CHAPTER 3: BOTTLENECKS AND SOLUTIONS
Chapter 3: Bottlenecks and Solutions

The main purpose of the CBOS project is to identify bottlenecks and develop potential project solutions to address the safety and operational problems. Chapter 3 provides a general overview of that process. The first step is to locate the bottlenecks and the second step is to develop solutions to address safety and operational issues.

3.1 CBOS Purpose

The purpose of the Corridor Bottleneck Operational Study (CBOS) is to identify bottlenecks and develop potential project solutions to address the safety and operational problems. CBOS is a new approach to identify and analyze safety-spot improvements. This approach is the trend for state and federal to seek operational and low-cost “fixes” at spot-specific locations to address safety issues.

FHWA Localized Bottleneck Reduction (LBR) Program

ODOT’s CBOS is in response to Federal Highway Administration (FHWA) and SAFETEA-LU work with the Localized Bottleneck Reduction (LBR) Program. The LBR Program is targeted at point-specific locations (e.g., ramps, lane squeezes, weave areas, abrupt changes in highway alignments, etc) or small corridors of delay, as opposed to larger “mega-projects” or systemic congestion. Systemic congestion is often analogous to entire corridors or regional congestion; a situation that is far and above the focus of this program area. The LBR Program focuses on recurring bottlenecks; i.e., those that are operationally influenced by design or function, and impacted upon by excessive traffic demand.

Recurring Bottlenecks

CBOS is not a corridor-level analysis to develop a project to add capacity to the freeway system. Its purpose is to address site-specific recurring bottlenecks to reduce the conflicts (weaving, merging or drop lanes) and allow for a more stable flow of traffic at problematic interchanges. Every one of the bottlenecks identified in CBOS occurs at a freeway interchange as vehicles enter or leave the mainline. Therefore, improvements are designed to reduce the amount of conflicts with the mainline traffic. The addition of an auxiliary lane will allow for the weaving and merging occurring in a separate lane and not on the mainline. The result is a smoother flow of through traffic on the mainline. Recent ODOT safety analysis has indicated that by adding auxiliary lanes in weave/merge sections of freeways the crash rates will be reduced by nearly 30%.

Safety and Operational Improvements

The focus of the CBOS is on relieving recurring congestion chokepoints (as opposed to nonrecurring congestion cause) and the operational influences that cause them. Widening, lengthening or restriping these problem areas to unclog them can often be done with a lower cost, less intensive “footprint.” These safety improvements will not provide long-term capacity relief to congestion problems, but they will improve safety at the time of their construction and, over time, the bottleneck location will continue to operate more safely.

Why ODOT Builds Auxiliary Lanes

Another expected benefit of freeway mainline improvements is that the frequency of crashes will be reduced. This is considered a key element of any proposed concept since the existing weaving distances are short and crash rates are high, and freeway collisions create significant costs to society in terms of safety, delay, and reliability.

To help quantify and compare the potential benefits of auxiliary lanes, ODOT prepared a before-and-after study of similar improvements in the Portland metropolitan area. ODOT investigated two urban sites in Region 1 where an auxiliary lane was built within the last 20 years. The data show the safety benefits of reducing the intensity of weaving activity on the freeway mainline. An auxiliary lane improvement by itself may reduce crashes about 30% to 70%, depending on how long the lane is and how many interchanges it connects.

Comparison of Annual Average Mainline Crashes Before and After Improvements

<table>
<thead>
<tr>
<th>Improvement Type</th>
<th>Comparable Improvement</th>
<th>Before</th>
<th>After</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Auxiliary Section</td>
<td>I-205 Southbound at Sunnyside Road Interchange</td>
<td>12</td>
<td>8</td>
<td>32%</td>
</tr>
<tr>
<td>Long Auxiliary Section</td>
<td>US 26 Eastbound, Cornell Road to OR 217 (Across multiple interchanges)</td>
<td>37</td>
<td>10</td>
<td>73%</td>
</tr>
</tbody>
</table>

Auxiliary lanes at interchanges help improve of the ramp area safety by separating slower traffic by allowing merging traffic to adjust to the proper speed before merging into traffic. The reduced interference decrease the possibly of conflicts that may congest the freeway.

