



OR-211 ROAD SAFETY AUDIT

Eagle Creek-Sandy Highway at Dubarko Road

Mile Point 5.20 – 5.60

Audit Date: October 13-14, 2011



Road Safety Audit (RSA)

Eagle Creek-Sandy Highway
Mile Point 5.20 – 5.60

Prepared For:

Oregon Department of Transportation (ODOT)

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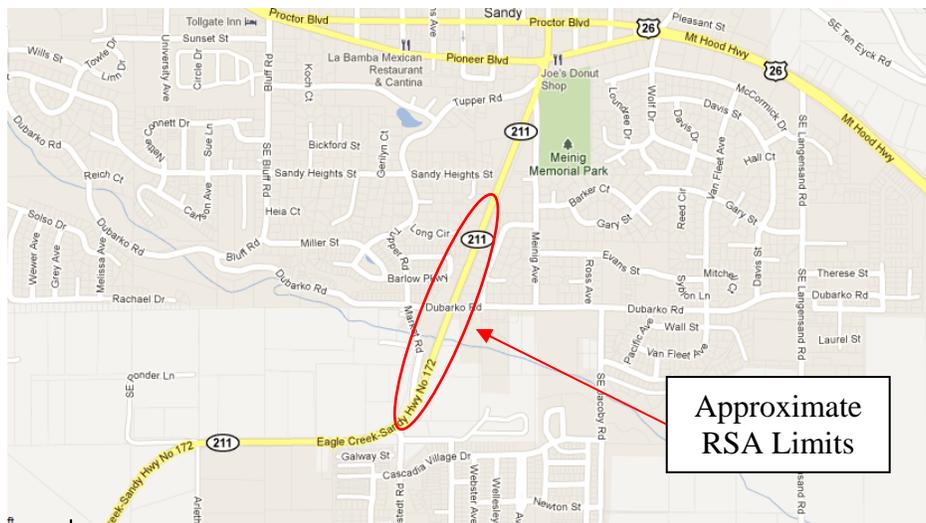
January 5, 2012

Background:

This Road Safety Audit (RSA) is for the Eagle Creek-Sandy Highway (OR-211) at the intersection of Dubarko Road in the City of Sandy. The purpose of the RSA is to conduct a safety evaluation of the roadway infrastructure, intersection, signing, pavement markings, traffic operations, and all necessary incidental items for a complete audit. The intent is to identify potential safety issues contributing to crashes and recommend a variety of treatments to address those issues.

The RSA study limits are from approximate mile points 5.20 to 5.60. This corresponds to the portion of OR-211 from SE Bornstedt Road to approximately 1000ft north of the highways intersection with Dubarko Road. Within the study area, OR-211 has a two-lane cross section (one lane in each direction) and a 2010 ADT (Average Daily Traffic) of approximately 5700 vehicles per day. The posted speed through this section of the highway is 45mph. The highway is classified as a district highway. Although the highway is not classified as a freight and truck route, approximately 10% of the traffic observed is truck traffic. OR-211 serves as a major arterial in the City of Sandy Transportation System Plan (TSP).

Dubarko Road intersects OR-211 at MP 5.39. At the intersection, each leg of Dubarko Road has a shared through/right-turn lane, and a left-turn lane. To the west of the intersection, Dubarko road is classified as a minor arterial. To the east, the road is classified as a residential minor arterial. The posted speed on Dubarko road is 25mph. Dubarko Road is stop controlled at the intersection. The morning peak hour at the intersection occurs from 7:00am to 8:00am. The evening peak hour occurs from 4:25pm to 5:25pm.



Audit Vicinity Map

The RSA Team met with the Project Owner and the Project Development Team on Thursday October 13, 2011 at ODOT Region 1 Headquarters in Portland, Oregon. The Project Owner said that the RSA study limits are listed as a top 5% high crash location in the 2011 State Safety Priority Index System (SPIS). Due to the number of crashes at the location, a Statewide Transportation Improvement Project (STIP) is in the planning stages of development. The Project Owner would like the RSA to report on potential road safety issues and identify opportunities for improvements at the intersection that can be considered for inclusion in the STIP Safety Project. The Project Development Team then introduced the STIP Safety Project.

STIP Safety Project:

- The purpose of this project is to reduce the frequency and severity of crashes.
- The safety project will widen the roadway prism and provide left turn refuges at the intersection of OR-211 and Dubarko Road.
- Trees will be cut back southeast of the intersection to improve sight distance.

- The bank northeast of the intersection will be cut back in order to increase sight distance.
- The proposed roadway section includes two 12' travel lanes, a 14' median and 6' shoulders.
- The project may impact the culvert at Tickle Creek, which may require it to be replaced with a fish passage culvert.
- Mitigation may be required for impacts to riparian area if the culvert is replaced.
- \$1.5 million in Fish Passage money is available in 2014.

