ATTACHMENT A – Crash Rate Analysis

EXPLANATION

There are multiple steps to determine the crash rates comparison described in OAR 734-051-4020(3)(c). This document explains how to determine whether the approach location is within a highway segment that is 20 percent higher than the statewide average for similar segments on the state highway system. Attachment C provides a flowchart illustration of major steps described in the evaluation procedures below.

PROCEDURES

In the following procedures, an example will demonstrate the analysis of a request for an approach on OR 22 (Salem Highway No. 72) at mile point 7.50 in Salem. It will use data published in the 2011 Traffic Crash Summary. Attachment B shows the values selected in each step of the example.

STEP 1 – Determine Statewide Average Crash Rate

i) Determine if the highway segment is designated as urban or rural.

The urban or rural designation is needed to determine which category of the statewide average crash rates will be used in the comparison. Look up this information for the study segment by highway and mile points in the most recent "Crash Rate Book" at the following link: http://www.oregon.gov/ODOT/Data/Pages/Crash.aspx

Example: The example approach is located at mile point 7.50 on Highway No. 72, Salem. This location is between mile points 6.20 and 7.52, which is designated "Urban City." See Attachment B.

ii) Determine highway functional classification.

Next, determine the highway functional classification of the study segment. This information is needed for comparison to the appropriate statewide average crash rate. Look up the functional classification for the study segment by highway number (not route number) and mile point using the table at the following link:

http://www.oregon.gov/ODOT/Data/Documents/FC_NHS_State_Highway_List.pdf

Example: The example approach is located at mile point 7.50 on Highway No. 72. The approach location falls within the mile point segment 3.34 – 7.92 which has a functional classification of "Other Principal Arterial." See Attachment B.

iii) Determine statewide average crash rate.

Next, determine the crash rate for the state highway segments within the functional classification that is similar to the study segment. These rates are available in Table II of the "Crash Rate Book" available at the following link:

http://www.oregon.gov/ODOT/Data/Pages/Crash.aspx

For the statewide average crash rate, use the portions of the table under the subcategories of “Urban Cities,” “Suburban Areas,” “Rural Cities” or “Rural Areas” since these categories group the comparable segments more specifically. (Do **not** use the “TOTAL STATE HWY SYSTEM,” “URBAN HWY SYSTEM” or “RURAL HWY SYSTEM” portions of the table as those report summaries for data based only on location and not the functional classification of the roads, and they report combined averages of the urban, suburban and rural jurisdictions.)

Enter the statewide average crash rate into the “State Crash Rate” field on the Findings Tab in CHAMPS.

Example: For the example study segment, the 2011 statewide average crash rate is 2.84 for Urban Cities- Non-Freeways – Other Principal Arterials. See Attachment B.

STEP 2 – Determine Local Crash Rate

i) Determine local crash rate from most recently published Crash Rate Tables.

Using the highway and mile point of the approach location highway, find the published local crash rate in “Section II State Highway Crash Rates” in the most recent “Crash Rate Book” available at the following website:

http://www.oregon.gov/ODOT/Data/Pages/Crash.aspx

Example: The example approach is located at mile point 7.50 on Highway No. 72, which is an urban segment within Salem. The approach location falls within the 1.32-mile segment starting at mile point 6.20. For this highway segment, the published local crash rate is 2.65, based on 44 reported crashes in the 1.32-mile long segment with an AADT of 34,443 vpd. See Attachment B.

ii) Assess published local crash rate

Next, assess whether the published local crash rate is representative of the highway at the proposed approach location. Factors to consider when determining if the published local crash rate reasonably represents the segment of highway in the vicinity of the approach location are:

- **Highway Segment Length.** Is the highway segment length in the published data especially long (greater than one mile) or short (less than one-half mile)? Short highway segment lengths in combination with low highway AADTs can result in high crash rates, even when the number of crashes is low.
- **Urban/Rural.** Does the roadside character change from urban to rural within the highway segment?
- **Highway AADT.** Is the highway AADT in the published Crash Rate Tables close to the highway AADT at the proposed approach location? Low highway AADTs in combination with short highway segment lengths can result in high crash rates, even when the number of crashes is low.
- **Site ADT.** Is the site ADT for the proposed approach especially low, e.g., 30 vpd? Low ADT approaches may not be a safety concern on highway segments with a high crash rate.