3.2 Common Causes and General Locations of Bottlenecks

Previous traditional transportation solutions for freeway congestion bottlenecks were large-scale extensive, corridor-wide mega-projects. The recent economic downturn has resulted in a re-evaluation of developing congestion relief. Transportation agencies are now looking to understand and identify specific causes of freeway bottlenecks and develop the “best fit” solution to address congestion and safety concerns.

Recurring, localized bottlenecks occur any time the rate of approaching traffic is greater than the rate of departing traffic. The causal effect can usually be attributed to the existence of at least one of two factors:

- **Decision Points**, such as entrance and exit ramps, merge areas, weave areas, and lane drops; or
- **Physical Constraints**, such as curves, underpasses, narrow structures, or absence of shoulders.

Figure 3-1 provides a summary of common locations for bottlenecks. The common causes for bottlenecks are illustrated in Figure 3-12. This figure indicates that the major causes are related to decision point characteristic.
3.3 What and Where Are the Bottlenecks?

Based on the review of Bottleneck Operations Detail Figures including PORTAL data, ODOT cameras, and field travel time data, thirty-six (36) bottlenecks are identified along the I-5, I-205, I-84, I-405, and US 26 corridors. The study corridor bottlenecks are classified by direction, time of day (AM Peak or PM Peak), and location. A description of the contributing factors is also included.

This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures, while more detailed analyses and findings are presented in Technical Memorandum 3, which is included in Appendix A.

I-5 Corridor Bottleneck Operational Detail Findings

A total of seven (7) bottlenecks locations are identified within the I-5 study corridor; three bottlenecks are in the northbound direction and four in the southbound direction. These bottlenecks are illustrated in Figure 3-2 and Figure 3-3. Bottleneck numbers B-3 and B-7 have been removed. B-3, a southbound auxiliary lane was built in 2011 and for B-7 a northbound auxiliary lane was built in 2010.

I-205 Corridor Bottleneck Operational Detail Findings

A total of twelve (12) bottleneck locations are identified within the I-205 study corridor; six bottlenecks are in the northbound direction and six in the southbound direction. These bottlenecks are illustrated in Figure 3-4 and Figure 3-5.

I-84 Corridor Bottleneck Operational Detail Findings

A total of seven (7) bottleneck locations are identified within the I-84 study corridor; three bottlenecks are in the eastbound direction and four in the westbound direction. These bottlenecks are illustrated in Figure 3-6 and Figure 3-7.

I-405 Corridor Bottleneck Operational Detail Findings

A total of four (4) bottleneck locations are identified within the I-405 study corridor; one bottleneck is in the northbound direction and three in the southbound direction. These bottlenecks are illustrated in Figure 3-8 and Figure 3-9.

US 26 Corridor Bottleneck Operational Detail Findings

A total of six (6) bottleneck locations are identified within the US 26 study corridor; five in the eastbound direction and one in the westbound direction. These bottlenecks are illustrated in Figures 3-10 and Figure 3-11.

3.4 Region Bottleneck Summary

Figure 3-12 illustrates the Regional Bottleneck Summary based on the analysis of the corridor bottleneck operational detail findings and the fatal flaw screening process.
### I-5 Northbound

**I-5: B1. Terwiliger Boulevard ON Ramp (AM & PM)**
- **Influence Area:** Terwiliger Boulevard ON Ramp to north of Barbur Boulevard ON ramp (AM) north of Haines Street ON ramp (PM)
- **Congestion Duration:** 4 hours daily (7:15-8:45 AM and 3:00-5:30 PM)
- **Contributing Factors:** Short acceleration lane, horizontal curvature, grade, high mainline and ramp volumes.
- **Influence Area Crashes:** Rate: 0.50 per MVMT; Frequency: 233 crashes

**Operations Summary:**
- **Activation Area:** Terwiliger Boulevard ON Ramp area
- **Speed:** During the AM bottleneck activation speeds drop as low as 25 mph (AM) and 20 mph (PM).
- **Volume (2008 AM Peak Hour):** Mainline: 7,800; Terwiliger ON Ramp: 650.
- **Volume (2008 PM Peak Hour):** Mainline: 4,750; Terwiliger ON Ramp: 450.