RSA Process:

Following the meeting at Region 1 Headquarters, the RSA Team reconvened at Sandy City Hall where the majority of the RSA work was completed. The RSA schedule included a start-up meeting to discuss details, one day of field review (including night time), and a presentation of the RSA findings. The following members participated in the RSA:

RSA Team Members:

Mark Barrett, E.I.T. – Graduate Engineer, Region 1 ODOT
 Dan Serpico, P.E. – Senior Traffic Analyst, Region 4 ODOT
 Derryl James, P.E. – Lead Senior Roadway Designer, Region 2 ODOT
 Mark Buffington – Transportation Maintenance Manager, Region 2 ODOT
 Eric Ford – Transportation Maintenance Manager, Region 1 ODOT
 Liz Storn, E.I.T. – Engineering Technician, City of Sandy
 Sgt. Ernie Roberts – Sandy Police Department

RSA Resource Members:

Sandy Prock, P.E. – Senior Project Leader, Region 1 ODOT
 Kate Freitag, P.E. – Traffic Operations Engineer, Region 1 ODOT
 Sue D'Agnes – Traffic Manager, Region 1 ODOT

The RSA Start-Up Meeting expanded on information presented during the Kick-Off meeting. The team began a detailed review of the crash data from the years 2001 through 2010. A summary of the principle crash data is provided below.

Crash Data Summary:

- 38 Total Crashes from 2001 through 2010. (26/38 crashes occurred in 2006-2010)
 - City of Sandy noted that Dubarko Road was completed in 2007 allowing traffic to use it as an alternative to US26 West.
- Majority of the crashes (21/38) were angle crashes.
- Severity of the crashes: 1 Fatal, 2 Injury A, 12 Injury B, 10 Injury C, and 13 PDO.
- Majority of drivers live within 25 miles of the crash location
- Majority of crashes occurred in dry road conditions
- 4 crashes (10% of total crashes) were left turn crashes
- 22 crashes (58% of total crashes) were crossing type collisions
 - Majority failed to Yield Right of Way
 - Almost half involve a driver under the age of 20 years
- Police reports indicate:
 - Drivers on Dubarko Road didn't see vehicles on the highway
 - Drivers on the highway often report that the driver on Dubarko Road "just pulled out in front of me."
- Sgt. Roberts indicates that speed is a factor in many of the crashes
 - It is difficult (and sometimes unsafe) to enforce the speed limit due to the lack of a shoulder and restricted sight distances.

The crash data shows that the primary crash concern is collisions involving vehicles crossing the intersection.

Following the RSA Start-Up meeting, the RSA Team conducted several field reviews. During the field reviews, team members evaluated the existing conditions of the roadway infrastructure, as well as observed driver behavior throughout the RSA limits.

RSA Findings:

This report is organized to describe the safety issues identified by the RSA Team in order of how quickly the recommended countermeasures could be implemented. Recommendations are organized into three categories; short-term, mid-term, and long-term recommendations. The short-term recommendations are to be considered as maintenance projects. The mid-term recommendations are to be considered for implementation as the planned STIP Safety Project. The long-term recommendations should be considered for implementation in the future as this portion of Sandy develops.

SHORT-TERM RECOMMENDATIONS (Maintenance Projects)

ISSUE: Vehicles Exceeding the Speed Limit

Description of Safety Issue:

During the RSA Start-Up meeting, crash data and information from Sgt. Roberts revealed speed is often a factor in crashes at the location. During the field reviews, vehicles speeds were consistently observed 5mph to 10mph above the posted speed of 45mph. Coupled with the restricted sight distances and the skew angle of the intersection, vehicle speeds can contribute to crossing crashes when motorists misjudge gaps in fast moving traffic, and fail to yield right-of-way.

Safety Risk:

Exposure: Medium
Probability: High
Consequence: High
Resulting Road Safety Risk: High

Suggestion:

The treatments listed below were identified as potential measures for reducing speed along the audit section. Each of the suggested treatments above can be used in combination with each other. Utilizing a combination of these treatments may increase the effectiveness in reducing vehicle speed on the highway. The RSA Team recommends consideration of the following:

- **Consider Increased Education:** Public Service Announcements and drivers education for students. Education in high schools would target the drivers under the age of 20.
- **Consider Increased Enforcement:** Grants may be available to increase enforcement and allow overtime hours.
- **Consider Installing Driver Speed Feedback Signs:** These signs could be installed as a means of emphasizing the need to reduce vehicle speeds to the posted speed limits. The feedback sign would be installed in conjunction with the speed limit sign, and would display a vehicles speed to the driver.
- **Consider Installing Speed Reduction Markings:** striping to decrease speeds by giving the impression that speed is increasing.



SHORT-TERM RECOMMENDATIONS (Maintenance Projects)

ISSUE: Inconsistent Striping

Description of Safety Issue:

In general, the RSA Team found the existing striping to be effective and in good condition. However, the RSA Team did identify some minor issues regarding the striping near the intersection.

- **Bike Lane Striping:** The existing bike lane adjacent to the southbound right turn lane on OR-211 does not have a bike lane leading into it and terminates on the south side of the intersection, leading bicyclists directly into the guardrail in the SE Quadrant of the intersection. This forces bicyclists to enter the travel lane at a high rate of speed due to the roadway grade, and when drivers may not be expecting them to do so.
- **Legends on One Leg of Dubarko Road and Not the Other:** The number and location of lane legends on the west leg of Dubarko Road are not consistent with the east leg of Dubarko Road. This striping may contribute to confusion for drivers navigating the intersection.



