas like Meadows can handle over 20,000 skiers per day. The Timberline and Ski Bowl ski areas are limited in attendance due to parking restrictions. They would like more parking.
- Intersections become an issue during heavy snows. These include the Ski Bowl and Government Camp Loop accesses. He said that these intersections will have 10 feet of snow or more during the ski season.
- The chain-on/chain-off locations were described as “poor” with the best location at MP 48 where there is a dedicated lane in the eastbound direction.
- Trucks sometimes go past the chain-on location and then get stuck further up the hill blocking traffic.

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- The following safety issues were noted:
 - Motorists drive too fast for conditions.
 - Motorists stop in the middle of the road to “chain-on”.
 - Drivers park where they should not, especially at Mirror Lake Trailhead. Last year this snow park area was closed due to parking encroaching into the travel lane. In the summer, they have had as many as 14 illegally parked vehicles towed in a day. The westbound left-turn movement into the Mirror Lake parking area is an issue.
 - Rocks fall onto the pavement. This is principally a westbound roadway problem, primarily in the spring months. ODOT is considering some cut back of the rock face at the Mirror Lake curve. This area extends from this curve (MP 52) to MP 49.5.
 - The trees overhanging the roadway (west of MP 47.6) cause concern during heavy snowfall because chunks of snow from the overhanging branches come loose and fall into the travelway.

The RSA Team met on Tuesday morning, June 16, 2009 at the ODOT Maintenance Facility at Government Camp. This facility served the RSA Team as a base during the pre-audit meeting, field reviews and RSA analysis activities. The schedule for the RSA Team was as follows:

Tuesday, June 16 th	
8:30 am to 12 noon	Pre-audit meeting
1:00 pm to 5:00 pm	Field reviews – Government Camp area to Mirror Lake Curve (start on the east end)
9:30 pm to 11:00 pm	Night field review – entire corridor
Wednesday, June 17 th	
8:30 am to 12 noon	Field reviews – Camp Creek Campground to Mirror Lake Curve (start on the west end)
1:00 pm to 5 pm	RSA analysis – RSA Team discussion of issues/suggestions
Thursday, June 18 th	
8:30 am to 4:00 pm	RSA analysis – RSA Team discussion of issues/suggestions
Friday, June 19 th	
10:00 to 12 noon	Findings Presentation at ODOT Region 1 offices

During the pre-audit meeting, other individuals attended the discussions and provided input. Several of these individuals also participated in other aspects of the RSA. These individuals included:

Jim McNamee	TMM, ODOT Dist. 2C, Region 1
Jerry Sabel	Highway 26 Safety Corridor (CAC)
Sue D’Agnese	ODOT Region 1 Traffic Manager
Mike Reel	Oregon State Police
KC Humphery	ODOT Region 1 Transportation Safety Coordinator
Katherine Carlos	ODOT Engineering Intern

The pre-audit meeting further expanded the discussions of the day before. Mr. Freeman provided a presentation that explained the RSA process and followed with detailed crash data for concentrated crash locations from the year 2000 to 2008. The data was initially for the entire corridor and then focused on specific locations along the corridor. A copy of this presentation is attached (Appendix “A”). Some of the principal crash information is as follows:

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- Crashes have decreased in recent years from the early 2000s. It was noted that the use of magnesium chloride as a deicer started in either 2004 or 2005 and combined with some roadway improvements it likely contributes to the reduction.
- The total number of crashes is likely under reported especially for Injury C and Property Damage Only (PDO) as there is no requirement for a police report for these crashes. Officer Reel feels the reporting for Fatal, Injury A, and Injury B type crashes to be accurate.
- The exact locations of crashes might be inaccurate, because it might be recorded to the closest MP location.
- The highest crash type is running off the road and hitting a fixed object, which is followed by rear-end crashes. Head-on and side-swipe crashes are also common types.
- Most crashes occur on Saturday or Sunday (**approximately 50% of all crashes occur over weekends**), and the highest months of crashes are January and December (**approximately 40% during December/January**). The month of January has more total crashes than the months of May through September even though these summer months are the five highest months of traffic volumes on Mt. Hood Highway
- The time of day with the highest number of crashes is 3 pm to 6 pm (**approximately 25% of all crashes occur 3-6 pm**). The RSA Team noted that the time period from 9 pm to midnight also had a high number of crashes, likely associated with night skiing.
- **70% of all crashes occur with either ice or snow** on the roadway. When considering wet pavement, this increases to 80%.

This information allowed the RSA Team to focus on the safety concerns for locations as the field reviews were conducted. During the discussions, Officer Reel noted that many of the crashes he has worked are speed related. He and Mr. Sabel discussed an educational brochure regarding speeding and the time saved versus the increased danger of a crash. This has been previously prepared but not funded for printing and distribution.



Many Crashes are Related to Speed

The report is organized to describe the safety issues starting with the entire corridor and then from west to east (increasing MPs).

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Summary of High and Medium Safety Risk Locations:

As a result of the RSA analysis, the RSA Team found five (5) locations with safety issues to have a high safety risk. These issues are:

- Mountain Highway Corridor Section (MP 47.0 – 52.4) – Many speed related crashes in poor weather conditions
- Map Curve (Vicinity of MP 49.7) – Westbound crashes at Map Curve and on Top 15% SPIS
- Section between Map Curve (MP 49.7) and Mirror Lake Curve (MP 51.7) – Unacceptable configuration of existing westbound passing lane
- Mirror Lake Curve (Vicinity of MP 51.7) – Westbound crashes at Mirror Lake Curve
- Ski Bowl East Access (MP 52.85) – Unacceptable intersection spacing, skewed intersection angle, and highway turn lanes and on Top 10% SPIS

The RSA team also found eleven (11) locations with safety issues to have a medium safety risk. These issues are:

- Entire Corridor – Lack of inlaid pavement markers and delineators reflectivity
- Entire Corridor – Lack of sign consistency and retro-reflectivity
- Government Camp Summit Corridor Section (MP 52.4 – 54.3) – Challenging Accessibility to Growing Surrounding Land Uses
- Tree Cleared Area MP 47.6 – 48.8 – Lack of westbound passing lane
- Tree Cleared Area MP 47.6 – 48.8 – Lack of chain-on/chain-off areas
- Mirror Lake Curve (Vicinity of MP 51.7) – Undesirable location of chain-on area
- Ski Bowl West Access (MP 52.5) – Lack of intersection sight distance and highway turn lanes
- Western Government Camp Loop Road (MP 52.98) - Unacceptable intersection spacing, intersection sight distance, and highway turn lanes
- Multorpor Bridge (Vicinity of MP 53.5) – Limited westbound passing opportunity and on Top 25% SPIS
- Eastern Government Camp Loop Road (MP 54.0) - Unacceptable intersection traffic operations, intersection sight distance, and turn lanes
- Timberline highway (MP 54.3) - Unacceptable intersection angle, intersection sight distance, and turn lanes

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RSA FINDINGS

Appendix "B" provides a summary of the issues identified during the RSA by location and suggestions to improve the issues.

LOCATION: ENTIRE CORRIDOR

Issue: Lack of In Pavement Reflectors and Delineators

Description of Safety Issue:

During the night field review, it was noticeable that the existing inlaid reflective pavement markers (RPM) and delineators have lost their reflectivity (see Figure 1). Certain sections of the road did not even have RPMs anymore and the delineator spacing was inconsistent (see Figure 2). Approximately 30% of all crashes occurred during dawn, dark, or dusk.



Figure 1



Figure 2

Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

Consider installing new inlaid RPMs and delineators. Consider delineator closer spacing at locations where the horizontal alignment entails to a design speed below 55 mph.

Issue: Lack of Sign Consistency and Retro-reflectivity

Description of Safety Issue:

The signs are of varying standards with spacing (see Figure 3), number, message (see Figure 4: rocks and slides), and retro-reflectivity issues.



Figure 3



Figure 4

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Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

Consider conducting a sign study along the corridor to upgrade to current signing standards. Attention should be placed on sign spacing and retro-reflectivity. The RSA Team suggests that all signs in the corridor have high-intensity reflective sheeting.

Issue: Non-standard Guardrails**Description of Safety Issue:**

The existing guardrails do not have reflective markers (see Figure 5) and some guardrail ends (see Figure 6) are non-standard.



Figure 5



Figure 6

Safety Risk:

Exposure: Low

Probability: Low

Consequence: Medium

Resulting Road Safety Risk: Low

Suggestion:

Consider investigating the existing guardrails along the corridor to upgrade to current guardrail standards, especially the guardrail ends. The addition of reflective markers will better delineate the roadway during times of low visibility and at night.

Issue: Limited Public Outreach**Description of Safety Issue:**

The crash data shows a very high percentage of younger drivers, which are most likely linked to the recreational activities. Approximately 55% of drivers involved with crashes are younger than 35 years. Further, the number of available parking spots at the ski resorts and hiking trail access points is limited, leading to motorists to park in restricted areas.

Safety Risk:

Exposure: Low

Probability: Low

Consequence: Low

Resulting Road Safety Risk: Low

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Suggestion:

Consider targeting outreach advertising to the younger driver by communicating the limited time saved by reckless speed and describing the mortality difference between speed on the slopes and speed on the road. The OSP is already discussing opportunities to provide education brochures through its day-to-day enforcement activities. Additionally, the outreach should focus on providing information of alternative modes of transportation. This outreach should include working with winter recreational facilities and/or transit agencies to establish reliable public transit alternatives. The US Forest Services could consider providing kiosks at their snow parks with safety related brochures similar to safety messages that are provided at rest areas.

LOCATION: MOUNTAIN HIGHWAY CORRIDOR SECTION (MP 47.0 – 52.4)

Issue: Many Speed Related Crashes in Poor Weather Conditions

Description of Safety Issue:

As noted in the introduction section of the RSA, Mt. Hood Highway has two distinct sections within the overall project limits. The western part from MP 47 to the western entrance to Ski Bowl (vicinity of MP 52.6) is a 55 mph posted speed mountain highway that is generally two lanes eastbound, providing a climbing lane, and one lane westbound. The roadway has a number of horizontal curves and sections with longitudinal grades of more than 6%. There are very few access points for this section and most are trails into the National Forest. The roadway characteristics are very different in the summer and winter months due to the heavy snowfall in the winter. The speed designations for the roadway are typical for normal road conditions that do not apply during icy conditions. As mentioned by the OSP, the majority of the crashes along this corridor are speed related – motorists driving too fast for the conditions. In addition, approximately 70% of all crashes occur in the presence of ice and snow.

Safety Risk:

Exposure: Medium

Probability: High

Consequence: High

Resulting Road Safety Risk: High

Suggestion:

Mt. Hood Highway is a 55 mph posted facility with advance curve-speed warning signs where appropriate. These warning signs should be revisited to determine the correct curve speed. Introducing a lower speed limit along this section of the corridor based on weather conditions with variable message signs could be operated from a remote location. Consideration should be given to apply photo speed enforcement only when the Variable Speed Limits (VSL) is used. Washington Department of Transportation (WashDOT) has been successful implementing VSLs along US 2 in Wenatchee, Washington (see Figures 7 and 8), but does not have automated speed enforcement. Washington Department of Transportation (WashDOT) uses a correlation between speed and road conditions such as:

- traction tires required – 40 mph;
- chains required – 30 mph; and
- emergency/accident – 25 mph.