- **Number of Crashes.** Is the number of crashes in the published Crash Rate Tables especially high? If so, it may be better to calculate a local crash rate for a shorter highway segment.
- **Local Knowledge.** Is district staff aware of safety concerns in the area?
- **Physical Evidence.** Is there physical evidence of a safety concern in the area, such as skid marks on the highway at the site?

If the published local crash rate is deemed representative of the highway at the proposed approach location, use the published local crash rate as the local crash rate for further analysis, and enter the published local crash rate into the "Local Crash Rate" field on the Findings Tab in CHAMPS and go to Step 3.

If the published local crash rate is deemed **not** representative of the highway at the proposed approach location, calculate a custom local crash rate either using the Crash Summary Report or manually, as described in Steps 2(a) through 2(c).

Example: The published local crash rate is 2.65, based on 44 reported crashes in the 1.32-mile long segment with an AADT of 34,443 vpd. Because there is a high number of reported crashes in the segment, large spikes in the highway AADT, and significant changes in the roadside character, calculating a custom local crash rate, based on a custom segment length, is recommended.

STEP 2a *(optional)* **–** Select custom segment length for local crash rate

This step is optional and is only necessary when the published local crash rate is not representative of the highway at the approach location.

The published local crash rate reports may not represent the highway in the vicinity of the approach when the segment length is less than one-half mile or greater than one mile. When the segment is less than a half-mile long, the comparison may not be appropriate due to inputs to the crash rate formula. For segments over one mile, the road and traffic characteristics may change enough to not fully represent the area of the approach. In these cases, a calculated custom crash rate is preferred.

Before the custom local crash rate can be calculated, an appropriate custom segment length must be determined. The custom segment length needs to be an appropriate length considering the conditions at the proposed approach location, representative of the highway in the vicinity of the approach, and an adequate length to compare to the statewide average crash rate.

A general guideline for selecting a custom segment length is to use one-half mile in urban areas (one-quarter mile on either side of the approach) and one mile in rural areas (one-half mile on either side of the approach). Consult the Region Access Management Engineer (RAME) when establishing the beginning and ending mile points of the custom segment. The custom segment length may need to be adjusted based on the following factors:

- Operational characteristics, such as traffic flows and volumes (highway AADT, traffic composition, speed);
- Geometric characteristics, such as lanes, medians, sidewalks, bike facilities;

- Roadside culture, such as schools, business districts, residential areas; and
- Highway functional classification (urban or rural) and categories, such as freeway, expressway, arterial, collector.

Using a custom local crash rate, instead of the published local crash rate, is a decision that should be made by the RAME or other qualified staff and should consider factors such as:

- If the approach location is at or near the break point of the published segment;
- If the published segment length is too short (less than one-half mile); or
- If the published segment length is longer than one mile.

The RAME will help determine the custom segment length that is long enough to be evaluated against the comparable statewide average crash rate and other factors that may affect the segment used.

When calculating a crash rate for a custom segment length, consideration must be given to the factors that directly influence the crash rate calculation. Those factors include:

- Mile point/Engineering station equations within the custom segment that may affect the numeric length of the segment;
- Other roadbeds associated with the same mile point (couplets, spurs, connections, frontages roads, etc.); and
- Significant change in one of the formula inputs (such as a large difference in highway AADTs reported within the segment).

If there are no concerns with anomalies in the custom segment length, use the Crash Summary Report to calculate the local crash rate as described in Step 2(b). If there are concerns with anomalies in the custom segment length, manually calculate a custom local crash rate, as described in Step 2(c).

STEP 2b *(optional)* **–** Calculate local crash rate using the Crash Summary Report

This step is optional and is only necessary when the published local crash rate is not representative of the highway at the approach location and there are no concerns with anomalies in the custom segment length such as those listed in Step 2(a).

The custom local crash rate can be determined using the Crash Summary Report, which is available at the following link:
http://transnet.odot.state.or.us/hwy/trs/Web%20Pages/CRS.aspx

To generate a summary report, click on the underlined text that says “Summary Report.” Fill in the highway and mile point information and click on the “View Report” button.

The Crash Summary Report summarizes the last three years of crash data as a product of the SPIS process. This tool estimates a crash rate for a custom segment length, if the segment is fairly short with no equations or other anomalies. It uses highway AADT (by averaging the highway AADT at the beginning and ending mile points), segment length (numeric difference between points) and number of crashes for the same period as the

latest SPIS listing. Depending on the specific segment chosen, there can be problems such as incorrect lengths (mile point equations), extra crashes (those coded to secondary roadbeds such as couplets, spurs, connections and frontage roads), or incorrect highway AADTs (variation between two points due to major accesses/streets).