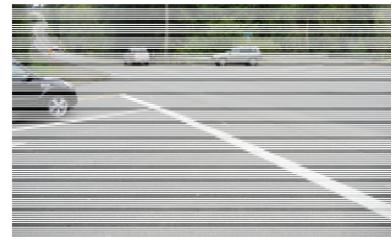
Bike Lane Leading into Guardrail



East Leg

West Leg

- **Stop Bar Location:** During field observations, the RSA Team observed several vehicles cutting into the left turn lane on Dubarko Road when making a left off of the highway. This is likely a result of the skew angle of the intersection. The RSA Team also observed that when a vehicle occupies each lane, the stop bar places the vehicles in a location that blocks the other vehicles sight distance.



Stop Bars on east leg of Dubarko Rd.

Safety Risk:

Exposure: Low
Probability: Medium
Consequence: Low
Resulting Road Safety Risk: Medium

Suggestion:

The RSA Team recommends the following improvements be considered at the intersection:

- **Consider Modification of the bike lane in the NW Quadrant:** Striping the bike lane as a buffered bike lane would still allow bicyclists to use the area, but will also indicate that they should expect a change in the roadway ahead. This will also preserve the existing width of the right turn lane, and reserve the width to incorporate a bicycle lane in the future.
- **Consider Adding Legends to Dubarko Road (west leg):** Adding legends to the west leg of Dubarko Road may help avoid confusion by making it clear where the lanes are intended to go. It will also bring a uniform appearance to the intersection that aids in driver understanding.



Buffered Bike Lane Example

- **Consider Staggering Stop Bars:** Stop bars could be adjusted to better accommodate the turning pattern of vehicles turning left from the highway onto Dubarko Road. Staggering the stop bars may help drivers stop in a location that will not block the sight distance for a driver stopped in the adjacent lane waiting for a gap.

SHORT-TERM RECOMMENDATIONS
(Maintenance Projects)

ISSUE: Missing and Non-Standard Signing

Description of Safety Issue:

The RSA Team identified the following missing and/or non-standard signing:

- **Directional Arrow Auxiliary Signs (M6-4):** The existing directional sign at the intersection are yellow with a black arrow. The current standard directional sign is white with a black arrow.
- **Advanced Intersection Warning Signs:**
 - Missing advanced intersection warning sign and street name rider for northbound traffic.
 - Missing street name rider on the existing warning sign for southbound traffic.



Directional Arrow Auxiliary Sign

Safety Risk:

Exposure: Medium
Probability: Medium
Consequence: Low
Resulting Road Safety Risk: Low



Existing Southbound Intersection Warning Sign



Missing Northbound Intersection Warning Sign

Suggestion:

The proposed signing improvements are intended to help alert drivers on the highway that they are approaching a major intersection with Dubarko Road. Providing these feature will warn drivers of potential conflicts, and may help reduce vehicle speeds.

- **Consider Installing a New Directional Arrow Auxiliary Signs (M6-4):** The RSA Team recommends replacing the existing yellow-black direction arrow sign with the standard white-black sign.
- **Consider Installing Advanced Intersection Warning Signs:**
 - Advanced intersection warning sign and street name rider for northbound traffic.
 - Street name rider on the existing advanced intersection warning sign for southbound traffic.

MID-TERM RECOMMENDATIONS
(STIP Safety Project)

ISSUE: Skew Angle of the Intersection and Sight Distance Obstructions

Description of Safety Issue:

Dubarko Road intersects OR-211 at an angle of approximately 70 degrees. This creates a skew angle of approximately 20 degrees from perpendicular. The skew angle of the intersection and the embankment in the NE Quadrant of the intersection contribute to a limited sight distance at the intersection.

Drivers approaching the intersection on Dubarko Road “bob” their torso forward and back to check for oncoming vehicles on the highway. Drivers in the NE Quadrant were observed leaning forward and back to see past the bank and check for southbound vehicles approaching on the highway. Drivers in the SW Quadrant were often seen craning their neck to the right to check for northbound vehicles on the highway. Additionally, once a driver from the west leg of Dubarko Road commits to a through or left turn movement they almost immediately lose the ability to see the south leg of the intersection.

Safety Risk:

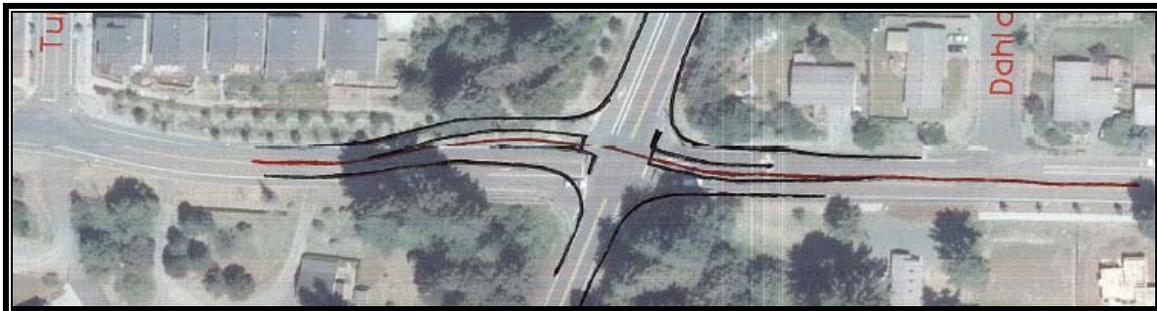
Exposure: High
Probability: High
Consequence: High
Resulting Road Safety Risk: High