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Figure 7



Figure 8

LOCATION: GOVERNMENT CAMP SUMMIT CORRIDOR SECTION (MP 52.4 – 54.3)

Issue: Challenging Accessibility to Growing Surrounding Land Uses

Description of Safety Issue:

Mt. Hood Highway has two distinct sections within the overall project limits. The Government Camp Summit Corridor section stretches from the western entrance of Ski Bowl (vicinity of MP 52.6) to the Timberline Highway (vicinity of MP 54.3) intersection. The land uses surrounding the roadway and its characteristics have changed and are continuing to change. Mt. Hood Highway is the only road serving this area and there are multiple intersections in this two-mile section. The Ski Bowl West Access, the Ski Bowl East Access, and the 90-degree Western Government Camp Loop Road/Tyrolean Drive intersections are currently spaced approximately 1,700 feet and 600 feet, respectively (see Figure 9). Approximately one mile to the east, the Eastern Government Camp Loop Road intersection is approximately 1,300 feet from the Timberline Highway intersection (see Figure 9). The road section in the vicinity of the Ski Bowl East Access and Western Government Camp Loop Road/Tyrolean Drive intersections is on the Top 10% Safety Priority Index System (SPIS). This section experienced 49 crashes in 2000-2008 of which 13 were rear-ends and 8 were turning movements. The section in vicinity of the Eastern Government Camp Loop Road and Timberline Highway intersections experienced 50 crashes of which 15 were rear-ends and 14 were turning movements. Additionally, 30 of the 99 crashes occurred during dawn or night. Intersection spacing, turn lane parameters, intersection angles, traffic operations, and lack of lighting have likely all contributed to these crashes. Traffic volumes will continue to increase due to occurring and planned developments. In addition, there is a demand to increase the snow park areas.



Figure 9

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Safety Risk:

Exposure: Low

Probability: High

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

The Government Camp Summit section should be considered as a unit, because the traffic operations at the one intersection likely impact the adjacent intersections. The surroundings along this corridor section are continuing to change and consideration should be given to lower the speed to 45 mph through Government Camp. The RSA Team recognizes that Mt. Hood Highway is a truck route, but felt this section of roadway is similar to reduced speed sections in Rhododendron and Zigzag. Additionally, consideration should be given to reconfigure the intersections to provide improved intersection angles and intersection spacing, especially the Ski Bowl accesses. In the near-future, traffic volumes will likely require the installation of either traffic signals or roundabouts at these intersections. Roundabouts would slow traffic down entering this road section. The geometric layout of roundabouts would be based on the design vehicle for the corridor. Encouraging slower speeds through this section could also include cross sectional elements such as introducing a raised landscaped median, curbed outside edges, narrower shoulders and/or lanes, etc. In addition, consideration should be given to provide street lighting along this road section with appropriate transition areas to/from the dark approaches.

LOCATION: TWO-LANE SECTION MP 47 - 48

Issue: Inappropriate Roadway Shoulder**Description of Safety Issue:**

The existing paved shoulder from before the curve west of Camp Creek Campground entrance to just before MP 48 is typically 4-6 feet (see Figure 10). This area has trees very close to the travel lane and within the typical clear zone associated with a 55-mph facility. Due to the proximity of the trees, it is generally not comfortable for motorist to pull off on the shoulder if needed (see Figure 11). The narrow shoulder also restricts sight distance to the few access points. During the winter, the snow berms will further restrict the shoulder width and sight distances. The trees overhanging the roadway also cause concern during heavy snowfall, because chunks of snow from the overhanging branches come loose and fall into the travelway.



Figure 10



Figure 11

Safety Risk:

Exposure: Low

Probability: Low

Consequence: Medium

Resulting Road Safety Risk: Low

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Suggestion:

Widen the paved shoulder to a minimum of 8 feet to meet ODOT standards. In addition, consideration should be given to remove trees closest to the road in the curve to improve sight distance and to provide reasonable roadside clearance.

LOCATION: CAMP CREEK CAMPGROUND (VICINITY OF MP 47)

Issue: Relative Sharp Curve West of Intersection

Description of Safety Issue:

West of the Camp Creek Campground entrance is a curve to the right in the westbound direction (see Figure 12). There are trees in the north side of the roadway approximately 10-12 feet from the edge of travel lane that are within the typical clear zone associated with a 55-mph facility. These trees restrict the sight distance through the curve and a westbound driver's ability to see and negotiate the curve. Also, sight distance is limited for a vehicle broken down in the curve, and for seeing eastbound vehicles on Mt Hood Highway approaching the intersection (see Figure 13). This location is west of the area that crash data was provided. The "Curve Ahead" sign is 48"X48".



Figure 12



Figure 13

Safety Risk:

Exposure: Low

Probability: Low

Consequence: Medium

Resulting Road Safety Risk: Low

Suggestion:

Consider cutting back trees to improve visibility of the curve and ability to negotiate the curve. This will also achieve decision sight distance for a broken-down vehicle in the curve and for intersection sight distance for a vehicle with a camper trailer making a left-turn from Camp Creek Campground Road. Additionally, consider increasing the size of the "Curve Ahead" to 60"x60" and use high intensity reflective sheeting to enhance retro-reflectivity. This will improve motorist awareness of the approaching curve.

LOCATION: TREE CLEARED AREA MP 47.6 - 48.8

Issue: Lack of Westbound Passing Lane

Description of Safety Issue:

Westbound traffic does not have many passing opportunities coming from the summit at Government Camp (MP 54.0) to this road section. Approximately 5.5 miles to the east of this location, there is a 3,000-foot three-lane cross section (two eastbound and one westbound)

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between the Eastern and Western Government Camp Loop Road intersections that allows westbound traffic to pass by using one of the oncoming eastbound lanes. There is a 3,000-foot westbound passing lane approximately 2.5 miles to the east (MP 51.7 to MP 51.13) of this location. Crash data shows 15 crashes along this one-mile section (MP 47.6 to 48.8) with 11 occurring in the westbound direction of which, 3 involved eastbound traffic in 2000-2008. The road alignment has a winding up-and-down topography that does not provide passing opportunity, and motorists might become frustrated.

Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: High

Suggestion:

The existing width between the cleared treelines is more than 95 feet over a length of approximately one mile and there is opportunity to provide a four-lane cross section (e.g., 8-foot shoulders, 12-foot lanes, and 2-foot median; total of 66 feet) from MP 47.9 to MP 48.7 (approximately 4,200 feet). Based on the RSA Team review, it is desirable to extend this proposed westbound lane as far as possible (approximately one mile) to provide ample opportunity for passing in a downhill section. In addition, advance signing communicating the location of the next passing lane should be placed immediately beyond the end of the previous westbound passing lane.

Issue: Lack of Clearly Defined Chain-on and Chain-off Areas

Description of Safety Issue:

There are no official chain-off areas in the westbound direction but instead wide open gravel areas (see Figure 14) and the eastbound slow-moving vehicle lane is currently used as a chain-on area during winter time (see Figure 15). Traffic traveling eastbound to the Mt. Hood area receives information regarding the use of chains at the VMS at Rhododendron (MP 43.76) and then ground mounted signs along this section for the mountain area. Currently these static signs are placed by ODOT maintenance when needed.



Figure 14



Figure 15

Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

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Suggestion:

The existing width between the treelines is more than 95 feet over a length of approximately one mile and there is opportunity to provide a four-lane cross section plus a 16-foot (minimum) wide chain-on/chain-off area replacing the shoulder (4 12-foot lanes, 2-foot median, and 2 16-foot chain-on/chain-off areas; total of 82 feet). A chain-off area of approximately 3,500 feet can be provided in the westbound direction, as well as a 3,500 feet chain-on area in the eastbound direction (in addition to the slow-moving vehicle lane). These chain-on/chain-off areas need to be clearly signed. The ground mounted regulatory signs for chain-on areas should be changed from manual installation to be automated. One RSA Team member reported that other locations have the “drum” type signs that roll the sign legend based upon the need. To further enhance motorist information regarding conditions on Mt. Hood and the need to chain-on, an overhead VMS for eastbound traffic should be considered at approximately MP 47.5. This sign can be used for providing information regarding mountain road conditions and the upcoming chain-on area. The VMS should also have a sign verification camera installed to the west of the sign. This sign would aid motorists to safely enter the chain-on area. A second camera in the chain-on area should be considered for the purpose of monitoring activities in the chain-on area. This camera could be remotely monitored (Portland) so that ODOT maintenance and Oregon State Patrol can be notified.

Issue: Winding Horizontal Alignment with Roller Coaster Profile

Description of Safety Issue:

There are 6 consecutive reversing curves with one travel lane in each direction and an eastbound slow-moving vehicle/climbing lane starting at MP 47.9 (see Figure 16). During winter the slow-moving vehicle lane becomes the chain-on area. The existing profile has a roller coaster (up-and-down) effect (see Figure 17) and together with the winding road places oncoming traffic (especially during night time) directly in front of them from a driver's perspective. Crash data shows 15 crashes along this section with 3 crashes in 2000-2008 between eastbound and westbound traveling vehicles.



Figure 16



Figure 17

Safety Risk:

Exposure: Medium

Probability: Low

Consequence: Median

Resulting Road Safety Risk: Low

Suggestion:

It is suggested to straighten this roadway section by providing a tangent section between approximately MP 47.7 and the existing curve at MP 48.8. The up-and-down topography will not be as critical since traveling traffic will continue along a straight line. However, motorists still need to negotiate decision sight distance over vertical crest curves for someone pulling out of a chain-up area. There might be opportunities to fill a few feet in the sag curves without extending the fill slopes beyond the existing tree lines.

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LOCATION: MAP CURVE (VICINITY OF MP 49.7)

Issue: Westbound Crashes at Map Curve

Description of Safety Issue:

The crash history for this curve shows this location to be Top 15% SPIS (see Figure 18). There have been 23 crashes between 2000-2008 having no fatalities and 15 injuries. 18 of the 23 crashes were for westbound traffic; hit fixed object crashes (11) makes this the most prevalent type, with rear-end and head-on type crashes next with 4 crashes each. Crash data does show 7 crossover crashes (approximately 30%) at this location. The curve is after 1.5 miles of relatively straight road beyond the summit at Government Camp. The curve is posted for 40 mph with a "Curve Ahead" (36"x36") sign (see Figure 19).



Figure 18



Figure 19

Safety Risk:

Exposure: High

Probability: High

Consequence: High

Resulting Road Safety Risk: High

Suggestion:

There are multiple options for improving this location. The first is to replace the existing "Curve Ahead" sign with a 60"x60" post mounted sign with high intensity sheeting. A 60"x60" sign should be considered for future improvement as an overhead sign with flashing beacons (bouncing ball over and under). In addition to improved signage at the curve, advance signage (Sharp Curve Ahead) communicating the location of the sharp curve could be placed half-a-mile in advance of Map Curve. There is a rock-fall project scheduled for 2011 that entails cutting back the rock face. Associated with this project, other options can be considered. The rock face would be cut back approximately 30-40 feet. This could allow the westbound lane to be pulled to the inside of the curve providing a median and minimum 10 feet paved outside shoulder for incident response purposes. Within the median a barrier treatment should be considered to reduce the crossover and head-on crashes. Several median treatments (e.g., cable barrier) were discussed by the RSA Team, but for maintenance and snow removal purposes, the concrete barrier appears to be the preferred option. The concrete barrier will also eliminate the possibility of a westbound vehicle making a left turn into the Map Curve viewpoint that may be causing some of the rear-end crashes. The concrete barrier design should address decision/stopping sight distance and will likely require a wider median along certain sections (especially the eastbound traffic on the outside of the curve). The barrier should be carried through the curve and safely terminated in a tangent section. Further, the barrier could have retro-reflective treatments installed on the top of the barrier to further delineate the curve in darkness.