**Data Sources:**

### I-5: B2. Lower Boones Ferry Road OFF Ramp (AM)**
- **Influence Area:** Lower Boones Ferry Road OFF Ramp to north of Barbur Boulevard ON ramp.
- **Congestion Duration:** 7:15-8:30 AM
- **Contributing Factors:** Two closely spaced ON ramps merging into high through mainline volume.

**Influence Area Crashes:** Rate: 0.22 per MVMT; Frequency: 119 crashes

**Operations Summary:**
- **Activation Area:** Between the Lower Boones Ferry Road OFF Ramp and the Westbound Nyberg St. ON Ramp.
- **Speed:** Bottleneck activation speeds drop as low as 30 mph.
- **Volume (2009 ADT):** Mainline: 59,790; Nyberg St. ON (EB to NB) Ramp: 11,440.
- **Volume (2009 AM Peak Hour):** Mainline: 5,000; Nyberg St. ON (EB to NB) Ramp: 1,150.
- **Observations:** Queue starts between the Lower Boones Ferry Road OFF Ramp and the Westbound Nyberg St. ON Ramp; however, the end of the queue is inconclusive. Observations suggest that the queue ends before the I-205 ON Ramp.

**Data Sources:**

### I-5: B3. Westbound Elligsen Road ON Ramp (PM) [Solution for B3 constructed in 2013]
- **Influence Area:** Westbound Elligsen Road ON Ramp to south of Elligsen Road OFF Ramp.
- **Congestion Duration:** PM
- **Contributing Factors:** Two closely spaced ON ramps merging into high through mainline volume.

**Influence Area Crashes:** Rate: 0.50 per MVMT; Frequency: 119 crashes

**Operations Summary:**
- **Activation Area:** Between the westbound Elligsen Road ON Ramp and the Elligsen Road OFF Ramp.
- **Speed:** Bottleneck activation speeds drop as low as 30 mph.
- **Volume (2007 ADT):** Mainline: 58,030; Elligsen ON (EB to NB) Ramp: 6,580.
- **Observations:** The length of queue is inconclusive. PORTAL does not have data for this ramp location and the single day of travel time data does not reflect a reduction in speed to or below 35 mph. However, the single day of travel time data was collected during the month of March, not during the peak traffic month. Although the PORTAL data is limited and a single day of travel time data does not support this location as a bottleneck, based on numerous independent observations and general driver perception, the Stafford Rd. ON Ramp location is a questionable section of northbound I-5 when estimating travel time through the area.

**Data Sources:**

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**NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.
Corridor Bottleneck Operations Study for I-5, I-205, I-84, I-405, and US 26

Rate: 0.44 per MVMT; Frequency: 51 crashes
2.75 hours daily (7:15 AM - 9:30 AM)

Between Sandy Boulevard/Columbia Boulevard ON Ramp and the WB Airport Way OFF Ramp
Bottleneck activation speeds drop as low as 35 mph

The Columbia Boulevard/Highway 30 OFF Ramp area

AM bottleneck is confined to the Hwy 26/Powell Boulevard ON Ramp merge. PM bottleneck spans both the Division Street ON Ramp and the Columbia Boulevard ON Ramp.

Mainline: 4,500; Foster ON Ramp: 1,200

Hwy 26/Powell ON (AM)/Division ON Ramp (PM) to north of Hwy 26/Powell/Division OFF Ramp.
Both the AM and PM bottlenecks propagate from the Foster Road ON Ramp merge, high mainline and ramp volumes.