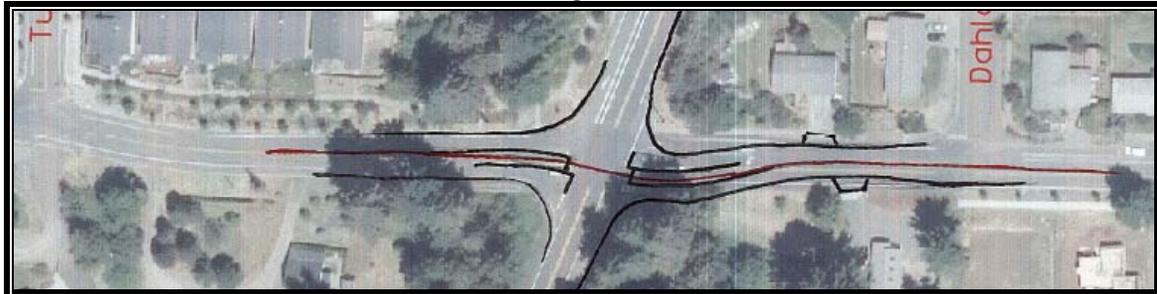
Embankment in NE Quadrant of Intersection

Suggestion:

- **Consider Cutting Back the Embankment in the NE Quadrant:** Cutting back this embankment would improve the available sight distances for drivers, and improve their ability to judge gaps in traffic before entering or crossing the highway.
- **Consider Realignment of Dubarko Road:** The RSA Team sketched two conceptual ideas (shown below) for realignment of Dubarko Road that would reduce the skew angle of the intersection. Realigning the intersection to intersect closer to a perpendicular angle can maximize the available sight distance, improve safety, increase efficiency, and improve the operation and safety for bicycle and pedestrian movements.



Intersection Realignment to the North



Intersection Realignment to the South

MID-TERM RECOMMENDATIONS
(STIP Safety Project)

ISSUE: Narrow Highway Cross Section

Description of Safety Issue:

The RSA Team identified several safety issues related to the cross section of the highway.



Existing Roadway Cross Section

- Lane width of 10.5' that does not appear to have any traffic calming effects
- Non-recoverable slopes, not protected by guardrail
- Lack of standard shoulder
- Sidewalk only exists in NW Quadrant adjacent to the southbound right turn lane
- Some sections have a pavement edge that drops off (mainly near the intersection)



Pavement Edge

Drivers were observed shifting toward the centerline as they shy away from the steep non-recoverable slopes. In addition, they are forced to shift toward the slope as oncoming vehicles approach. This is especially true when they are meeting a large vehicle on the roadway. Additionally, vehicles turning onto and off of the highway were seen off-tracking into adjacent lanes in order to complete the maneuver. This is exacerbated by the skew angle of the intersection.

The lack of a shoulder forces bicyclists and pedestrians who choose to travel the highway to walk or bike in a travel lane or on a steep and unstable slope. Many of the observed pedestrians were seen walking in the roadway or the ditch, some even chose to walk with their back to traffic. Interviewed pedestrians expressed a desire for pedestrian facilities (a sidewalk or shoulder). Drivers were often seen crossing over the centerline to give space to bicyclists and pedestrians.

Safety Risk:

Exposure: High
Probability: Medium
Consequence: High
Resulting Road Safety Risk: High



Pedestrian and Bicycle Use along OR-211

Suggestion:

- **Consider Widening OR-211 to Obtain Shoulders:** Shoulders from US26 to SE Bornstedt Road would help accommodate observed bicycle and pedestrian use. Providing a shoulder enhances the safety of bicyclists and pedestrians. A shoulder provides a space for disabled vehicles or law enforcement to park off of the roadway, increases sight distance, and provides a recovery space for crash-avoidance maneuvers and driver error.
- **Consider Widening Travel Lanes to Full Standard:** Widening travel lanes increases sight distances. Several vehicles were observed crossing over the centerline when making right-turns, and when passing bicyclist/pedestrians. Wider travel lanes would reduce the occurrence of off-tracking into opposing lanes.
- **Careful Consideration of Left-Turn Lanes:** The RSA Team understands that the current STIP Project proposes to construct left-turn lanes. Careful consideration of left-turn lanes is suggested as the construction of left-turn lanes may not improve safety at the intersection and may not be warranted at this time. The detailed crash analysis revealed very few left-turn crashes and a predominant crash type of crossing crashes. Left-turn lanes will increase the crossing distance and potentially increase speeds on the highway.

MID-TERM RECOMMENDATIONS
(STIP Safety Project)

ISSUE: Intersection Visibility

Description of Safety Issue:

The intersection of OR-211 and Dubarko Road is located in a suburban area. However, the roadside characteristics lend to a more rural feeling roadway. This is one of the first major intersections northbound motorists encounter as they enter the City of Sandy. In addition, as southbound vehicles leave the City of Sandy, the roadway quickly transitions out of the urban downtown setting. As a result of these settings and the highway's profile, the intersection blends into the roadside environment. Spacing in the roadside delineators is inconsistent as several delineators are missing and have not been replaced. In dark conditions, the highway has approximately 500ft of existing illumination north of the intersection provided by the luminaries adjacent to the southbound right turn lane. South of the intersection there is no illumination. Near the intersection, the highway transitions from illuminated to dark very quickly as shown in the images below.



