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**TO: Stephanie Popp, Project Leader
Region 4 Construction**

**FROM: Peter L. Schuytema, P.E., Sr. Transportation Analyst
Transportation Planning Analysis Unit**

**SUBJECT: Grandview – Nels Anderson Traffic Analysis Technical Memo
The Dalles-California Highway No. 4
MP 133.71 to MP 134.75**

As requested, I have completed the traffic analysis for the Grandview – Nels Anderson Project. The project’s purpose is to improve safety by reducing the number of approaches along US97 from Grandview Drive to Nels Anderson Road via the use of medians and frontage roads. The purpose of this technical memo is to show the result of the traffic analysis for the project. Alternative 1, the right-in/right-out (RIRO) frontage road connection to US97, is the recommended alternative and was selected as the preferred alternative by the project development team.

The north part of Bend is experiencing pressure from new development along US97. US97 in the project location is a five-lane expressway and a major freight route in central Oregon. There are currently signals at Robal Road and Cooley Road and several driveway approaches to US97 in the project area. There have been numerous crashes at the intersections and driveways.

The purpose of this project is to increase safety on this section of US97. It will not address any current or future capacity problems. The major intersections on the project currently exceed operational standards and any new development will cause a negative impact. The project is a short-term safety enhancement, so the analysis is limited to the year 2001 with and without additional development added to vacant lots east of US97.

Traffic Volume Background

The no-build traffic analysis is based on 2001 intersection counts and 1999 driveway counts. All counts were seasonally adjusted to the peak month (August). Most of the 1999 counts were not

grown to 2001 because they are at businesses that have a high amount of primary trips (destination rather than impulse) that do not increase much with increasing through traffic. The final volumes north of Grandview Drive are consistent with the 30th highest hour volumes at the South Redmond Automatic Traffic Recorder #09-020 accounting for the volumes at the Deschutes Market Road interchange (See Figures 1a and 1b).

Alternative Development

All alternatives assumed that the following:

- The US97/ Grandview Drive intersection becomes a right-in/right-out/left-in intersection.
- A connecting roadway between Hunnell Road and Clausen Drive would be added to allow traffic to make the east bound to northbound left turn via Cooley Road from the Grandview Drive area.
- Clausen Drive, Lucky's Tavern, Tired Iron Auto Recycle, and the Bend Center driveways on the west side of US97 become RIRO's because of the added median.
- A frontage road is added from the Robal Road/ Nels Anderson Road intersection north through the properties east of US97, so all direct accesses are removed from the east side of US97 between Robal Road and Cooley Road.
- The intersections of Cooley Road, Robal Road, and Nels Anderson Place with US97 remain the same.

The addition of a median on US97 will improve safety at each of the remaining approaches to US97. Eliminating the left turn the minor street, i.e. Grandview Drive, will reduce the number of conflict points from nine to five. Intersection conversion to a RIRO, i.e. Clausen Drive, will further reduce the number of conflict points to just two. The eastside frontage road has the effect of lowering the total amount of conflict points from 27 to 2 at the connection to US97.

Four build alternatives were developed based on the number and location of the right-in/right-out (RIRO) connections to the frontage road from US97 or Cooley Road:

- Alternative 1, with the US97/ Frontage Road RIRO; See Figures 2a – 2d.
- Alternative 2, without the US97/ Frontage Road RIRO, See Figures 3a - 3d.
- Alternative 3, with both the US97/ Frontage Road and Cooley Road RIRO's; See Figures 4a – 4d.
- Alternative 4, without the US97/ Frontage Road RIRO, but with the Cooley Road RIRO; See Figures 5a – 5d.

Additional development was added to the vacant lots east of US97 and north of Robal Road to further refine left turn lane storage requirements, frontage road spacing, and to determine the individual alternative performance in a developed scenario. The developed scenario used average ITE trip generation rates, a 25% lot-to-floor- area ratio, and adjacent commercial uses to determine a reasonable build-out of the vacant parcels allowed by current zoning. The land uses included:

- Big-box home improvement store (i.e. Lowe's)
- Gas station including car wash and convenience store
- Two fast-food restaurants with drive-through
- Drive-through bank

The trip generation resulted in an additional 900 peak hour trips to/from the “development.” Only about 250 new trips were added to US97, US20, Bend Parkway, Third Street, and Cooley Road. The remaining 650 are pass-by or diverted trips, which show up as turning movements onto Cooley Road, the frontage road system, and Robal Road depending on the alternative.