Bottleneck activation speeds drop as low as 30 mph
Congestion in the right lane builds after the EB I-5
Cross reference # with
Inconclusive data
Range: This is the segment that contains
Queuing/congestion extends from north of the study area and is exacerbated at the Sandy Boulevard/
Mainline: 66,530; Powell ON Ramp: 9,750; Division ON Ramp: 7,890
Rate: 0.26 per MVMT; Frequency: 61 crashes
The Foster Road ON Ramp area
of
Westbound I-5
AM queues are confined to the Hwy 26/Powell ON Ramp merge point. In the AM, queues recover north of the Hwy 26/Powell
Bottleneck activation speeds drop as low as 15 mph (AM) and 10 mph (PM)
Influence Area 3 hours daily (3:00 PM - 6:00 PM)
Sandy Boulevard/Columbia Boulevard ON Ramp to Sandy Boulevard OFF Ramp
- Mainline: 4,140; Sunnybrook ON Ramp: 110; Sunnyside ON Ramp: 10,090
- Mainline: 71,520; Columbia OFF Ramp: 14,400

The Columbia Boulevard/Highway 30 OFF Ramp area

For a more detailed analysis of the bottlenecks, please refer to the report on I-5, I-205, I-84, I-405, and US 26.
I-205 Southbound

Detector Location (2007 Data Used)

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<tbody>
<tr>
<td>Hwy. 26 / Division St. / Powell Blvd. OFF Ramp</td>
<td>11,040</td>
<td>10,040</td>
<td>8,300</td>
<td>65</td>
<td>5:15 PM - 8:00 AM</td>
</tr>
<tr>
<td>Division St. ON (19.3)</td>
<td>6,400</td>
<td>5,700</td>
<td>4,540</td>
<td>50</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>Johnson Creek Blvd. ON (16.2)</td>
<td>4,540</td>
<td>4,040</td>
<td>3,050</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>Sunnyside Rd. OFF</td>
<td>4,040</td>
<td>3,540</td>
<td>2,650</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>Sunnybrook Rd. ON (14.3)</td>
<td>3,540</td>
<td>3,040</td>
<td>2,050</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>Milwaukee Expwy/89th Dr. OFF</td>
<td>2,650</td>
<td>2,250</td>
<td>1,540</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>Milwaukee Expwy/89th Dr. ON (13.6)</td>
<td>1,540</td>
<td>1,100</td>
<td>850</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>WB I-205 224th Dr. / 82nd Dr. OFF</td>
<td>1,100</td>
<td>850</td>
<td>650</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>WB I-205 82nd Dr. / Gladstone OFF</td>
<td>850</td>
<td>650</td>
<td>500</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>Highway/43 ON (11.1)</td>
<td>650</td>
<td>500</td>
<td>400</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
<tr>
<td>99E / McLoughlin Blvd. OFF Ramp</td>
<td>400</td>
<td>300</td>
<td>250</td>
<td>40</td>
<td>4:30 AM - 7:30 AM</td>
</tr>
</tbody>
</table>

**Data Sources:**

1. Data collected from traffic cameras
2. Information from ODOT
3. Data collected from travel time runs
4. Information from observations

**Operations Summary:**

- Bottleneck #10: 224th/82nd Dr. On-Ramp: 1 hour daily (10:45-11:45 PM)
- Bottleneck #11: 99E/McLoughlin Blvd. Off-Ramp to Hwy. 213/Off-Ramp: 1.25 hours daily (7:15-8:45 AM)
- Bottleneck #12: Hwy. 43/Off-Ramp: 1.25 hours daily (7:15-8:45 AM)

**Contributing Factors:**

- Traffic volume
- Lane drop
- High mainline and ramp volumes
- Turbulence from upstream lane drop

**Influence Area:**

- Highway 26
- Division Street
- Powell Boulevard

**Consequences:**

- Increased travel times
- Increased congestion

**Figure 3-5**

*Figure 3-5 shows the I-205 Southbound Bottleneck Details with data collected from PORTAL, data collected from travel time runs, information from ODOT, and information from observations. It also displays the bottlenecks with their activation ranges and contributing factors.*
Corridor Bottleneck Operations
I-84 Eastbound Bottleneck Details

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**Figure 3-6**

**I-84 Eastbound**

**I-84: B1. 5 SB ON Ramp (AM & PM)**

- **Influence Area:** 5 SB (mainline to 1-5 SB mainline)
- **Concentration Duration:** 12 hours or more daily (7:00 AM to 7:00 PM)
- **Contributing Factors:** High ramp demand.