Existing Illumination north of Intersection



No Illumination south of Intersection

Safety Risk:

Exposure: Medium
Probability: Medium
Consequence: Medium
Resulting Road Safety Risk: Medium

Suggestion:

- **Consider Installing Illumination:** Additional illumination in the SE Quadrant of the intersection could help to better define the intersection at night. Additional illumination would produce a more urban feeling roadway, as well as enhance the safety of bicyclists and pedestrians traveling along the highway.
- **Consider Installing Delineators:**
 - Mainline and radius delineators: As the intersection approaches, spacing could be decreased between the delineators to better delineate the intersection.
 - Install guardrail delineators to further delineate the intersection.
- **Consider Installing Warning Beacons:** Warning beacons could be installed on the advanced intersection warning signs to help alert motorist of the upcoming intersection.
- **Consider Installing a Dynamic Advanced Warning Sign system:** This system would install flashing beacons on the advanced intersection warning signs. The flashing beacons would be activated by detection on Dubarko Road. This system would help alert motorists on the highway of the potentially conflicting cross traffic ahead, only when vehicles are present on Dubarko Road at the intersection.

MID-TERM RECOMMENDATIONS
(STIP Safety Project)

ISSUE: Lack of Enforcement Abilities

Description of Safety Issue:

Vehicle speeds were commonly observed in excess of 55mph (posted speed is 45mph); even with the presence of several people wearing orange vests standing near the intersection. High speeds make it difficult for the drivers on Dubarko Road to judge gaps before navigating their way through the intersection. Vehicles traveling at a high speed are less likely to be able to avoid a collision. Additionally, crashes involving higher speeds often result in more severe injuries.

Sgt. Roberts expressed that the police department is aware of the speeding issue but they find it difficult to enforce. Enforcement is difficult due to the narrow lanes on the highway, lack of a shoulder, steep slopes, and sight distance restrictions at the intersection. There is only one location that an officer can utilize to check vehicle speeds. From this location an officer is only able to see vehicles on the north leg of the intersection. If an officer does stop a vehicle for violating the speed limit, finding a location to stop the vehicle is difficult due to the lack of a shoulder to pull off of the roadway.

Safety Risk:

Exposure: Medium
Probability: Medium
Consequence: Medium
Resulting Road Safety Risk: Medium

Suggestion:

- **Consider Providing Enforcement Pads:** The RSA Team recommends considering enforcement pads if the STIP Safety Project does not construct shoulders. The enforcement pads are intended to improve safety for enforcement activities.

LONG-TERM RECOMMENDATIONS (Future Project)

ISSUE: Increasing Demand and Future Land Development

Description of Safety Issue:

As development in this area of the City of Sandy occurs, demand on OR-211 and Dubarko Road will increase for all modes of transportation including automobile, pedestrian, and bicyclists. These increases will place a higher demand on efficient operation of the intersection, as well as the multi-modal network. Field observation indicates that there is established pedestrian use along the highway even with the lack of existing pedestrian amenities. While the crash data provided to the RSA Team did not reveal any pedestrian or bicycle related crashes, the RSA Team believes future development will increase the number of bicyclists and pedestrians traveling along the highway which will increase the potential to increase crashes; further necessitating facilities that enhance the safety of bicyclists and pedestrians.

Safety Risk:

Exposure: Medium
Probability: Medium
Consequence: High
Resulting Road Safety Risk: Medium

Suggestion:

- **Consider Installation of Sidewalks:** The RSA Team recommends that ODOT work with the City of Sandy and conduct a corridor evaluation for the installation of sidewalks. The evaluation should consider current pedestrian usage, expected pedestrian volumes in the future, destinations of pedestrians, alternative routes, and constructability of the sidewalks. The results of the corridor evaluation should be used to establish the limits of sidewalk construction along OR-211.
- **Consider a Signal Warrant Analysis and Traffic Impact Study (TIS):** The RSA Team recommends a study be conducted (in the future) to determine the configuration of the intersection and improvements that may be warranted for the intersection. The analysis should include features such as channelization, turn lanes, a traffic signal, roundabout, and/or other approved alternatives.

Appendix “A”

Road Safety Audit Findings Presentation



ROAD SAFETY AUDIT Eagle Creek- Sandy Hwy. (OR211)