The segment must be reviewed to determine if any of the concerns exist. The ODOT Highway Inventory Summary reports the entire state highway system by mile point and any differentiating factors, i.e., equations, frontage roads, connections and other conditions that affect the direct distance between two points. It is available at:

http://highway.odot.state.or.us/cf/highwayreports/aml_summary_parms_by_route_no.cfm

If it is determined that equations exist, highway AADTs vary widely in the study segment, or there are other road types (connections, frontage roads, etc.), then the RAME or other qualified staff needs to determine if the Crash Summary Report may be used and how to adapt the information. Whenever any of these concerns exist, calculate the crash rate by the manual process described in Step 2(c).

If there are no concerns, the Crash Summary Report may be used to calculate the crash rate for the custom segment length. To use this tool, enter the highway number and beginning and ending mile points. It will output the average highway AADT and the computed crash rate using the crash rate equation (the equation is shown in Step 2(c)). The custom local crash rate is listed in the third data box on the right as the "Computed Crash Rate." Other crash and SPIS information is summarized on the outputs. Enter the calculated local crash rate into the "Local Crash Rate" field on the Findings Tab in CHAMPS.

Example: The example approach is located at mile point 7.50 on Highway No. 72. Assume that a custom segment length is selected from mile point 7.25 to mile point 7.75 (7.50 +/- 0.25 mile on each side of the approach). Using the Crash Summary Report, input Highway No. 072 and the beginning and ending mile points of 7.25 and 7.75.

The custom segment crash rate ("Computed Crash Rate") is 3.91 in the 2012 Crash Summary Report (based on 2009 to 2011 data). See Attachment B.

STEP 2c *(optional)* **–** Manually calculate local crash rate using the Crash Summary information

Note: This step is optional and is only necessary when the published local crash rate is **not** representative of the highway at the approach location and there are concerns with anomalies in the custom segment length.

This section describes the process to manually calculate the local crash rate for a custom segment length when it undesirable to use the Crash Summary Report.
To determine the crash summary information, enter the highway name or state highway number and the segment beginning and ending mile points into the Transportation Data Section Crash Reports program at http://hwynetintra.odot.state.or.us/TVC/

Next, select the correct roadway type (all and "include Z mileage" for this example). Then, select the three most recent complete years of data for comparison to the inputs from the

comparable state crash rate tables. Select the print format report for a printable data summary that reports the number of crashes in the specified segment.

Next, determine the highway AADT from the State Highway Vehicle Classification Database at http://highway.odot.state.or.us/cf/highwayreports/traffic_parms.cfm

Use the available data from the most current year. When the segment has more than one highway AADT listed in the tables, a weighted average can be used. The simple formula to weight the AADT appropriately is:

Weighted AADT = [(AADT1 x length1) + (AADT2 x length2)] / (length1 + length2)

Where AADT1 and length1 represent data for the first portion of the segment and AADT2 and length2 represent the data for the second part of the segment.

Use the Crash Rate Equation to compute a crash rate. Report the value to two decimal places.

$$\text{Crash Rate Equation} = \frac{\text{(number of crashes X 1,000,000)}}{\text{(segment length in miles) X (number of days in period) X (segment AADT)}}$$

Enter the calculated local crash rate into the "Local Crash Rate" field on the Findings Tab in CHAMPS.

Since the comparable statewide average crash rate includes intersection crashes, intersection crashes should not be excluded or analyzed separately unless done so as part of a separate safety investigation.

Example: The example approach is located at mile point 7.50 on Highway No. 72. Assume that a custom segment length was selected from mile point 7.25 to mile point 7.75 with no equations (7.50 +/- 0.25 mile on each side of the approach). Using the Transportation Data Section Crash Reports program, input Highway No. 072, the beginning mile point (7.25) and ending mile point (7.75) and choose 01/01/2009 through 12/31/2011. Clicking on the "Summary by Year Report" button produces a report that lists 88 crashes in this half-mile section in a three-year time period.