- **Operations Summary:**
  - **Activation Range:** Along the entire ramp
  - **Speed:** Ramp speeds drop as low as 10 mph and are only as high as 35 mph
  - **Volume:**
    - **(2007 AADT):** 1-5 SB to 84 EB: 21,550
    - **(2008 AM Peak Hour):** 1-5 SB to 84 EB: 23,750
    - **(2008 PM Peak Hour):** 1-5 SB to 84 EB: 2,150

- **Observations:** Ramp advisory speed posted at 45 mph

---

**I-84: B2. 1-5 SB/ NB Merge (PM)**

- **Influence Area:** Grand Ave. ON Ramp to 1-5 NB (mainlines)
- **Concentration Duration:** Approximately 4 hours daily (2:15-6:30 PM)
- **Contributing Factors:** High facility-to-facility ramp volumes. Although there is an add lane for the ON ramp from 1-5 NB, the activation area acts as a merge as vehicles reposition to avoid conflict with the next closely spaced ON ramps.

- **Influence Area Crashes:** Rate: 1.21 per MVMT; Frequency: 88 crashes

- **Operations Summary:**
  - **Activation Range:** Between Grand Avenue ON Ramp and 1-5 SB/ NB merge
  - **Speed:** Bottleneck speeds drop as low as 5 mph
  - **Volume:**
    - **(2007 AADT):** 1-5 SB to 84 EB: 21,550
    - **(2008 AM Peak Hour):** Mainline: 2,700; 1-5 NB ON Ramp: 1,300

- **Observations:** Vehicles coming from the 1-5 southbound ramp merge left very quickly once on I-84 mainline to avoid conflicting with the downstream Grand Avenue and Irving Street ON ramp vehicles.

---

**I-84: B3. 39th Avenue ON Ramp (PM) (INCONCLUSIVE)**

- **Influence Area:** 39th Ave. ON Ramp to 1-5 NB (mainlines)
- **Concentration Duration:** Inconclusive data

- **Contributing Factors:** Inconclusive data

- **Influence Area Crashes:** Rate: 0.87 per MVMT; Frequency: 347 crashes

- **Operations Summary:**
  - **Activation Range:** 39th Ave. ON Ramp merge area
  - **Speed:** Inconclusive data
  - **Volume:**
    - **(2007 AADT):** Mainline: 70,170; 39th ON Ramp: 10,780
    - **(2008 AM Peak Hour):** Mainline: 4,730; 39th ON Ramp: 570

- **Data Sources:**
  - PORTAL
  - **Note:** Observations showed congestion emanating from the 16th/living ON Ramp area until the ramp meter turned on. Once the ramp meter was on, no further congestion was observed.

---

**I-84: B4. 205 SB ON Ramp (AM & PM)**

- **Influence Area:** Troutdale/Main St Dr. OFF (MP 16.7) to 257th Ave. ON (MP 17.6)

- **Concentration Duration:** 12 hours or more daily (7:00 AM to 7:00 PM)

- **Contributing Factors:** High mainline and moderate ramp volumes. Spillback from downstream 1-205 congestion (see I-205 graphics, Bottlenecks 3 and 8).