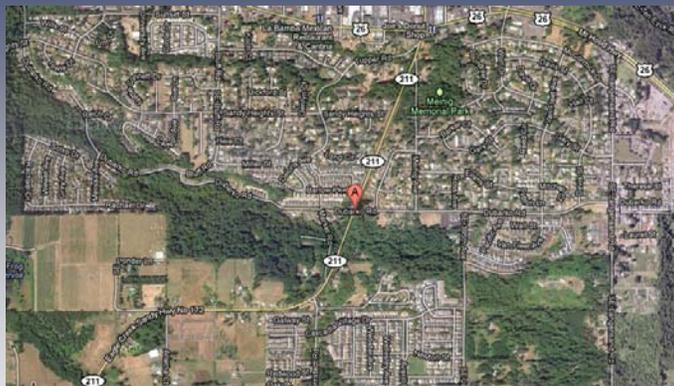
RSA FINDINGS PRESENTATION

Dubarko Road
Mile Point 5.20 to 5.60

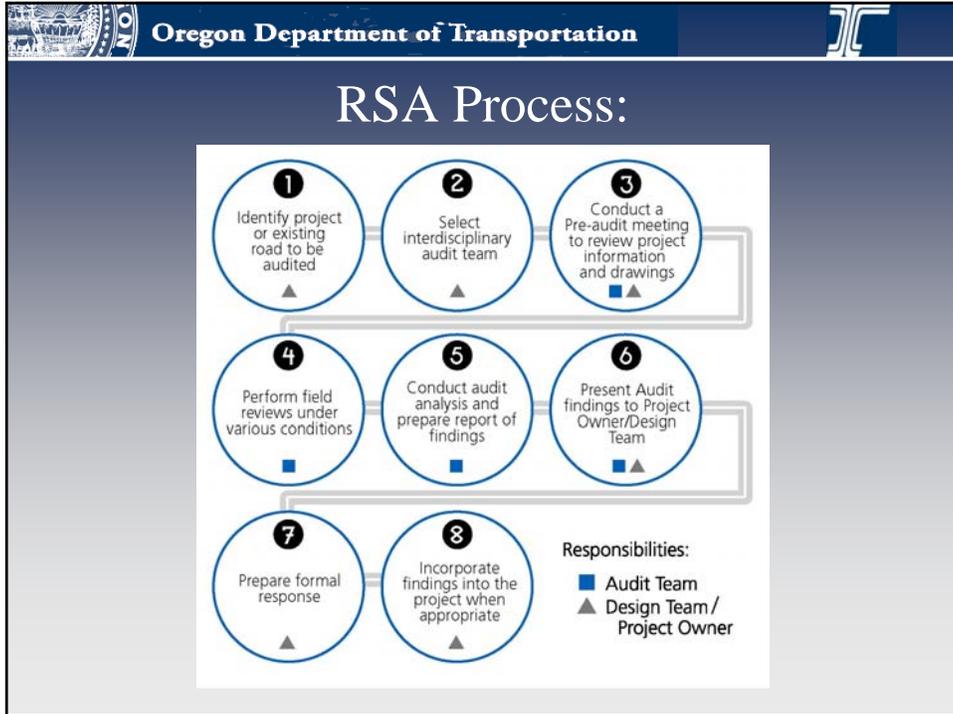
ODOT Region 1
October 13th and 14th, 2011



Eagle Creek-Sandy Highway at Dubarko Rd. OR211 - MP 5.2 to MP 5.6



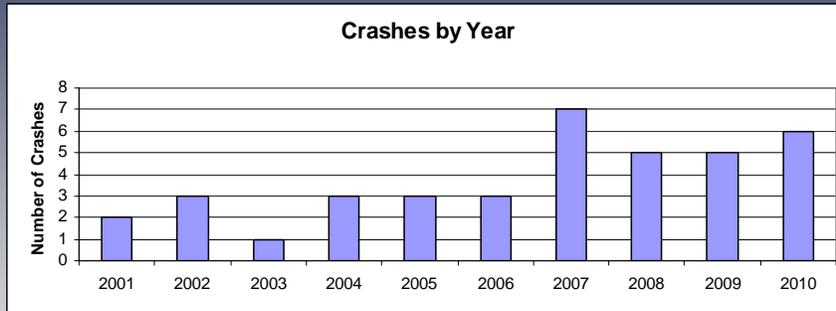
- The general objective is for the audit team, as selected by ODOT, to execute a Road Safety Audit.
- Elements of the audit shall include safety of roadway infrastructure, intersections, signing, pavement markings, traffic operations, and all necessary incidental items for a complete audit.



- Oregon Department of Transportation**
- ## RSA Team Members
- Dan Serpico – Region 4 Traffic
 - Derryl James – Region 2 Roadway
 - Mark Buffington – Dist. 2A Clatskanie
 - Eric Ford – Dist. 2C Sandy
 - Liz Storn – City of Sandy
 - Sgt. Ernie Roberts – Sandy Police Department
- ## Team Resources
- Sue D’Agnese – Region 1 Traffic Manager
 - Kate Freitag – Region 1 Traffic
 - Sandy Prock – Region 1 Project Leader



Crash Data:



- **38 Total Crashes from 2001 through 2010**
 - **22/38 crossing OR211**
 - **21/22 Failed to Yield Right of Way**
- **Only 4/38 involve left turn movements (No Fatal, No Injury A) Only 2/4 involve mainline left turners.**



Details of the 22 Crossing Crashes:

- 5/22 Dubarko (W-E) Striking OR-211 (S-N)
- 5/5 Ran into the OR-211 (S-N) Vehicle
- 9/22 drivers were less than 20 years old
- Majority of drivers were residents within 25 miles of the crash
- 1 Fatal, 2 Injury A Crashes
- 6/22 Occurred in dark conditions
- Majority of crashes occurred in dry road conditions.



Details of the 22 Crossing Crashes:

- DMV Crash Reports typically indicate
 - Dubarko drivers didn't see the mainline vehicle.
 - OR-211 drivers report the side-street vehicles "just pulled out in front of me."
- Only 1 cited driver for alcohol involved



Details of Fatal and Injury A Crashes:

- Fatal – OR-211 (N-S) crash into Dubarko (E-W) and included and Injury A
- Injury A – OR-211 (N-S) crash into Dubarko (E-W). Driver under the age of 20. Motorcycle.
- Injury A – OR-211 (S-N) crash into Dubarko (W-E)



- Photo of Crossing Vehicle



Existing Conditions:

- Good Striping
- Good Pavement
- Centerline Recessed Pavement Markers
- Illumination for SW Quadrant of intersection



- Side street has bike lanes, sidewalks, striping, legends, signage for the highway
- Good Drainage



Existing Conditions:

- Drivers seem to navigate the intersection well.
 - Vehicles stop at stop signs.
 - Vehicles turning left off highway reduce their speed. Following vehicles reduce their speed as well.