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Issue: Undesirable Chain-On Area Location

Description of Safety Issue:

There is an existing chain-on area for eastbound traffic in the sharp horizontal curve at Map Curve (see Figure 20). There is poor sight distance for uphill traffic to see eastbound vehicles rejoining the roadway around the curve. The curve does not have curve chevron signage for downhill traffic (see Figure 21) as the chain-on area is built on this curve, and a roadside barrier is placed on the top of the embankment at the outside edge of the chain-on area. 5 of the 23 crashes that were recorded at this location are for eastbound traffic, of which 4 occurred during snow/ice conditions.

Safety Risk:

Exposure: Medium

Probability: Low

Consequence: Medium

Resulting Road Safety Risk: Medium



Figure 20



Figure 21

Suggestion:

Considerations should be given to remove/close the existing chain-on area in the curve, bringing the concrete barrier to the shoulder location, and adding standard curve chevron signage for downhill traffic. Provide a new chain-up area (16-20 feet wide) to the east around the curve along the tangent section (see Figures 22 and 23). This area could be as long as 1500 feet (MP 49.85 to MP 50.13).



Figure 22



Figure 23

LOCATION: SECTION BETWEEN MAP CURVE (MP 49.7) AND MIRROR LAKE CURVE (MP 51.7)

Issue: Inadequate Westbound Passing Lane

Description of Safety Issue:

The westbound traffic has a passing lane starting (see Figure 24) in the Mirror Lake curve

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extending down the mountain through S-curves (see Figure 25) for approximately 3,000 feet, terminating (see Figure 26) just beyond the second curve. The signs for the termination of the passing lane have both signs mixed with the chevron signage identifying the second curve and are difficult to see (see Figure 27). The RSA Team also observed westbound vehicles passing in the no passing areas approaching this curve, because west of the aforementioned passing lane the next opportunity to pass is approximately 5-6 miles. The crash data shows there have been 10 crashes in this section with two fatalities and 5 crashes between eastbound and westbound vehicles.

Safety Risk:

Exposure: High

Probability: High

Consequence: High

Resulting Road Safety Risk: High



Figure 24



Figure 25



Figure 26



Figure 27

Suggestion:

The passing lane should be lengthened. The issue for the Mirror Lake curve will be discussed in the next safety issue regarding extending the passing lane east to begin in the tangent section. The passing lane should also be extended to the west into the tangent section following the second curve. The signage for terminating the passing lane should be located in the tangent section beyond the curve chevron signs. The RSA Team suggests that the length of the passing lane be a minimum of one mile based on the westbound traffic volumes, downhill grade, and lack of passing opportunities. It is also suggested that signage (e.g., "Passing Lane - XX Mile Ahead") be placed on the westbound lane immediately beyond the previous passing opportunity. Following this extended passing lane, a similar new sign should be installed identifying the distance to the next passing lane (potentially 2 to 2.5 miles ahead at MP 49). To address the crash issue between eastbound and westbound vehicles, the concrete barrier suggested for the Map Curve and Mirror Lake Curve should be extended through this section. (*The previously described issues for Map Curve and forthcoming issues for Mirror Lake Curve have suggested providing median barrier in both curves.*) This will eliminate two of the barrier wall termination sections to improve safety. Special attention needs to be given to the design of the termination sections, as

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well as the median width to meet the appropriate decision and stopping sight distance (especially for motorist traveling along the outside of curves). To accommodate the concrete barrier, the roadway section should be widened to provide appropriate inside shoulders in each side of the barrier, as well as a 12-foot lane and a 10-foot paved outside shoulder where only one westbound lane exists. The wider outside shoulder would provide adequate width for traffic to pass in case of an incident.

LOCATION: MIRROR LAKE CURVE (VICINITY OF MP 51.8)

Issue: Sharp Curve at Mirror Lake

Description of Safety Issue:

This curve has a higher number of crashes (compared to Map Curve) and has a curve warning sign posted for 35 mph (see Figure 28). This sign actually describes an S-curve with a 35 mph supplemental sign. The crash data shows a total of 33 crashes between 2000 and 2008 resulting in 1 fatality and 12 injuries. The crash types had a uniform mix of head-on, side-swipe, fixed object and rear end. The reports show that there were 7-9 crossover crashes with the 1 fatality in the reporting period. Most crashes occurred during inclement conditions with 27 during snow/ice road conditions and an additional 5 in wet pavement conditions. There was a uniform distribution of eastbound and westbound crashes. The field observation shows that this is the first significant curve west of Ski Bowl (MP 52.6) and is on a significant downhill grade. Driving the curve westbound, the downhill grade contributes to difficulty in speed reduction through the curve. The current "Curve Ahead" sign is post mounted and appears to be 36"x36". The RSA Team also observed westbound traffic making left turns into the Mirror Lake Trailhead parking area. This can contribute to the reported rear-end crashes. Another issue observed by the RSA Team is that the passing lane is introduced in this curve (see Figure 29). It is not very visible to westbound traffic and is not signed.



Figure 28



Figure 29

Safety Risk:

Exposure: High

Probability: High

Consequence: High

Resulting Road Safety Risk: High

Suggestion:

There are multiple suggestions for this curve area. The initial immediate improvement could be replacing the existing S-curve sign with a 60"x60" "Curve Ahead" sign having high intensity reflective sheeting and adding an additional "Curve Ahead" sign for the second curve (splitting the message of the existing S-curve sign). The supplemental speed advisory sign (based on actual curvature) should also be increased in size and have high intensity sheeting. In the future, consideration should be given to have the first sign mounted overhead with flashing beacons (bouncing ball) for Mirror Lake Curve. In addition to improved signage at the curve, advance signing (Sharp Curve Ahead) communicating the location of the sharp curve could be placed half-a-mile in advance of Mirror Lake Curve. As discussed for potential solutions at Map Curve to improve the crossover crash situation, consideration should be given to providing median

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protection through the curve area as well. In discussion with ODOT maintenance staff, the concrete barrier appears to be the best option for snow removal and maintenance purposes. As discussed, consideration should be given to connecting the two proposed concrete barrier sections (i.e., Map Curve and Mirror Lake Curve) to provide a continuous section. The barrier will aid many of the crash types including the rear-end crashes for westbound left-turning vehicles into the parking area. The RSA Team also suggests moving the start of the passing lane further to the east, introducing it in the tangent section more visible to the driver, and having proper signing. This will require cutting the rock face back to provide room for both extending the passing lane and provide the concrete barrier. Consideration was given to eliminate the passing lane, but due to the limited passing opportunity for westbound traffic over an extensive road section, the RSA Team deemed this option infeasible.

Issue: Undesirable Mirror Lake Hiking Trail Parking Location

Description of Safety Issue:

A high-use parking area exists on the south side of the highway on the very tight Mirror Lake Curve (see Figure 30). There is limited sight distance for westbound left-turn vehicles crossing two eastbound travel lanes into this parking area (see Figure 31). Motorists leaving the parking area also need to turn left across the two eastbound lanes coming around the curve, as well as finding a gap in the westbound approaching downhill traffic. Entering traffic destined to the east is joining the eastbound traffic around the curve (out of sight) that would be unexpected for eastbound traveling traffic.



Figure 30



Figure 31

Safety Risk:

Exposure: Low

Probability: Low

Consequence: Medium

Resulting Road Safety Risk: Low

Suggestion:

Consider moving the trailhead to the vicinity of the Ski Bowl West access and extend/connect the existing trail (about 4000') to the new parking area. This parking area could be moved to the east and constructed on the straight section of the highway, or built in the vicinity of Ski Bowl and then given access via the Ski Bowl West access. The removal of the parking area would provide the opportunity to use the existing wide embankment near this curve to widen the shoulders and/or introduce a possible median.

LOCATION: SKI BOWL ACCESSES (MP 52.4 TO MP 53.1)

Issue: Undesirable Ski Bowl West Access Location and Configuration (MP 52.50)

Description of Safety Issue:

This intersection is approximately 1,700 feet from the Ski Bowl East Access. This intersection has a very skewed intersection angle of less than 40 degrees. There is no westbound left-turn lane

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into Ski Bowl at this location (see Figure 32). The intersection sight distance, especially to the east, is limited due to the vertical crest curve to the east of this intersection (see Figure 33). There have been 9 crashes from 2000-2008 including 1 fatality. These crashes represent 3 fixed object, 3 rear-end, 1 turning, 1 side-swipe, and 1 head-on type crashes.



Figure 32



Figure 33

Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

The Ski Bowl West Access should be realigned to the east by approximately 350 feet to the top of the crest curve (see Figure 34). This location would provide the optimum intersection sight distance and provide the opportunity to provide a standard westbound left-turn lane. The left and right turners can be separated at this realigned conventional T-intersection. Providing a 90-degree conventional T-intersection with appropriate deceleration distance for turning movements along the highway could address the majority of the crashes at this intersection. The side-street movements (especially the left-turns) will experience long delays and as traffic increases in future, this movement would become more challenging. A future consideration at this intersection could be a signal or a modern roundabout.

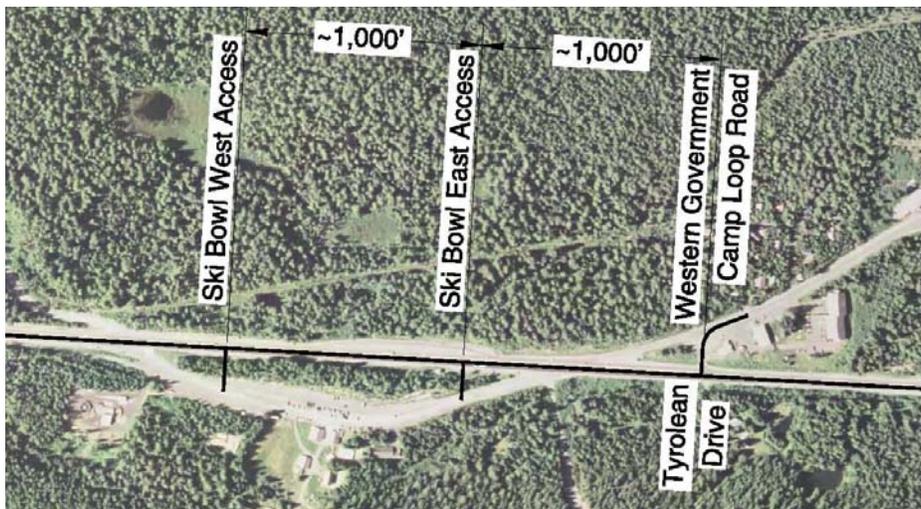


Figure 34

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Issue: Undesirable Ski Bowl East Access Location and Configuration (MP 52.85)

Description of Safety Issue:

This intersection is approximately 1,700 feet from the Ski Bowl West Access and approximately 600 feet from the Tyrolean Drive intersection. Tyrolean Drive was recently added as a south leg to the 90-degree Western Government Camp Loop Road intersection. The 600-foot intersection spacing does not provide appropriate deceleration and/or storage lengths for back-to-back left-turns (see Figure 35). This intersection has a very skewed intersection angle of less than 30 degrees. The Ski Bowl West Access had 33 crashes of which 10 were rear-ends, 8 fixed objects, and 8 turning movements. The crash history for this intersection shows this location to be Top 10% SPIS. The skewed intersection angle results in a very wide open paved area (see Figure 36). It is also difficult to determine the correct in/out paths as the skewed intersection with long intersection crossing distances. This is further compounded by snow in the winter. This undesirable intersection configuration likely contributes to crashes at this location.