- **Contributing Factors:**
  - **Speed:** Inconclusive data
  - **Volume:**
    - **(2007 AM Peak Hour):** 1-5 SB: 4,730; 1-5 NB: 1,300

---

**Data Sources:**
- PORTAL
- **Note:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.
I-84 Westbound

**I-84 Bottleneck Operations**

**I-84: SB Diverge (AM & PM)**
- **Influence Area**: to 33rd Avenue
- **Activation Range**: 4 hours daily (6:00-10:00 AM; 3:00-7:00 PM)
- **Contributing Factors**: High mainline and ramp volumes, horizontal and vertical curvature, sudden advanced signage
- **Influence Area Crash Rate**: 0.71 per MVMT, Frequency: 99 crashes; PM
- **Influence Area Crash Rate**: 0.25 per MVMT, Frequency: 391 crashes

**Operations Summary**
- **Activation Range**: 4 hours daily (6:00-10:00 AM; 3:00-7:00 PM)
- **Contributing Factors**: High mainline, auxiliary lane, and moderate ramp volumes. Closely spaced ON Ramps, downstream lane drop/diverge, and advanced signage for above-mentioned bottleneck.
- **Influence Area Crash Rate**: Rate: 0.91 per MVMT, Frequency: 292 crashes

**Influence Area**
- **Inconclusive Bottleneck Activation Range**
- **Bottleneck Influence Area - Cross reference # with data boxes above**
- **Influenced by a bottleneck outside of this study area**

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**I-84 Westbound Bottleneck Details**

*NOTE: Queuing extends from downstream/adjacent corridors and impacts mainline operations.*
I-405 Northbound

I-405: B1. US 26/12th Ave. (PM)

**Influence Area:** Between US 26/12th Ave. OFF and I-5 SB ON Ramp, in the auxiliary lanes

**Congestion Duration:** Approximately 3 hours daily (3:45-6:30 PM)

**Contributing Factors:** High OFF Ramp volumes, weaving volumes, and closely spaced ramps. OFF Ramp merge to US 26 congestion (see US 26 graphic, Bottleneck 4).

**Influence Area Crashes:** Rate: 2.84 per MVMT; Frequency: 195 crashes

**Operations Summary:**
- **Activation Range:** Weave area between 6th Avenue ON Ramp and US 26/12th Avenue OFF Ramp
- **Speed:** Bottleneck activation speeds drop as low as 5 mph
- **Volume (2007 ADT):** Mainline: 37,720; 6th ON Ramp: 21,830; 12th/US 26 OFF Ramp: 34,980
- **Volume (2007 PM Peak Hour):** Mainline: 3,940; 6th ON Ramp: 380; 12th/US 26 OFF Ramp: 2,380

**Data Sources:**
- Kirby Ave. OFF (MP 3.7)
- Salmon St. OFF (MP 1.3)
- 4th Ave. OFF (MP 0.8)
- I-5 NB ON (MP 0.0)
- 6th Ave. OFF (MP 1.0)
- 6th Ave. ON (MP 1.2)
- US 26 ON (MP 1.9)
- US 30 ON (MP 3.1)
- US 26/12th Ave. OFF (MP 1.3)
- Kirby Ave. OFF (MP 3.7)
- Burnside St. ON (MP 2.5)
- Glisan St. ON (MP 2.6)
- I-5 SB ON (MP 0.5)
- Naito Pkwy. OFF (MP 0.1)
- I-5 NB ON (MP 0.0)

**LEGEND**
- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

* NOTE: Queuing extends from downstream/adjacent corridors and impacts mainline operations.

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**Figure 3-8**
Corridor Bottleneck Operations
I-405 Northbound Bottleneck Details

Data collected from PORTAL website
Data collected from travel time runs
Information from ODOT
Information from observations
Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 - 59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

Total crashes from 2004 through 2008
Poor lane utilization while positioning for US 26 OFF Ramp.

Broadway OFF Ramp to US 26 ON Ramp
Rate: 0.73 per MVMT; Frequency: 53 crashes

19 Crashes

Bottleneck speeds drop as low as 5 mph.

Range: This is the segment that contains the bottleneck speeds drop as low as 5 mph.