RSA FINDINGS:

Pedestrian Use:

- During site visits we observed crossing pedestrians and pedestrians walking along the highway (in roadway or ditch)





RSA FINDINGS:

- Interviews with user group expressed alternate routes had sidewalks but were out of direction and grades too difficult to navigate.
- OR 211 is signed for peds to use path in park heading south



RSA FINDINGS:

Bicycle use:

- Observed bicyclist traveling in wrong direction in the travel lane, no shoulder to use





RSA FINDINGS:

- Speed – drivers seem to be exceeding the posted speed.
- No Advanced Intersection Ahead sign for northbound
- No Street Name Rider for southbound
- Intersection street name signs may be sub-standard and difficult to see.
- Lack of radius delineators



RSA FINDINGS:



- OR-211 Signs have yellow-black arrow. Is this the best sign to use?
- Bike Lane starts at beginning of southbound right turn decel lane. Ends into guardrail at intersection



RSA FINDINGS:

- Side street (west) has different legend places than eastbound and east side does not have staggered stop bar



RSA FINDINGS:

- Pavement edge – some sections have a drop off





RSA FINDINGS:

- Slopes – Non-recoverable
- Shoulders – lacking
 - Lack of shoulders reduces enforcement abilities
- Lane Width - consistently narrow - measured at 10'4" at some places.



RSA FINDINGS:

- Sight Distance
 - Bank in the NE quadrant needs to be cut back to obtain better sight distance. Bank decreases sight distance and make drivers pull forward beyond the stop bar.
 - Trees in the SW quadrant could be trimmed to open up better sight distance





RSA FINDINGS:

- Skew Angle
 - Dubarko Road intersects OR-211 at an angle that makes some turn maneuvers difficult due to sight distances and vehicle tracking
 - Observed drivers bobbing their torso to extend their view
 - Observed left turning vehicles off the highway off tracking into oncoming lanes
 - Observed right turning vehicles crossing the centerline (before and after their turn)



Observed Drivers Video





Video of Right Turn Vehicle Off-tracking



Short Term Recommendations:

- **REDUCE SPEED:**
 - Driver Feedback Signs with “Your Speed Is”
 - Speed Reduction Markings
 - Increase Enforcement – possible Grant for OT
 - Education – PSA announcements, speed kills, drivers education for students





Short Term Recommendations:

- **STRIPING IMPROVEMENTS:**
 - Modify bike lane and create traversable median with striping
 - Add legends to west Dubarko Rd.
 - Redesign Stop Bar Placement

- **SIGNING IMPROVEMENTS**
 - Add advanced intersection sign for northbound with street rider
 - Add flasher to advanced intersection ahead signs
 - Add street rider to southbound intersection warning sign
 - Adding radius and mainline delineators
 - Decrease spacing as you approach intersection
 - Install guardrail delineators



Mid-Term Recommendations:

- **Cut Bank in NE quadrant to improve sight distance**
- **Realign Dubarko Road**
 - To improve skew angle, lane alignment and sight distance
- **Install luminaries in SE quadrant**
- **Widen lane widths to 12' Standard**
- **Construct paved shoulders to 6' Standard**
 - Increased roadway cross section would enable for other safety improvement implementation
- **Dynamic Advanced Warning System**
 - Flashing beacon on intersection ahead sign activated by side street detection
- **Provide enforcement pads**



Long Term Recommendations:

- Corridor evaluation for the installation of sidewalks
- Intersection Improvement Analysis
 - Channelization, signal, round-a-bout, etc

Current STIP Safety Project

- Installation of left turn lane may not be warranted today and may not improve safety for the crash type and severity occurring at intersection.
- Detailed Crash analysis showed crossing crashes being the most common and there were few left turn / mainline crashes.
- Installation of a left turn lane increases the crossing distance and may make that movement more hazardous.
- Installation of a left turn refuge may increase speeds on the highway.



Recommended Tasks:

- Speed Zone Study from Bornstedt Road to Highway 26.
- Measure Intersection Sight Distance for left turn, right turn, and crossing maneuver.
 - Determine what improvements are required
- Research recent pedestrian severe injury crash.
- Expand crash data for corridor study to determine limits of shoulder widening and pedestrian improvements.