Figure 35



Figure 36

Safety Risk:

Exposure: High

Probability: High

Consequence: High

Resulting Road Safety Risk: High

Suggestion:

As an immediate improvement, the Ski Bowl East Access southbound movement should be signed as a right-turn only allowing no through movement to Ski Bowl, all eastbound highway left-turns should occur at this intersection (none at the Tyrolean Drive intersection), and all southbound left-turns should be signed and directed to make a left at the Tyrolean Drive intersection. The objective of these alterations is to address the crashes in the north-south directions, as well as turning crashes at this intersection. A near-term solution for consideration is that the Western Government Camp Loop Road traffic should be redirected to the current 90-degree Tyrolean Drive intersection to the east, while the north leg at the Ski Bowl East Access should be disconnected. The Ski Bowl East Access should be realigned to the west and provide an intersection spacing of approximately 1,000 feet (MP 52.79) from the realigned Ski Bowl West Access and approximately 1,000 feet from the Tyrolean Drive intersection (see Figure 34). This would provide sufficient distance to develop standard back-to-back left-turn lanes between this intersection and the Tyrolean Drive intersection. The left and right turners can be separated at this realigned conventional T-intersection. The side-street movements (especially the left-turns) would experience long delays and as traffic increases in the future, this movement would become more challenging. Providing a 90-degree conventional T-intersection with appropriate deceleration distance for turning movements along the highway would address the majority of the crashes at this intersection. A future consideration at this intersection could be a signal or a modern roundabout.

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Issue: Undesirable Tyrolean Drive Intersection Location and Configuration (MP 52.98)

Description of Safety Issue:

This intersection is approximately 600 feet from the Ski Bowl East Access. A southern fourth leg (Tyrolean Drive) has recently been added making this a side-street stopped controlled intersection. The intersection experienced 16 crashes of which 6 were rear-ends, 3 fixed objects, and 7 other. There is no westbound left-turn lane (see Figure 37) and the eastbound left has non-standard deceleration and/or storage lengths (see Figure 38). The intersection radii are small and westbound right-turns almost have to come to a stop in the single westbound travel lane before making a turn. All the intersection parameters relate to a lot of friction at this node.



Figure 37



Figure 38

Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

As an immediate improvement, all southbound left-turns on Government Camp Loop Road should be signed and directed to make the left at this intersection and not at the skewed Ski Bowl East Access. The Ski Bowl East Access southbound movement should be signed as a right-turn only allowing no through movement to Ski Bowl. The objective of these alterations is to address rear-end and other crashes, as well as turning crashes at this intersection. Future improvements should consider realigning Western Government Camp Loop Road to this 90-degree Tyrolean Drive intersection (MP 52.98) and disconnect with the Ski Bowl East Access intersection. The north leg should better align with the south leg and consideration should be given to provide separate turn lanes. A westbound left-turn lane should be provided and the eastbound left-turn should be modified to provide sufficient deceleration distance. During snowy conditions the southbound left at the 90-degree access would have limited intersection sight distance to the east due to an approximately 10-foot snow wall. It should be considered to widen the shoulder or add a westbound right-turn lane to provide proper intersection sight distance. Adding a westbound right-turn lane would address right-turning vehicles decelerating in the only one westbound travel lane. The side-street movements (especially the left-turns) will experience long delays, and as traffic increases in the future, this movement will become more challenging. Providing a 90-degree conventional T-intersection with appropriate deceleration distance for turning movements along the highway would address the majority of the crashes at this intersection. A future consideration at this intersection could be a signal or a modern roundabout.

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LOCATION: MULTORPOR BRIDGE (VICINITY OF MP 53.5)

Issue: Limited Westbound Passing Opportunity

Description of Safety Issue:

The crash history for this road section shows this location to be Top 25% SPIS. There have been 6 crashes from 2000-2008, including 3 injury crashes. There were 3 crashes between westbound and eastbound traffic. This is a three-lane cross section with one westbound and two eastbound lanes with supplemental non-standard signage (see Figure 39). The pavement marking allows westbound traffic to pass over a section of approximately 3,000 feet (see Figure 40). During the fieldwork, the RSA Team saw several undesirable westbound passing maneuvers.



Figure 39



Figure 40

Safety Risk:

Exposure: Medium

Probability: Medium

Consequence: High

Resulting Road Safety Risk: Medium

Suggestion:

The proposed improvements at the Tyrolean Drive intersection include the provision of westbound left and right-turn lanes off the highway. In addition, one of the suggested improvements at the Eastern Government Camp Loop Road intersection is to move the intersection to the west. Both these intersection improvements will shorten the existing length for passing opportunity. Consideration should be given to eliminate passing opportunity for westbound traffic. This section of Mt. Hood Highway appears to have environmental sensitive areas along both sides of the road. Therefore, providing an additional westbound lane in the future will be challenging.

LOCATION: EASTERN GOVERNMENT CAMP LOOP ROAD (VICINITY OF MP 54.0)

Issue: Undesirable Intersection Configuration

Description of Safety Issue:

This 90-degree intersection is approximately 1,300 feet from the Timberline Road intersection. It has an eastbound left-turn, as well as a westbound right-turn along Mt. Hood Highway. The westbound right-turn has to yield to the eastbound left-turn in the intersection throat. The north leg is very wide with very short exclusive southbound left and right-turn lanes in addition to the two inbound lanes (see Figure 41). The westbound right-turn lane from the highway is not visible for approaching motorists until breaking over the vertical curve (see Figure 42). This intersection had 22 crashes of which 9 were turning movements, 8 rear-ends, and 4 fixed objects. Observations indicate that westbound motorists were slowing excessively prior to reaching the right-turn lane in anticipation of turning at the intersection. There is another intersection less than

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100 feet to the north from the highway providing access to the rest area and Government Camp Loop Road (see Figure 43), as well as a gas station with no defined access. There is a lot of open pavement which leads to driver confusion, especially when the pavement markings have faded and during snowy conditions. This intersection also has a flashing beacon and some lighting (see Figure 44). There is a vertical curve to the east that limits intersection sight distance. The left-turning vehicles block the sight distance of the right-turning vehicles. Additionally, the stop sign is far from the lanes and difficult to see, especially at night.



Figure 41



Figure 42



Figure 43



Figure 44

Safety Risk:

Exposure: Low

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

Consideration should be given to extend the westbound right-turn lane over the vertical crest curve so that approaching vehicles can enter the turn lane and decelerate in the turn lane. This could address crashes related to traffic in the westbound direction. Consideration should also be given to better define the north leg of the intersection by clearly linking the intersection to the Government Camp Loop Road. The rest area and gas station would then access the Government Camp Loop Road. It is understood that during the winter, the rest area typically generates more traffic compared with the Government Camp Loop Road. From spring through fall, striping and signing should suffice, but during the winter season (snowy conditions) it would be challenging to clearly define who has right-of-way. Another consideration would be to realign Government Loop Road further to the west separating the gas station and rest area activities from the conventional T-intersection with Mt. Hood Highway (see Figure 45). A new intersection location would provide better intersection sight distance, as well as turn lanes with appropriate deceleration.

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Figure 45

Issue: Poor Intersection Operations

Description of Safety Issue:

The 2009 traffic volumes indicate that some of the signal warrants might be met at this location. As developments continue to grow in Government Camp it would become more challenging for all users entering this intersection. As previously noted, this intersection had 22 crashes of which 9 were turning movements.

Safety Risk:

Exposure: Low

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

There is a relatively high minor street left-turn movement at this intersection that will experience long delays (waiting to find a gap) as traffic continues to grow along the highway. The introduction of a signal or a roundabout would provide the necessary gaps and address the turning movement crashes. An intersection feasibility study should be completed to determine what traffic control device would be appropriate at this location (e.g., traffic signal or roundabout). There is currently some street lighting at this intersection. Illumination at this intersection should be evaluated and upgraded to meet appropriate intersection and transition requirements.

LOCATION: TIMBERLINE HIGHWAY (VICINITY OF MP 54.3)

Issue: Undesirable Intersection Configuration

Description of Safety Issue:

This intersection is approximately 1,300 feet from the Eastern Government Camp Loop Road intersection. This 40-degree intersection has an eastbound left-turn, as well as a westbound right-turn along Mt. Hood Highway. This intersection together with the Eastern Government Camp Loop Road intersection had a total of 50 crashes including 18 injury type crashes (see Figure 46). There were approximately 17 crashes at this intersection that included a wide spectrum of crash types, such as 5 turning/angle, 4 fixed objects, 3 sideswipes, 2 rear-ends, 1 head-on, 1 pedestrian, and 1 other. The north leg is very wide at the intersection where the right-turn is significantly flared (see Figure 47). The left-turning vehicles block the sight of the right-turning vehicles. The combination of the horizontal and vertical curves to the east limits intersection sight distance (see Figure 48). The westbound right-turn is signed and striped to yield to the eastbound

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left-turn. There is a lot of open pavement that leads to driver confusion, especially when the pavement markings have faded and during snowy conditions. ODOT maintenance staff indicated that the several southbound right-turners from Timberline Highway use the flared right-turn and the wide shoulder as an unofficial add lane onto the highway (see Figure 49).



Figure 46



Figure 47



Figure 48



Figure 49

Safety Risk:

Exposure: Low

Probability: Medium

Consequence: Medium

Resulting Road Safety Risk: Medium

Suggestion:

Consideration should be given to clearly define this intersection, especially slowing the southbound right-turn, because it is currently used as an unofficial add lane onto the wide shoulder. Options for consideration might include: 1) Provide an approximately 100-foot southbound right-turn lane to avoid the left-turn queue blocking the high volume southbound right-turn. Eliminating the wide flared southbound right-turn provides the opportunity to realign the southbound right-turn lane more perpendicular to the highway. This modification would address the "merge" type crashes between westbound and southbound traffic. 2) Consideration was given to realign the bottom part of Timberline Road to "T" more perpendicular with the highway, but due to the longitudinal grade along Timberline Highway and current intersection angle, the RSA Team deemed this option infeasible. 3) A consideration might be to provide an acceleration lane for the southbound traffic onto the highway, but there is not sufficient distance to merge prior to the start of the westbound right-turn lane at the existing Eastern Government Camp Loop Road intersection. This can be treated as a westbound auxiliary lane between the two intersections, but it would introduce a weaving section, and it would be challenging to define the travel patterns during winter season. 4) However, if the Eastern Government Camp Loop Road is moved to the west (as suggested in previous sections), then there might be sufficient distance to provide an acceleration lane and an appropriate taper.

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Issue: Poor Intersection Operations

Description of Safety Issue:

The 2009 traffic volumes indicate that the side-street traffic will have challenges in the future to find gaps. There is no street lighting at this intersection.

Safety Risk:

Exposure: Low

Probability: Low

Consequence: Medium

Resulting Road Safety Risk: Low

Suggestion:

An intersection feasibility study should be completed to determine what traffic control device would be appropriate at this location in the future (e.g., traffic signal or roundabout). Consideration should be given to provide street lighting at this intersection and along this road section with appropriate transition areas to/from the dark approaches.

Appendix "A"

Road Safety Audit Findings Presentation

ROAD SAFETY AUDIT Mt. Hood Highway (Hwy. 26)

Camp Creek Campground to Timberline Road
(Mile Post 47.19 to 54.23)

For ODOT, Region 1
Clackamas County, Oregon

June 19, 2009

Presented by: John R. Freeman, P.E., PTOE



Presentation Outline

- Overview of Road Safety Audit (RSA) Process
- Review of Crash Data
- Overview of RSA Findings and Suggestions



RSA Team Leader – Jack Freeman, P.E., PTOE

- Co-author of FHWA's *Road Safety Audit Guidelines and Checklist*
- Lead over 20 RSA's in three states
- 37 years experience in design, traffic operations and safety
- Instructs FHWA's Designing and Operating Intersections for Safety Course, Road Safety Audits and Elder Road User
- 2003 ITE International President

Asst. Team Leader – Hermanus Steyn, Pr.Eng; P.E.