Because the custom segment length is not contained within a single segment of the Vehicle Classification Database, the highway AADTs will need to be averaged through the custom segment. The custom segment highway AADT is derived from the following data from the 2011 Vehicle Classification Database:

Mile point 7.14 = 33,000 vpd
Mile point 7.52 = 47,400 vpd
Mile point 7.92 = 47,400 vpd

$$\text{Weighted ADT} = \frac{(33{,}000 \times 0.27) + (47{,}400 \times 0.23)}{(0.27 + 0.23)} = \frac{8{,}910 + 10{,}902}{0.50} = \frac{19{,}812}{0.50} = 39{,}624$$

Using the above data in the Crash Rate Equation, the crash rate is calculated as follows:

$$\text{Crash Rate} = \frac{\text{(number of crashes X 1,000,000)}}{\text{(segment length in miles) X (365 days X 3 years) X (segment AADT)}}$$

$$\text{Crash Rate} = \frac{88 \times 1{,}000{,}000}{0.50 \text{ miles} \times (365 \times 3 \text{ years}) \times 39{,}624} = \frac{88{,}000{,}000}{21{,}694{,}140} = 4.06$$

Therefore, the calculated crash rate using 2009-2011 data is 4.06 crashes per million vehicle miles.

STEP 3 –Compare local crash rate to statewide average crash rate

OAR 734-051-4020(3)(c) states that when the local crash rate at the proposed approach is more than 20 percent above the statewide average crash rate for similar highways, then ODOT may approve an application with mitigation or deny an application where the applicant is unable to provide adequate mitigation to address a safety concern.

For the example approach used in this document, the statewide average crash rate was determined to be 2.84. The statewide average crash rate for comparison to the local crash rate is: Statewide Average Crash Rate X 120% = 2.84 X 1.20 = 3.41

The following table shows a comparison of the various crash rates calculated in Step 2 with the crash rate that is 20 percent greater than the statewide average crash rate. The comparison shows why it is important to use the appropriate calculation method since the results can vary significantly and become the basis for further evaluation for safety concerns.

Statewide Average Crash Rate X 120%		3.41	Threshold
Published Local Crash Rate (Step 2)		2.65	Below Threshold
Custom Local Crash Rates (Steps 2(b) and (c))			
	Crash Summary Report	3.91	Above Threshold
	Manual Calculation	4.06	Above Threshold

Since the custom local crash rates in this example are more than 20 percent above the average statewide crash rate, the RAME or other qualified staff needs to conduct a further evaluation to determine if the approach is a safety or operation concern. This investigation would include a specific review of the crashes in the immediate area of the site and the relationship of the crashes to the existing or proposed approach. See Step 4.

If the appropriate local crash rate is more than 20 percent above the statewide average crash rate, flag the local crash rate as a concern and go to Step 4. *(Note: CHAMPS automatically flags "Yes" when the local crash rate is 120 percent above the statewide average crash rate).*

If the appropriate local crash rate is not more than 20 percent above the statewide average crash rate, then no further evaluation of crash rates is needed. *(Note: CHAMPS automatically flags "No" when the local crash rate is less than 120 percent of statewide average crash rate).*

STEP 4 *(optional)* **–** Review to determine if local crash rate is a safety concern

This step is optional and is only necessary when the local crash rate is determined to be more than 20 percent above the average statewide crash rate. This review is to be conducted by the RAME or other qualified staff.

First, review the comparison of the crash rate calculations used for comparison to verify the accuracy of the results. Next, review the detailed crash history of the crash data occurring within the study segment. Factors to consider are:

- Number of crashes
- Type of crashes
- Direction of travel
- Location of crashes
- Crashes occurring at existing intersections and/or approaches
- Other factors that may contribute to crashes

If this review determines the local crash rate is a concern as it relates to the approach, then go to step 5. (The RAME will select "Yes" on the "Safety and Operational Concerns" field on the CHAMPS Findings Tab.)

If this review determines the local crash rate is not a concern as it relates to the approach, record the basis of this conclusion in the findings documentation. (The RAME will select "No" on the "Safety and Operational Concerns" field on the CHAMPS Findings Tab.) No further analysis of crash rates is needed.

STEP 5 – Decision

If the review in Step 4 determines the local crash rate is a concern as it relates to the approach, the RAME or other qualified staff needs to determine what, if any, mitigation will be required or if the application will be denied. If the decision is "Approval with Mitigation" or "Denial," the applicant must be offered a Pre-Decision Collaborative Discussion as set forth in OAR 734-051-3060.

Record the basis of the decision in the findings documentation.