Appendix “B”

Summary of Road Safety Audit Findings

SHORT TERM RECOMMENDATIONS

Issue	Suggestion	Agency Response/Comment
<p><u>Vehicles Exceeding the Speed Limit</u></p> <ul style="list-style-type: none"> • Speed is often identified as a factor in crashes. • Speeds consistently seen above posted speed limit. • Law enforcement finds it difficult to enforce speed limit. 	<ul style="list-style-type: none"> • <i>Consider Increased Education:</i> PSA announcements, and driver's education targeting drivers under the age of 20. • <i>Consider Increased Enforcement:</i> City of Sandy should look into available grants to increase enforcement. • <i>Consider Installing Driver Feedback Signs:</i> Emphasize the need to slow down. • <i>Consider Speed Reduction Markings:</i> Striping to decrease speeds by giving the impression speed is increasing. 	
<p><u>Inconsistent Striping</u></p> <ul style="list-style-type: none"> • Southbound bike lane in NW Quadrant has no bike lane leading into it, and sends bikers directly into the guardrail in the SW Quadrant of the intersection. • The west leg of Dubarko Road has different lane legends than the east leg of Dubarko Road. • Stop bars on east leg of Dubarko Road are not staggered. 	<ul style="list-style-type: none"> • <i>Consider Modification of the bike lane:</i> Stripe the bike lane as a buffered bike lane. • <i>Consider Adding Legends to Dubarko Road:</i> Add legends on the east leg of Dubarko Road to match the legends on the west leg. • <i>Consider Staggering Stop Bars:</i> Stagger the stop bars on Dubarko Road to enhance sight distances. 	
<p><u>Missing and Non-Standard Signing</u></p> <ul style="list-style-type: none"> • Non-Standard (yellow-black) directional arrow auxiliary signs posted at the intersection. • No advanced intersection ahead warning signs for northbound traffic. • No street name riders on intersection warning signs. 	<ul style="list-style-type: none"> • <i>Consider Replacing Directional Arrow Auxiliary Signs:</i> Replace with the current white-black standard sign (M6-4). • <i>Consider Installing Advanced Intersection Ahead Warning Sign:</i> sign should be installed for northbound traffic. • <i>Consider Installing Street Name Riders:</i> riders should be installed on northbound and southbound intersection ahead warning signs. 	

MID TERM RECOMMENDATIONS

Issue	Suggestion	Agency Response/Comment
<p><u>Skew Angle and Sight Distance Obstructions</u></p> <ul style="list-style-type: none"> • Skew Angle of approximately 20 degrees from perpendicular. • Embankment in the NE Quadrant obstructing sight distance. 	<ul style="list-style-type: none"> • <i>Consider Cutting Back Embankment:</i> Cutting back the embankment in the NE Quadrant will enhance the sight distance for westbound vehicles on the east leg of Dubarko Road. • <i>Consider Realignment of Dubarko Road:</i> Realign Dubarko Road to intersect closer to a perpendicular angle. This angle can maximize available sight distance, improve safety, increase efficiency, and improve the operation and safety for bicycle and pedestrian movements. 	
<p><u>Narrow Highway Cross Section</u></p> <ul style="list-style-type: none"> • Lane width of 10.5' that does not appear to have any traffic calming effects. • Non-recoverable slopes that are not protected by guardrail. • No existing shoulder. • Sidewalk only in the NW Quadrant. • Pavement edge drop off in some locations. 	<ul style="list-style-type: none"> • <i>Consider Widening OR-211 to Obtain Shoulders:</i> This would provide a safe location for bicyclists and pedestrians to travel. Vehicles would not have to cross the centerline to maneuver around bikes/peds. • <i>Consider Widening Travel Lanes:</i> widening would enhance sight distances, and accommodate vehicles turning patterns to reduce occurrence of crossing over centerline. • <i>Careful Consideration of Left-Turn Lanes:</i> Left-turn lanes may not improve safety at the intersection. 	
<p><u>Intersection Visibility</u></p> <ul style="list-style-type: none"> • Roadway is only illuminated to the north of the intersection. • First major intersection the highway encounters as it approaches the City of Sandy. • Missing roadside delineators 	<ul style="list-style-type: none"> • <i>Consider Installing Illumination in SE Quadrant:</i> Additional Illumination will better define the location of the intersection in dark conditions. • <i>Consider Installing Delineators:</i> Mainline and radius delineators to delineate the intersection. Additional guardrail delineators to further delineate the intersection. • <i>Consider Installing Warning Beacons:</i> Warning beacons installed on the advanced intersection warning signs. • <i>Consider Installing Dynamic Advanced Warning Sign System:</i> System to alert motorist on the highway of potential cross traffic ahead, only when vehicles are at the intersection. 	
<p><u>Lack of Enforcement Abilities</u></p> <ul style="list-style-type: none"> • Vehicles speed consistently above speed limit. • Enforcement does not have a good location to enforce the speed limit. 	<ul style="list-style-type: none"> • <i>Provide Enforcement Pads:</i> If shoulders are not constructed, consider construction of enforcement pads to improve safety for enforcement activities. 	

LONG TERM RECOMMENDATIONS	Issue	Suggestion	Agency Response/Comment
	<p><u>Increasing Demand and Future Land Development:</u></p> <ul style="list-style-type: none"> • Future development of the area will likely increase demand on OR-211, Dubarko Road, and the intersection. • Demand is likely to increase for all modes of transportation including automotive, pedestrian, and bicyclists. 	<ul style="list-style-type: none"> • <i>Consider Installation of Sidewalks:</i> The evaluation should consider current pedestrian usage, expected pedestrian volumes in the future, destinations, alternative routes, and constructability of the sidewalks. It should also establish the limits of sidewalk construction. • <i>Consider Signal Warrant Analysis and TIS:</i> A study should be conducted to determine the future needs of the intersection. Future improvements that should be evaluated include channelization, traffic signal, round-a-bout, and other approved alternatives that are consistent with the transportation system plan. 	