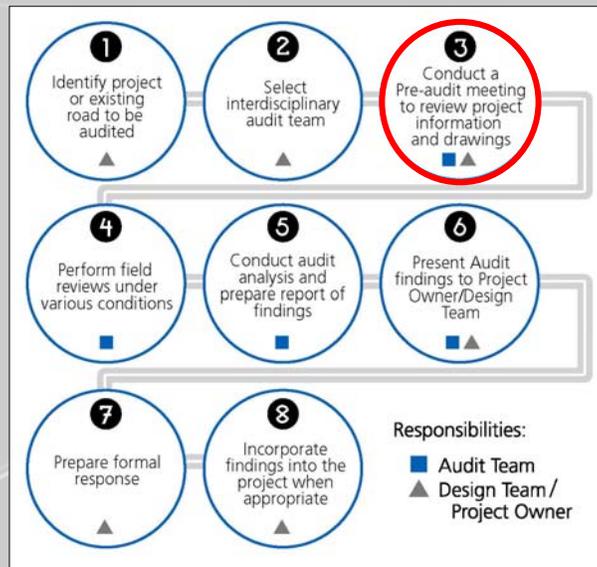
- Registered professional engineer in South Africa
- Worked as a roadway design engineer for a multi-discipline firm in South Africa (8 years)
 - Final design and on-site construction supervision of 13-km mountain pass
 - Evaluation and final design of rural highways
 - RSA was integral part of final design process
- Work at KAI since 2001
 - Develop road improvements based on anticipated traffic operations
 - Developing ways to incorporate upcoming HSM in day-to-day work
 - Actively participate in Geometric Design and Operational Effects of Geometric Design TRB Committees (and related subcommittees)

RSA Team Members

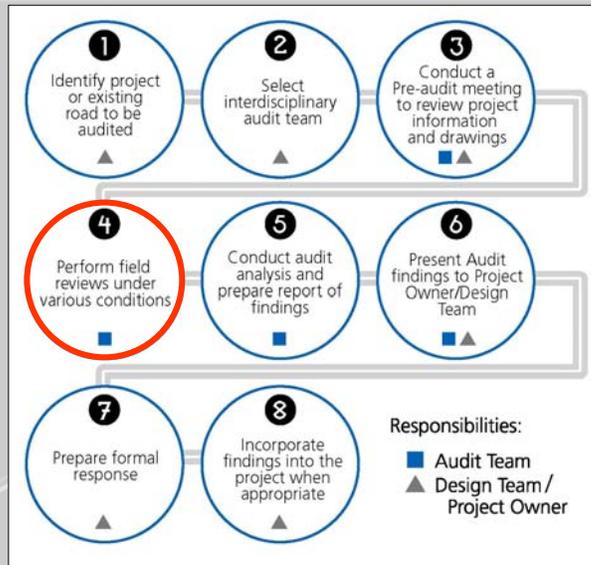
- Jack Freeman, P.E., PTOE – Team Leader
- Hermanus Steyn, Pr.Eng.; P.E., – Asst. Team Leader
- Carl Deaton, P.E. – Senior Roadway Designer, ODOT Region 2
- Robert Tolman – TMM, ODOT Region 5

- Team Resources
 - Jim McNamee – TMM, ODOT, Dist 2C, Region 1
 - Sue D’Agnese – ODOT Region 1 Traffic Manager
 - Jerry Sabel – Hwy 26 Safety Corridor CAC
 - Mike Reel – Oregon State Police

RSA Process – Pre-audit Meeting

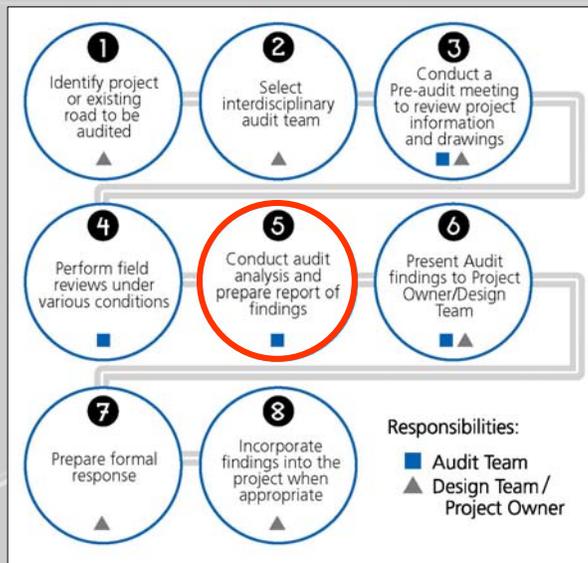


RSA Process – Field Review



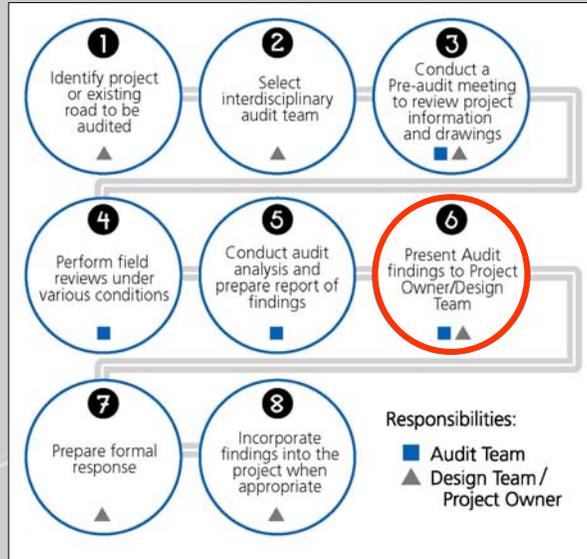
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RSA Process – RSA Analysis



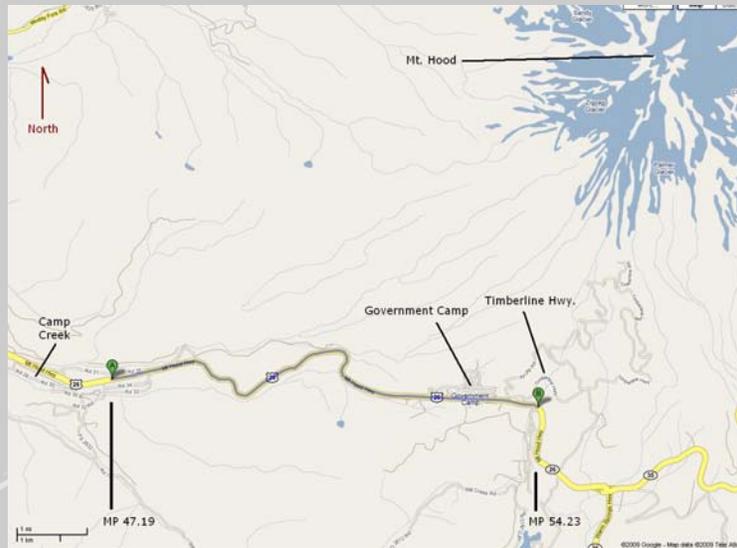
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RSA Process – Presentation of Findings



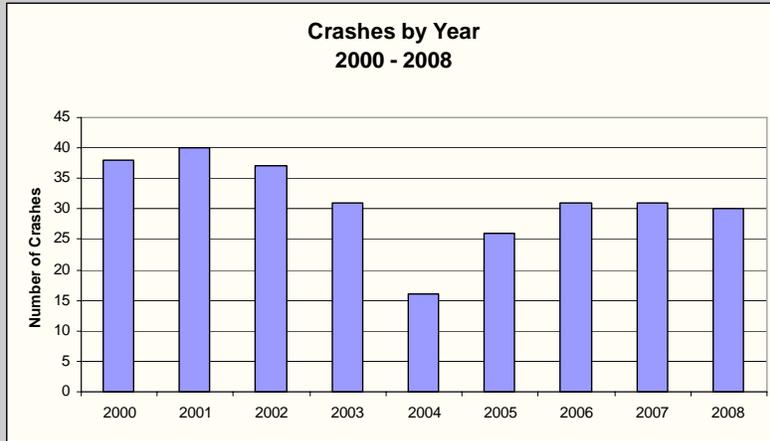
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Mt. Hood Highway RSA Segment (MP 47.19 to 54.23)



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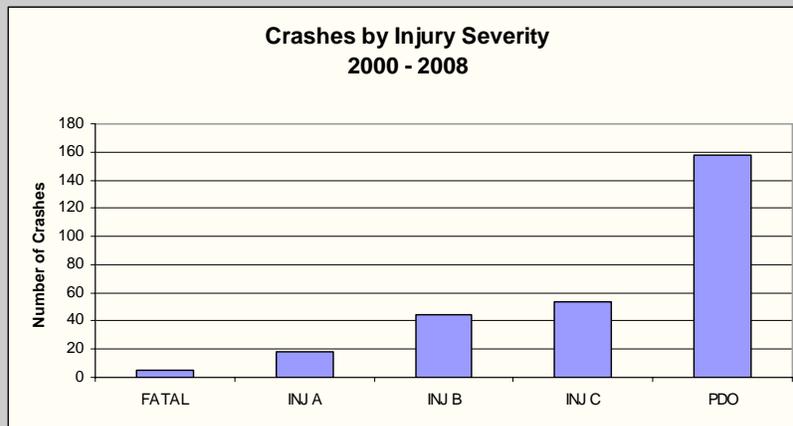
2000 – 2008 Crashes



Total Crashes = 280

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Crashes by Injury Severity

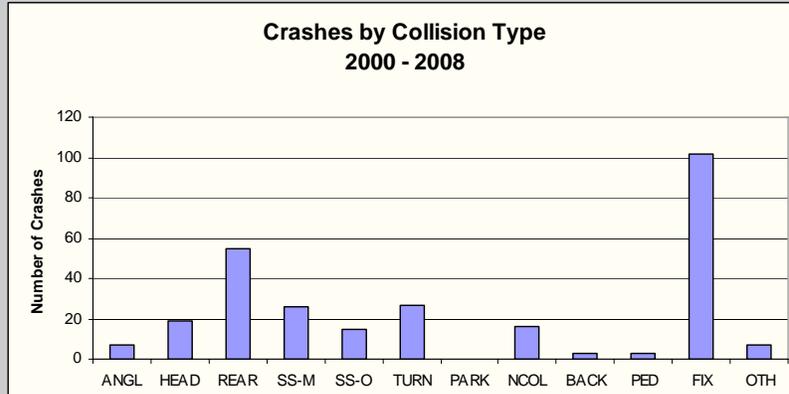


FATAL - Fatality; INJ A - Injury A; INJ B - Injury B; INJ C - Injury C; PDO - Property Damage Only

55% of all crashes are non-injury (PDO) crashes

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Crashes by Collision Type

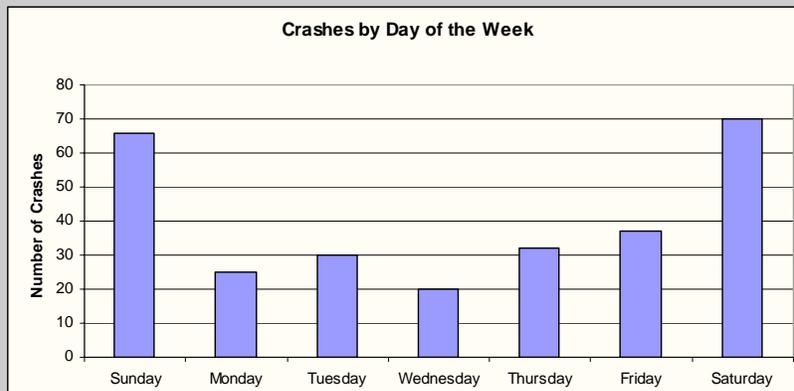


ANGL – Angle; HEAD – Head-On; REAR – Rear-End; SS-M – Sideswipe-meeting;
SS-O – Sideswipe-overtaking; TURN – Turning Movement; PARK – Parking Maneuver;
NCOL – Non-collision; BACK – Backing; PED – Pedestrian; FIX – Fixed/Other Object; OTH – Other