Table 1 shows the volume-to-capacity ratios for the alternatives with and without additional development trips on the east side of US97. The 1999 Oregon Highway Plan (OHP) v/c standard is 0.70 for a statewide expressway. The v/c standard will increase to 0.80 once Bend is officially designated Metropolitan Planning Organization status.

Table 1. Alternative Volume-to-Capacity Ratios

Intersection	Existing 2001 volumes					2001 Volumes with development			
	No-build	Alt. 1	Alt. 2	Alt.3	Alt.4	Alt. 1	Alt.2	Alt. 3	Alt.4
US97/Cooley	0.84	0.88	0.88	0.89	0.90	0.91	0.92	1.00	1.00
US97/Robal	0.80	0.84	0.84	0.83	0.82	1.16	1.20	1.06	1.08
Robal/ Nels Anderson		0.19	0.20	0.18	0.18	0.52	0.70	0.43	0.57

US97 & Robal Road

Table 1 shows the current v/c ratio of the US97/Robal Road intersection is 0.80 which exceeds the 0.70 OHP v/c standard. All of the alternatives increase the v/c because of the consolidation of access points. There is no difference between Alternatives 1 or 2 with current volumes, but when the adjacent lands are developed the v/c of Alternative 1 with the US97 access will be lower than Alternative 2. The v/c ratio at Robal Road drops further if the Cooley RIRO is added in Alternatives 3 and 4, at the expense of increasing the US97/Cooley Road v/c.

The right-in/right-out access on US97 to the frontage road is a benefit to the Robal Road intersection. The US97 RIRO access shortens the westbound queues on Robal Road and minimizes impacts to the current intersection v/c ratio. The RIRO access to US97 limits the westbound queue on Robal Road to 200’, which fits between US97 and Nels Anderson Road. Without the RIRO access, the queue grows to over 800’ which blocks the Nels Anderson Road intersection forming long queues on northbound Nels Anderson Road.

The westbound left turn lane at Robal Road should be lengthened from the current 120’ to a 225’ minimum length. This will prevent the westbound through-right movements from blocking the left turn lane and blocking the Robal/Nels Anderson intersection. In addition, the westbound approach green time should be lengthened a few seconds to help prevent blocking of the Robal/Nels Anderson intersection.

US97 & Cooley Road

All of the alternatives increase the US97/Cooley Road v/c because consolidating access points adds traffic to the intersection (See Table 1). Adding the frontage road RIRO on Cooley Road in Alternatives 3 and 4 increases the southbound left turn demand on US97, which increases the intersection v/c even further. With added development in the Robal Road area, this causes the Cooley Road intersection to fail prematurely. The southbound queues on US97 also increase and will require a longer southbound left turn lane.

The combined queues from left-turning southbound vehicles or right-turning northbound vehicles from US97 to Cooley Road fill the distance between the frontage road RIRO and US97. When a train occupies the nearby crossing, the combined traffic demand for eastbound Cooley Road and the frontage road RIRO will spill out into US97. This causes a serious safety hazard on US97 if the traffic does not divert south to Robal Road.

Since the Cooley Road RIRO would be within 500' of the railroad tracks, the ODOT Rail Division must be involved in the project development process. The Rail Division would have to approve the RIRO connection, which may require written authorization from a crossing order. The Rail Division requires that the nearest access be not closer than 100' from the crossing gate. Also, a raised median would be required along most of the length of Cooley Road between the railroad tracks and US97 to prevent any chance of a vehicle trying to make a left turn in. A "porkchop"-type island alone is not sufficient.

There is approximately 400 feet on Cooley Road between the railroad tracks and US97 with a slight grade eastbound on Cooley Road at US97. The AASHTO stopping sight distance (SSD) for Cooley Road is 400' based on the 45-mph speed limit. Placement of the frontage road RIRO anywhere between US97 and the railroad tracks will violate the minimum AASHTO SSD for a vehicle proceeding east on Cooley Road through the US97 intersection on a green light. ODOT uses intersection sight distance (ISD), which is more conservative than SSD, for design in the Highway Design Manual. The ISD for a 45-mph facility is 463' for passenger cars. The ISD for SUV's and trucks is considerably longer. Also, the recommended corner clearance (distance) from a major road to the first access for a 45-mph facility is 500'.