Cross reference # with

of US 30 OFF Ramp (on

Weave (PM)

Mainline: 2,700; US 30 ON Ramp: 1,400

Mainline: 37,170; US 30 ON Ramp: 18,070

(3:30

Rate: 0.68 per MVMT; Frequency: 48 crashes

Mainline: 2,070; US 26 ON Ramp: 1,700;

OFF Ramp Weave (PM)

X

Everett ON Ramp: (3:15

US 30 ON Ramp area

Poor lane utilization, high US 30 ON Ramp volume, and closely spaced ramps.

Bottleneck speeds drop as low as 5 mph.

Rate: 0.33 per MVMT; Frequency: 16 crashes

Detector Location (2007 Data Used)

Mainline: 3,730; Couch OFF Ramp: 610; Everett ON Ramp: 2,070; US 26 OFF Ramp: 2,600

Influence Area Crashes:

59 Crashes

Fremont Bridge

Inconclusive Bottleneck Activation

Activation

data boxes above

Bottleneck

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Chapter 3: Bottlenecks and Solutions

**US 26: B1. OR 217 On Ramp (AM)**

**Influence Area:** Between OR 217 drop and Cedar Hills Blvd. ON-ramp

**Activation Time:** 3 hours daily 7:01 AM-10:00 AM

**Contributing Factors:** High mainline and ramp volumes.

**Influence Area Crashes:** Rate: 1.23 per MVMT; Frequency: 189 crashes

**Operations Summary:**

- **Activation Range:** Between OR 217 drop and OR 217 ON-ramp gore point
  - Speed: 40 mph
  - OR 217 ON ramp gore point: 21 AM
  - Volume: 2,100 AM peak

- **Observation:** Some motorists use the long OR 217 ON-ramp acceleration lanes to bypass the mainline queue.

**Data Source:**

1. OR 217 ON ramp gore point
2. Scholls Ferry ON-ramp
3. OR 217 ON-ramp gore point
4. Data from travel time runs
5. ODOT data collected

---


**Influence Area:** Between Skyline/Scholls Ferry and either the OR 217 ON lane drop (LANE) or Cedar Hills Blvd. ON-ramp

**Activation Time:** 1 hour daily 7:00 AM-8:00 AM

**Contributing Factors:** High mainline and ramp volumes.

**Influence Area Crashes:** Rate: 1.49 per MVMT; Frequency: 222 crashes

**Operations Summary:**

- **Activation Range:** Scholls Ferry ON-ramp merge area
  - Speed: 70 mph
  - Widened lanes speed drop as low as 5 mph

**Data Source:**

1. OR 217 ON-ramp gore point
2. OR 217 ON-ramp gore point
3. Data collected from travel time runs
4. ODOT data collected

---

**US 26: B3. I-405 Positioning/Curves/Tunnel (AM & PM)**

**Influence Area:** I-405 Positioning/Skyline/Scholls Ferry/Old Zoom

**Activation Time:** Between I-405 drop and Scholls Ferry/Zoom

**Contributing Factors:** High mainline traffic volumes. Facility to facility connection.

**Influence Area Crashes:** Rate: 2.34 per MVMT; Frequency: 849 crashes

**Operations Summary:**

- **Activation Range:** Between I-405 drop and Scholls Ferry/Zoom
  - Speed: 40 mph
  - I-405 ON ramp gore point: 7:15 AM
  - OR 217 OFF ramp: 7:20 AM
  - Market OFF ramp: 7:30 AM

**Data Source:**

1. I-405 ON-ramp gore point
2. OR 217 ON-ramp gore point
3. Data collected from travel time runs
4. ODOT data collected

---

**US 26: B4. I-405 On-Ramp (AM & PM)**

**Influence Area:** I-405 on-ramp to Scholls Ferry/Old Zoom

**Activation Time:** 1 hour daily 7:00 AM-8:00 AM

**Contributing Factors:** High mainline traffic volumes. Facility to facility connection.

**Influence Area Crashes:** Rate: 1.23 per MVMT; Frequency: 196 crashes

**Operations Summary:**

- **Activation Range:** Along the entire ramp
  - Speed: 40 mph
  - Volume: 2007 ADT: 1,200 AM peak
  - OR 217 NB ON ramp: 1,090 AM peak