Crashes primarily fixed-object or rear-end crashes

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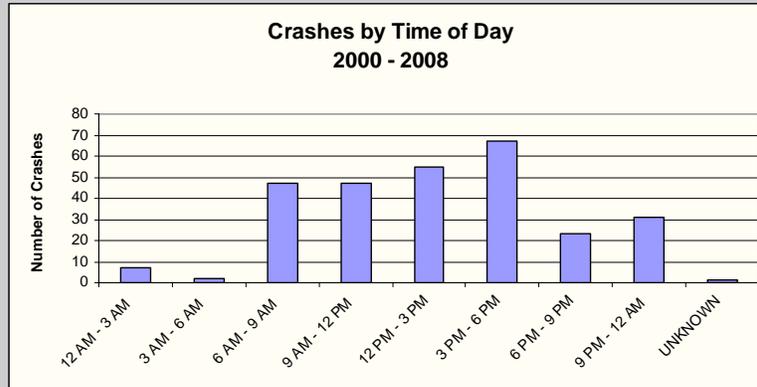
Crashes by Day of the Week



Crashes occur primarily during the weekends

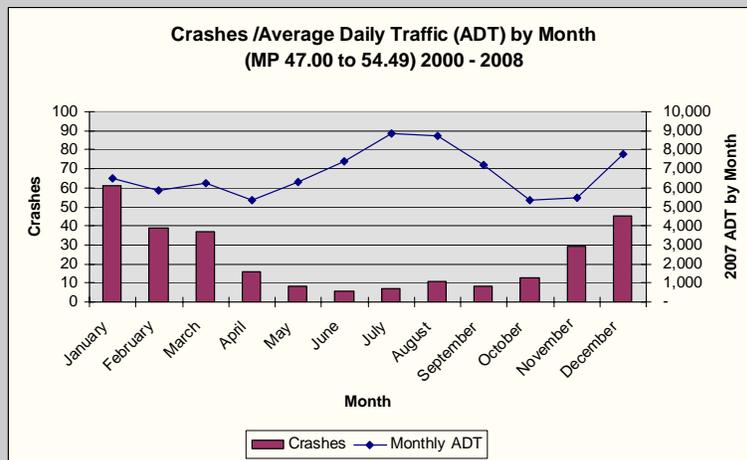
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Crashes by Time of Day



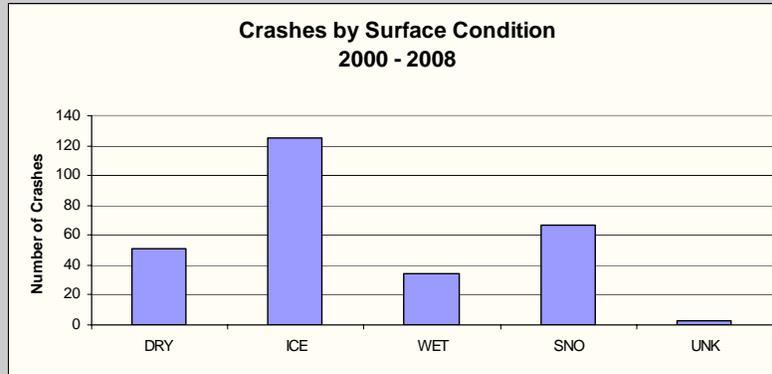
Crashes occur primarily during daylight hours

Crashes/ADT by Month



Crashes occur primarily during the winter months

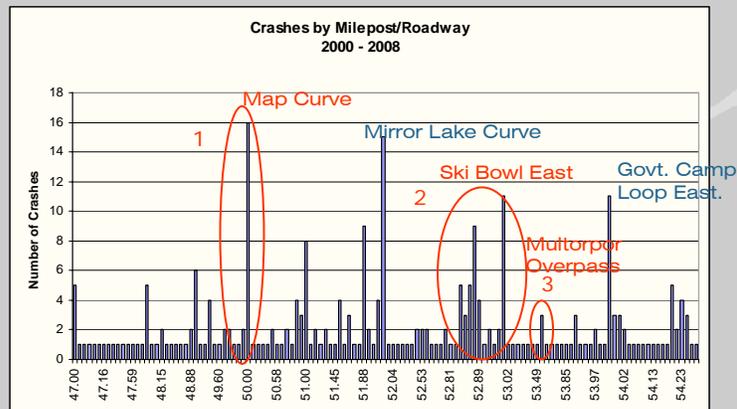
Crashes by Surface Condition



SNO - Snow; UNK - Unknown

Approximately 70% of crashes occur in the presence of ice and snow

Concentrated Crash Locations by Milepost



SPIS locations:

1. MP 49.91 - 50.09
2. MP 52.78 - 52.95
3. MP 53.45 - 53.59

Corridor Issues – Western Section – Camp Creek to Ski Bowl West

- **Mountain Highway**
 - 55 mph – speed is an issue
 - OSP Education
 - Minimum access
 - Curves
 - Chains on/off areas
 - WB passing areas
- **Potential solutions**
 - Variable Speed Limits (VSL) for poor roadway conditions
 - Consider photo speed enforcement – only when VSL is used
 - Better signs for curves; possible barrier separation
 - More Chain on/off areas
 - Electronic signs to inform public
 - More/longer WB passing areas
 - Improve signage



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Crash Analysis: Camp Creek Entrance MP 47.0 – 47.3



Years 2000 - 2008

- Total Crashes: 12
- Fatalities/Injuries: 1 / 8
- **Predominant Crash Types**
 1. Fixed object (6)
 2. Rear-end (2)
- **Predominant Road Conditions:**
 1. Snow/Ice (5)
 2. Dry (5)
 3. Wet (2)
- **Directional crash notes:**
 - Both rear-end crashes occurred in the westbound direction
 - Fixed-object crashes occurred in varied directions

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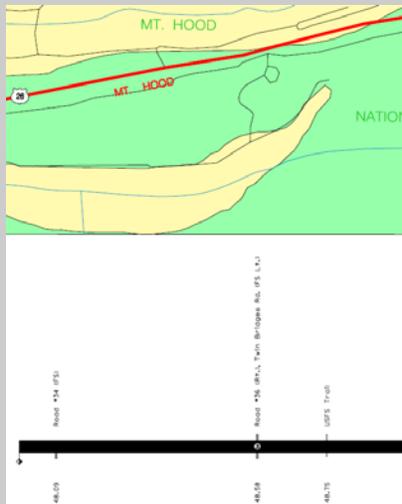
Issues - Suggestions

- Improve decision sight distance thru curve
 - Trim back trees inside curve
- Improve visibility of curve
 - Increase size of “Curve Ahead” sign
- Improve paved shoulder width to 8'



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Crash Analysis: MP 47.8 – 48.8 (Mt. Hood Hwy.)



Years 2000 - 2008

- Total Crashes: 15
- Fatalities/Injuries: 0 / 7
- Predominant Crash Types
 1. Fixed object (9)
 2. Side-swipe (4)
- Predominant Road Conditions:
 1. Snow/Ice (10)
 2. Wet (3)
 3. Head-On (3)
- Directional crash notes:
 - 10 crashes westbound (6 of these fixed-object)

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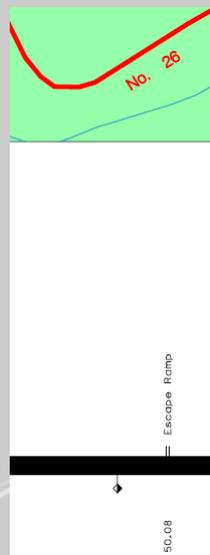
Issues-Suggestions

- 1 mile cleared section
 - Approximately 95' wide treeline to treeline
- Existing roadway – 3 lanes
 - Series of vertical and horizontal curves
- Improvements
 - Straighten road and improve vertical
 - 4 lanes – 2 each direction
 - 16' Chain on/off outside shoulders
 - Electronic signs for chain areas, mountain road conditions and VSL (if applicable)



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Crash Analysis: MP 49.91 – 50.09 (Map Curve)



Years 2000 - 2008

- Total Crashes: 23
- SPIS Top 15%
- Fatalities/Injuries: 0 / 15
- Predominant Crash Types
 1. Fixed object (11)
 2. Rear-end (4)
 3. Head-on (4)
- Predominant Road Conditions:
 1. Snow/Ice (14)
 2. Dry (5)
 3. Wet (4)
- Directional crash notes:
 - 18 of the 23 crashes occurred in the westbound direction
 - 7 cross over crashes

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Issues-Suggestions

- Curve posted for 40 mph
- Contains winter chain on/off area and summer overlook
- Improvements
 - Enhance “Curve Ahead” signage
 - Replace existing with 60”x60” high intensity
 - Consider future overhead with flashing beacons
 - Improve curve
 - Cut back rock face
 - Shift WB lane to inside of curve w/wider shoulders
 - Add median barrier
 - Modify chain on area
 - Close existing location
 - Shift up grade beyond curve



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Crash Analysis: MP 51.3 – 51.6 (bet. Map Curve & Mirror Lake)



Years 2000 - 2008

- Total Crashes: 10
- (non-SPIS)
- Fatalities/Injuries: 2 / 5
- Predominant Crash Types
 1. Fixed object (5)
 2. Head-on (2)
- Predominant Road Conditions:
 1. Snow/Ice (6)
 2. Wet (2)
 3. Dry (2)
- Directional crash notes:
 - 7 crashes WB (4 of these fixed-object)
 - 4 crashes between WB & EB vehicles

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Issues-Suggestions

- WB passing lane ends MP 51.6
 - Next passing lane 5 to 6 miles west
 - Passing lane termination signs mixed with chevron signs
- Improvements
 - Extend passing lane to be minimum of one mile long
 - Terminate in tangent and relocate signs into tangent
 - Consider barrier between Map Curve and Mirror Lake Curve
 - Add “Next Passing Lane – XX miles” sign



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Crash Analysis: MP 51.88 – 52.04 (Mirror Lake Curve)



Years 2000 - 2008

- Total Crashes: 33
- Fatalities/Injuries: 1 / 12
- Predominant Crash Types
 - Uniform mix of head-on, side-swipe, fixed object, and rear-end crashes
- Predominant Road Conditions:
 1. Snow/Ice (27)
 2. Wet (5)
 3. Dry (1)
- Directional crash notes:
 - Uniform distribution of eastbound and westbound crashes (no north- or southbound crashes)

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Issues-Suggestions

- Curve posted at 35 mph
- Mirror Lake Trailhead located in curve
- Improvements
 - Enhance “Curve Ahead” signage
 - Replace existing with 60”x60” high intensity
 - Consider future overhead with flashing beacons
 - Improve curve
 - Cut back rock face
 - Shift WB lane to inside of curve w/wider shoulders
 - Add median barrier



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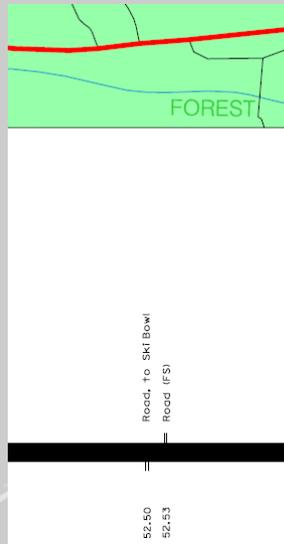
Corridor Issues – Eastern Section – Ski Bowl West to Timberline