Alternative 3 and 4 were dropped from further consideration because the addition of the RIRO on Cooley Road may improve the Robal Road intersection operation but it has a greater negative impact on the operation of the US97/Cooley Road intersection. The spacing between the railroad tracks and US97 is minimal under any conditions. It is not recommended that the ISD or the AASHTO SSD be lessened because a vehicle may not be able to stop in time if a vehicle pulls out in front from the frontage road RIRO without stopping.

US97 RIRO Frontage Road Access

A minimum length of 125' is needed to allow for vehicle storage between US97 and the frontage road. For maximum flexibility, the frontage road should be located as far as possible from US97.

Access control should be purchased along both sides of the connector for the entire length between US97 and the frontage road to prevent any future direct access. Any accesses on the connector road could compromise operations by creating traffic to back up onto US97.

The northbound right turn onto the US97 RIRO connector road meets the right turn lane criteria for the 2001 volumes. A right turn deceleration lane should be constructed to allow vehicles to safely turn from US97, reducing the chance of a rear-end collision. The intersection of the connector road with the frontage road only requires a single lane approach for each direction. The eastbound connector road approach would be stop-controlled.

Robal & Nels Anderson Intersection Configuration

The northbound movement from Nels Anderson Road to Robal Road needs to be stop-controlled. With added development, the 2001 volume-to-capacity (v/c) ratio for Alternative 1 is 0.52. If Robal Road is stop-controlled then the intersection v/c is 1.01, which queues traffic into the US97/ Robal Road intersection. The eastbound movement on Robal Road must be kept free flowing to prevent the possibility of traffic queuing back into the US97/Robal Road intersection.

Single lane approaches are adequate to handle the current volumes and may be adequate for future development. If at all possible, the intersection of Robal Road and Nels Anderson Road should be moved further away from US97. The westbound queue at the US97/Robal intersection in Alternatives 2 and 3 and any alternatives in the developed scenario will affect or block the Robal/Nels Anderson intersection in its current location. Any increase in distance would be helpful even though there is not enough room to prevent blocking of this intersection (900' would be needed).

Left Turn Storage Requirements on US97 for all alternatives

SimTraffic simulation runs for the peak hour (3:45 – 4:45 PM) were averaged to obtain the 95th percentile queues. Table 2, in a separate attachment, has the 95th percentile queues for all alternatives. Actual turn lane length will be longer because of added taper length. The left turn lanes need to be long enough to store the actual turning demand and long enough to ensure turning vehicles are not blocked by traffic in the adjacent through lane.

US97 & Grandview Drive

The southbound right turn onto Grandview Drive meets the right turn lane criteria for the 2001 volumes. A right turn deceleration lane should be constructed to allow vehicles to safely turn from US97, reducing the chance of a rear-end collision.

Conclusions & Recommendations

The recommended alternative is Alternative 1. Alternative 1 was selected by the project development team as the preferred alternative. The US97 RIRO access benefits the US97/Robal Road intersection by shortening westbound queues and making the intersection v/c less sensitive to future development. Alternative 2 does not perform as well as Alternative 1 as the intersection of Robal Road and Nels Anderson will be frequently blocked by westbound queues at the US97/Robal Road intersection.

Alternatives 3 and 4 worsen the operation of the US97/Cooley Road intersection and may create a safety problem on US97 because of queued vehicles stopped in the through lanes. The alternatives do not meet the AASHTO stopping sight distance or ODOT's intersection sight distance standards on Cooley Road. Placement of a RIRO intersection in the short distance between US97 and the railroad tracks could result in a safety hazard at the railroad crossing.

The following are design recommendations for Alternative 1:

- 125' minimum connector road length, with more separation desirable, between US97 and the frontage road.
- Access control along both sides of connector road for its entire length.
- The Robal Road/ Nels Anderson Road intersection should have the northbound Nels Anderson approach stop-controlled.
- Right turn deceleration lanes should be installed at both the US97 RIRO and Grandview Drive as they meet the right turn lane criteria.
- US97 & Cooley Road southbound left turn lane length – 300' + taper length
- US97 & Cooley Road northbound left turn lane length – 650' + taper length
- US97 & Robal Road southbound left turn lane length – 475' Minimum + taper length
- US97 & Robal Road westbound left turn lane length – 225' Minimum + taper length
- US97 & Robal Road westbound approach green time lengthened.

If you have any questions or comments, please call me at (503) 986-4110.

Attachments

cc: Don Crownover, Environmental Services
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