- Government Camp Summit Section
 - 55 mph
 - Increased access – more intersection crashes
 - Limited LT lanes
 - Skew angles
 - Some intersections lighted
 - Transitioning land uses
 - Development occurring/planned
 - Demand to increase snow park areas
- Potential solutions
 - Rework intersections
 - Change roadway character
 - Consider speed limit reduction to 45 mph
 - Consider roadway lighting



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Crash Analysis: Ski Bowl West Entrance at MP 52.4 – 52.6



Years 2000 - 2008

- Total Crashes: 9
- Fatalities/Injuries: 1 / 1
- Predominant Crash Types
 1. Fixed object (3)
 2. Rear-end (3)
 3. Mix of turning (1), side-swipe (1), and head on (1)
- Predominant Road Conditions:
 1. Snow/Ice (7)
- Directional crash notes:
 - Even split EB and WB
 - No northbound crashes

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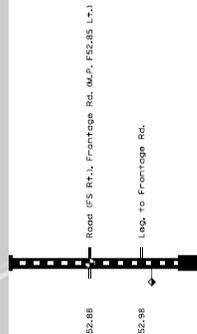
Issues-Suggestions

- Existing intersection is on skew with minor road opposite
- No WB LT lane into Ski Bowl West
- Improvements
 - Shift intersection to east to become "T"
 - Locate at crest of vertical curve
 - Provide LT lane



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SPIS Crashes: MP 52.78 – 52.95 (Ski Bowl East/Govt. Camp Loop)



Years 2000 - 2008

- Total Crashes: 49
- SPIS Top 10%
- Fatalities/Injuries: 0 / 16
- Predominant Crash Types
 1. Fixed object (14)
 2. Rear-end (13)
 3. Turning (8)
- Predominant Road Conditions:
 1. Snow/Ice (33)
 2. Dry (12)
 3. Wet/Unknown (2/2)
- Directional crash notes:
 - Half rear-end crashes occurred north to south at "Y"
 - Fixed object and turning crashes were evenly split EB and WB

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Issues-Suggestions

- Skewed intersection with multiple accesses
- Short LT lanes
- Has roadway lighting
- Improvements
 - Close skewed intersection to become 2 "T" intersections
 - Realign Ski Bowl East to be west of current location
 - Use existing full intersection at Tyrolean Drive for Government Camp Loop west access
 - Provide WB left to Tyrolean Drive
 - Provide adequate separation between intersections for back-to-back LT lane storage



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Crash Analysis: MP 53.45 – 53.59 (Multorpor Overpass)



Years 2000 - 2008

- Total Crashes: 6
- SPIS Top 25%
- Fatalities/Injuries: 0 / 3
- Predominant Crash Types
 1. Sideswipe (3)
 2. Head-on/Fixed/Angle (1/1/1)
- Predominant Road Conditions:
 1. Snow/Ice (6)
- Directional crash notes:
 - 3 crashes were between EB and WB vehicles
 - 1 crash NB with EB
 - 1 crash WB with WB
 - 1 fixed object crash EB

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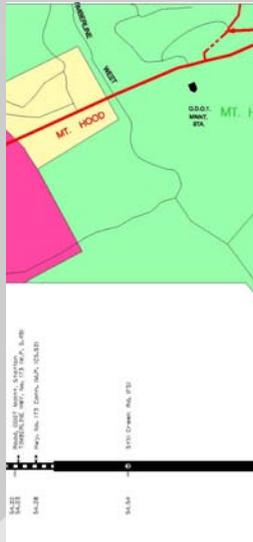
Issues-Suggestions

- Straight section with EB grade up to summit
- WB traffic able to pass with Yield
 - Anticipate to get more difficult with traffic increasing
- Improvement
 - Eliminate WB ability to pass
 - Needs passing lane improvements to west
 - Consider WB additional lane – environmental issues



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Crash Analysis: MP 53.9 - 54.3 (Gov't Camp East to Timberline)



Years 2000 - 2008

- Total Crashes: 50
- Fatalities/Injuries: 0 / 18
- Predominant Crash Types
 1. Rear-end (15)
 2. Turning (14)
 3. Fixed object (9)
- Predominant Road Conditions:
 1. Snow/Ice (34)
 2. Dry (10)
- Directional crash notes:
 - Even directional split through segment (no pattern detected)

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Issues-Suggestions

- High crashes and high volumes
- Rest area @ Gov't Camp Loop east
- Gov't Camp Loop may meet signal warrants
- LT and RT lanes provided at both intersections
- Improvements
 - Extend Gov't Camp Loop WB RT over the crest
 - Provide WB acceleration lane from Timberline
 - Consider WB auxiliary lane between intersections



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Next Steps

- Complete draft report by July 7th
- RSA team review (two weeks)
- Submit final report by July 28th

ROAD SAFETY AUDIT Mt. Hood Highway (Hwy. 26)

**Camp Creek Campground to Timberline Road
(Mile Post 47.19 to 54.23)**

**For ODOT, Region 1
Clackamas County, Oregon**

June 19, 2009

Presented by: John R. Freeman, P.E., PTOE

Appendix "B"

Summary of Road Safety Audit (RSA) Findings

Appendix “B” – Summary of RSA Findings

The table below provides all the issues identified during the RSA. Those shown in *italic* are high and medium risk safety issues. This table is formatted to allow ODOT to provide a response to each safety issue. The first three columns of this table are consistent with the RSA Report.

Issue	Location	Suggestion	Agency Response/Comment
<u><i>Lack of In Pavement Reflectors and Delineators</i></u>	<i>Entire Corridor</i>	<ul style="list-style-type: none"> • <i>Consider installing new inlaid RPMs and delineators.</i> • <i>Consider delineator closer spacing at locations where speeds are below 55 mph.</i> 	
<u><i>Lack of Sign Consistency and Retro-reflectivity</i></u>	<i>Entire Corridor</i>	<ul style="list-style-type: none"> • <i>Consider conducting a sign study along the corridor to upgrade to current signing standards.</i> 	
Non-standard Guardrails	Entire Corridor	<ul style="list-style-type: none"> • Consider investigating the existing guardrails along the corridor to upgrade to current guardrail standards, especially the guardrail ends. 	
<u>Limited Public Outreach</u> <ul style="list-style-type: none"> • Approximately 55% of drivers involved with crashes are younger than 35 years. 	Entire Corridor	<ul style="list-style-type: none"> • Consider targeting outreach advertising the younger driver. • Focus on providing information of alternative modes of transportation (establish reliable public transit alternatives). • The US Forest Services could consider providing kiosks at their snow parks with safety related brochures. 	
<u><i>Many Speed Related Crashes in Poor Weather Conditions</i></u> <ul style="list-style-type: none"> • <i>Approximately 70% of all crashes occur in the presence of ice and snow.)</i> 	<i>Mountain Highway Corridor Section (MP 47.0 – 52.4)</i>	<ul style="list-style-type: none"> • <i>Consideration should be given to apply photo speed enforcement only when the Variable Speed Limits (VSL) is used.</i> 	
<u><i>Challenging Accessibility to Growing Surrounding Land Uses</i></u> <ul style="list-style-type: none"> • <i>This road section experienced 99 crashes in 2000-2008 of which 28 were rear-ends and 22 turning movements.</i> 	<i>Government Camp Summit Corridor Section (MP 52.4 – 54.3)</i>	<ul style="list-style-type: none"> • <i>The surroundings along this corridor section are continuing to change and consideration should be given to lower the speed to 45 mph through the Government Camp.</i> • <i>Consideration should be given to reconfigure the intersections to provide improved intersection angles and intersection spacing. Encouraging slower speeds through this section could also include cross sectional elements.</i> • <i>Consideration should be given to provide street lighting along this road section with appropriate transition areas to/from the dark approaches.</i> 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<u>Inappropriate Roadway Shoulder</u> <ul style="list-style-type: none"> The existing paved shoulder is typically 4-6 feet. Trees are very close to the travel lane. 	Two-Lane Section MP 47 – 48	<ul style="list-style-type: none"> Widen the paved shoulder to a minimum of 8 feet to meet ODOT standards. Consideration should be given to remove trees closest to the road to improve sight distance and provide reasonable roadside clearance. 	
<u>Relative Sharp Curve West of Intersection</u> <ul style="list-style-type: none"> Trees are approximately 10-12 feet from the edge of travel lane. These trees restrict the sight distance through the curve. 	Camp Creek Campground (Vicinity of MP 47)	<ul style="list-style-type: none"> Consider cutting back trees to improve visibility of the curve and ability to negotiate the curve. Consider increasing the size of the "Curve Ahead" to 60"x60" and use high intensity reflective sheeting to enhance retro-reflectivity. 	
<u>Lack of Westbound Passing Lane</u> <ul style="list-style-type: none"> The road alignment has a winding up-and-down topography that does not provide passing. 	Tree Cleared Area MP 47.6 - 48.8	<ul style="list-style-type: none"> The existing width between the cleared treelines provides the opportunity to provide a four-lane cross section. Advance signing communicating the location of the next passing lane should be provided. 	
<u>Lack of Clearly Defined Chain-on and Chain-off Areas</u> <ul style="list-style-type: none"> There are no official chain-off areas in the westbound direction, but only wide open gravel areas. The eastbound slow-moving vehicle lane is currently used as a chain-on area during winter time. 	Tree Cleared Area MP 47.6 - 48.8	<ul style="list-style-type: none"> The existing width between the cleared treelines provides the opportunity to provide a four-lane cross section plus a 16-foot (minimum) wide chain-on/chain-off area These chain-on/chain-off areas need to be clearly signed, preferably with automated signage. To further enhance motorist information regarding conditions on Mt. Hood and the need to chain-on, an overhead VMS for eastbound traffic should be considered. 	
<u>Winding Horizontal Alignment with Roller Coaster Profile</u> <ul style="list-style-type: none"> There are 6 consecutive reversing curves with one travel lane in each direction and an eastbound slow-moving vehicle/climbing lane. The existing profile has an up-and-down effect and together with the winding road places oncoming traffic directly in front of them from a driver's perspective. 	Tree Cleared Area MP 47.6 - 48.8	<ul style="list-style-type: none"> It is suggested to straighten this roadway The up-and-down topography will not be as critical since traveling traffic will continue along a straight line. There might be opportunities to fill a few feet in the sag curves without extending the fill slopes beyond the existing tree lines. 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<p><u>Westbound Crashes at Map Curve</u></p> <ul style="list-style-type: none"> • The crash history for this curve shows this location to be Top 15% SPIS. • Crash data does show 7 crossover crashes (approximately 30%) at this location. • The curve is after 1.5 miles of relatively straight road beyond the summit at Government Camp. 	<p>Map Curve (Vicinity of MP 49.7)</p>	<p>First Option</p> <ul style="list-style-type: none"> • Replace the existing "Curve Ahead" sign with a 60"x60" post mounted sign with high intensity sheeting. A 60"x60" sign should be considered for future improvement as an overhead sign with flashing beacons (bouncing ball over and under). • To improved signage at the curve, advance signage (Sharp Curve Ahead) communicating the location of the sharp curve could be placed half-a-mile in advance of Map Curve. <p>Second Option</p> <ul style="list-style-type: none"> • The rock face would be cut back approximately 30-40 feet to allow the westbound lane to be pulled to the inside of the curve. • Within the median a barrier treatment should be considered to reduce the crossover and head-on crashes. 	
<p><u>Undesirable Chain-On Area Location</u></p> <ul style="list-style-type: none"> • There is an existing chain-on area for eastbound traffic in the sharp horizontal curve at Map Curve. • There is poor sight distance for uphill traffic to see eastbound vehicles rejoining the roadway around the curve. 	<p>Map Curve (Vicinity of MP 49.7)</p>	<ul style="list-style-type: none"> • Considerations should be given to remove/close the existing chain-on area in the curve, bringing the concrete barrier to the shoulder location, and add standard curve chevron signage for downhill traffic. • Provide a new chain-up area (16-20 feet wide) to the east around the curve along the tangent section. 	
<p><u>Inadequate Westbound Passing Lane</u></p> <ul style="list-style-type: none"> • The westbound traffic has a passing lane starting in the Mirror Lake curve extending down the mountain through S-curves for approximately 3,000 feet terminating just beyond the second curve. • The crash data shows there have been ten crashes in this section with two fatalities and five crashes between eastbound and westbound vehicles. 	<p>Section Between Map Curve (MP 49.7) and Mirror Lake Curve (MP 51.7)</p>	<ul style="list-style-type: none"> • The passing lane should to be lengthened by extending the passing lane east to begin in the tangent section. The passing lane should also be extended to the west into the tangent section following the second curve. • It is also suggested that signage (e.g., "Passing Lane - XX Mile Ahead") be place at strategic locations. • To address the crash issue between eastbound and westbound vehicles, the concrete barrier suggested for the Map Curve and Mirror Lake Curve should be extended through this section. 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<p><u>Sharp Curve at Mirror Lake</u></p> <ul style="list-style-type: none"> • This curve has a higher number of crashes compared to Map Curve. • The accident reports show that there have been 7-9 crossover crashes with the one fatality in the reporting period. • The westbound passing lane is introduced in this curve and is not very visible to westbound traffic and is not signed. 	<p>Mirror Lake Curve (Vicinity Of MP 51.8)</p>	<p>Option One</p> <ul style="list-style-type: none"> • Replace the existing S-curve sign with a 60"x60" "Curve Ahead" sign and add an additional "Curve Ahead" sign for the second curve. <p>Option Two</p> <ul style="list-style-type: none"> • Consideration should be given to have the first sign mounted overhead with flashing beacons (bouncing ball). • Advance signing (Sharp Curve Ahead) communicating the location of the sharp curve could be placed half-a-mile in advance of the curve. <p>Option Three</p> <ul style="list-style-type: none"> • Consideration should be given to providing median protection through the curve area. • Suggests moving the start of the passing lane further to the east introducing it in the tangent section more visible to the driver. 	
<p><u>Undesirable Mirror Lake Hiking Trail Parking Location</u></p> <ul style="list-style-type: none"> • A high-use parking area exists on the south side of the highway on the very tight Mirror Lake Curve. • There is limited sight distance for westbound left-turn vehicles into this parking area and motorists leaving the parking area that need to turn left. 	<p>Mirror Lake Curve (Vicinity Of MP 51.8)</p>	<ul style="list-style-type: none"> • Consider moving the trailhead to the vicinity of the Ski Bowl West access and extend/connect to the existing trail (about 4000') to the new parking area. • The removal of the parking area would provide the opportunity to use the existing wide embankment near this curve to widen the shoulders and/or the introduction of a possible median. 	
<p><u>Undesirable Ski Bowl West Access Location and Configuration (MP 52.50)</u></p> <ul style="list-style-type: none"> • This intersection is approximately 1,700 feet from the Ski Bowl East Access. • It has a skewed intersection angle of less than 40 degrees. • There is no westbound left-turn lane into Ski Bowl at this location. 	<p>Ski Bowl Accesses (MP 52.4 - 53.1)</p>	<ul style="list-style-type: none"> • The Ski Bowl West Access should be realigned to the east by approximately 350 feet to the top of the crest curve. • This location would provide the optimum intersection sight distance and the opportunity to provide a standard westbound left-turn lane. • Providing a 90-degree conventional T-intersection with appropriate deceleration distance for turning movements along the highway. 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<ul style="list-style-type: none"> • <i>The intersection sight distance especially to the east is limited due to the vertical crest curve to the east.</i> • <i>There have been 9 crashes from 2000-2008 including one fatality.</i> 			
<p><u><i>Undesirable Ski Bowl East Access Location and Configuration (MP 52.85)</i></u></p> <ul style="list-style-type: none"> • <i>This intersection is approximately 1,700 feet from the Ski Bowl West Access and approximately 600 feet from the Tyrolean Drive intersection.</i> • <i>The 600-foot intersection spacing does not provide appropriate deceleration and/or storage lengths for back-to-back left-turns.</i> • <i>This intersection has a very skewed intersection angle of less than 30 degrees.</i> • <i>The Ski Bowl West Access had 33 crashes and the crash data shows this location to be Top 10% SPIS.</i> 	<p><i>Ski Bowl Accesses (MP 52.4 - 53.1)</i></p>	<p><i>Option One</i></p> <ul style="list-style-type: none"> • <i>The Ski Bowl East Access southbound movement should be signed as a right-turn only allowing no through movement to Ski Bowl, all eastbound highway left-turns should occur at this intersection (none at the Tyrolean Drive intersection), and all southbound left-turns should be signed and directed to make a left at the Tyrolean Drive intersection.</i> • <i>Another near-term solution for consideration is, the Western Government Camp Loop Road traffic should be redirected to the current 90-degree Tyrolean Drive intersection to the east, while the north leg at the Ski Bowl East intersection should be disconnected.</i> <p><i>Option Two</i></p> <ul style="list-style-type: none"> • <i>The Ski Bowl East Access should be realigned to the west and provide an intersection spacing of approximately 1,000 feet (MP 52.79) from the realigned Ski Bowl West Access and approximately 1,000 feet from the Tyrolean Drive intersection.</i> • <i>This would provide sufficient distance to develop standard back-to-back left-turn lanes between this intersection and the Tyrolean Drive intersection.</i> • <i>Providing a 90-degree conventional T-intersection with appropriate deceleration distance for turning movements along the highway would address the majority of the crashes at this intersection.</i> 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<p><u>Undesirable Tyrolean Drive Intersection Location and Configuration (MP 52.98)</u></p> <ul style="list-style-type: none"> • The intersection experienced 16 crashes. • There is no westbound left-turn lane and the eastbound left has non-standard deceleration and/or storage lengths. 	<p>Ski Bowl Accesses (MP 52.4 - 53.1)</p>	<p>Option One</p> <ul style="list-style-type: none"> • The Ski Bowl East Access southbound movement should be signed as a right-turn only allowing no through movement to Ski Bowl, all eastbound highway left-turns should occur at this intersection (none at the Tyrolean Drive intersection), and all southbound left-turns should be signed and directed to make a left at the Tyrolean Drive intersection. • Another near-term solution for consideration is, the Western Government Camp Loop Road traffic should be redirected to the current 90-degree Tyrolean Drive intersection to the east, while the north leg at the Ski Bowl East intersection should be disconnected. <p>Option Two</p> <ul style="list-style-type: none"> • The north leg should better align with the south leg and consideration should be given to provide separate turn lanes. • A westbound left-turn lane should be provided and the eastbound left-turn should be modified to provide sufficient deceleration distance. • During snowy conditions the southbound left at the 90-degree access would have limited intersection sight distance to the east due to an approximately 10-foot snow wall. It should be considered to widen the shoulder or add a westbound right-turn lane to provide proper intersection sight distance. • Providing a 90-degree conventional T-intersection with appropriate deceleration distance for turning movements along the highway would address the majority of the crashes at this intersection. 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<p><u>Limited Westbound Passing Opportunity</u></p> <ul style="list-style-type: none"> The crash history for this road section shows this location to be Top 25% SPIS. This is a three-lane cross section with one westbound and two eastbound lanes with supplemental non-standard signage. The pavement marking allow westbound traffic to pass over a section of approximately 3,000 feet. 	<p>Multorpor Bridge (Vicinity of MP 53.5)</p>	<ul style="list-style-type: none"> Suggested intersection improvements at Tyrolean Drive and the Eastern Government Camp Loop Road will shorten the existing length for passing opportunity. Consideration should be given to eliminate passing opportunity for westbound traffic. This section of Mt. Hood Highway appears to have environmental sensitive areas along both sides of the road. Therefore, providing an additional westbound lane in future will be challenging. 	
<p><u>Undesirable Intersection Configuration</u></p> <ul style="list-style-type: none"> This 90-degree intersection is approximately 1,300 feet from the Timberline Road intersection. The north leg is very wide with very short exclusive southbound left and right-turn lanes in addition to the two inbound lanes. The westbound right-turn lane from the highway is not visible for approaching motorists until breaking over the vertical curve. This intersection had 22 crashes. 	<p>Eastern Government Camp Loop Road (Vicinity Of MP 54.0)</p>	<ul style="list-style-type: none"> Consideration should be given to extend the westbound right-turn lane over the vertical crest curve so that approaching vehicles can enter the turn lane and decelerate in the turn lane. Consideration should also be given to better define the north leg of the intersection by clearly linking the intersection to the Government Camp Loop Road. Another consideration would be to realign Government Loop Road further to the west separating the gas station and rest area activities from the conventional T-intersection with Mt. Hood Highway. A new intersection location would provide better intersection sight distance, as well as turn lanes with appropriate deceleration. 	
<p><u>Poor intersection operations</u></p> <ul style="list-style-type: none"> The 2009 traffic volumes indicate that some of the signal warrants might be met at this location. 	<p>Eastern Government Camp Loop Road (Vicinity Of MP 54.0)</p>	<ul style="list-style-type: none"> There is a relative high minor street left-turn movement at this intersection that will experience long delays (waiting to find a gap) as traffic continues to grow along the highway. An intersection feasibility study should be completed to determine what traffic control device would be appropriate at this location (e.g., traffic signal or roundabout). 	

Appendix “B” – Summary of RSA Findings

Issue	Location	Suggestion	Agency Response/Comment
<p><u>Undesirable Intersection Configuration</u></p> <ul style="list-style-type: none"> • This intersection is approximately 1,300 feet from the Eastern Government Camp Loop Road intersection. • This 40-degree intersection has an eastbound left-turn, as well as a westbound right-turn along Mt. Hood Highway. • There were approximately 17 crashes at this intersection that included a wide spectrum of crash types. • The north leg is very wide at the intersection where the right-turn is significantly flared. • The combination of the horizontal and vertical curves to the east limits intersection sight distance. 	<p>Timberline Highway (Vicinity Of MP 54.3)</p>	<ul style="list-style-type: none"> • Consideration should be given to clearly define this intersection, especially slowing the southbound right-turn, because it is current used as an unofficial add lane onto the wide shoulder. <p>Options for consideration might include:</p> <ul style="list-style-type: none"> • Provide an approximately 100-foot southbound right-turn lane to avoid that the left-turn queue blocking the high volume southbound right-turn. • If the Eastern Government Camp Loop Road is moved to the west, then there might be sufficient distance to provide an acceleration lane and an appropriate taper for the southbound right-turn. 	
<p><u>Poor intersection operations</u></p> <ul style="list-style-type: none"> • The 2009 traffic volumes indicate that the side-street traffic will have challenges in future to find gaps. • There is no street lighting at this intersection. 	<p>Timberline Highway (Vicinity Of MP 54.3)</p>	<ul style="list-style-type: none"> • An intersection feasibility study should be completed to determine what traffic control device would be appropriate at this location in future (e.g., traffic signal or roundabout). • Consideration should be given to provide street lighting at this intersection and along this road section with appropriate transition areas to/from the dark approaches. 	