**Data Source:**

1. I-405 ON-ramp gore point
2. Data collected from travel time runs
3. ODOT data collected

---

**US 26: B5. Ramp to I-405 Southbound (AM & PM)**

**Influence Area:** I-405 on-ramp to US 26 on-ramp

**Activation Time:** 7 hours daily 7:00 AM-10:00 AM, 3:00 PM-7:00 PM

**Contributing Factors:** Mainline to I-405 drop. Facility to facility connection. Vertical curvature.

**Influence Area Crashes:** Rate: 1.49 per MVMT; Frequency: 222 crashes

**Operations Summary:**

- **Activation Range:** Along the entire ramp
  - Speed: 40 mph
  - Volume: 2007 ADT: 1,200 AM peak
  - OR 217 NB ON ramp: 1,090 AM peak

**Data Source:**

1. I-405 NB ON-ramp gore point
2. Data collected from travel time runs
3. ODOT data collected

---


**Influence Area:** I-405 off-ramp to US 26 on-ramp

**Activation Time:** 1 hour daily 7:00 AM-8:00 AM

**Contributing Factors:** High mainline traffic volumes. Facility to facility connection. Vertical curvature.

**Influence Area Crashes:** Rate: 1.23 per MVMT; Frequency: 196 crashes

**Operations Summary:**

- **Activation Range:** Along the entire ramp
  - Speed: 40 mph
  - Volume: 2007 ADT: 1,200 AM peak
  - OR 217 NB ON ramp: 1,090 AM peak

**Data Source:**

1. I-405 NB ON-ramp gore point
2. Data collected from travel time runs
3. ODOT data collected

---

**NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.
Corridor Bottleneck Operations Study for I-5, I-205, I-84, I-405, and US 26

Chapter 3: Bottlenecks and Solutions

US 26 Westbound

Figure 3-11

Corridor Bottleneck Operations
US 26 Westbound Bottleneck Details

LEGEND

PORTAL Detector Location (2007 Data Used)
PORTAL Detector Location (Missing Data)
M.P. of ON/OFF Ramp Gore Point
Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
Bottleneck Influence Area - Cross reference # with data boxes above
Inconclusive Bottleneck: Activation Range

US 26: B6. I-405 Ramps/US 26 Merge (PM)

Influence Area: Between US 26 merge and I-405 mainline along I-405 ramps

Congestion Duration: Approximately 3 hours daily (3:30-6:45 PM)

Contributing Factors:
High ramp volume (including facility to facility connections), I-405 OFF ramp horizontal and vertical curvature. Lane drops on I-405 ramps. Positioning for climbing grade on US 26.

Operations Summary:

Activation Range: I-405 ramp merge areas

Speed: Bottleneck speeds drop as low as 10 mph

Volume (2007 ADT):
- Market ON Ramp: 12,370; ON from I-405 NB Ramp: 30,750; ON from I-405 SB Ramp: 27,030
- Volume (2007 PM Peak Hour):
  - Market ON Ramp: 1,300; ON from I-405 NB Ramp: 2,600
  - ON from I-405 SB Ramp: 2,600

Observation: Vehicles begin positioning for the downstream climbing grade as soon as the merge onto the US 26 mainline.

Data Sources:

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

Crashes:

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 - 59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

Total crashes from 2004 through 2008

PORTAL Detector Location (2007 Data Used)
PORTAL Detector Location (Missing Data)
M.P. of ON/OFF Ramp Gore Point
Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
Bottleneck Influence Area - Cross reference # with data boxes above
Inconclusive Bottleneck: Activation Range

Figure 3-11

0 - 19 Crashes
20 - 39 Crashes
40 - 59 Crashes
60 - 79 Crashes
> 80 Crashes

Total crashes from 2004 through 2008

PORTAL Detector Location (2007 Data Used)
PORTAL Detector Location (Missing Data)
M.P. of ON/OFF Ramp Gore Point
Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
Bottleneck Influence Area - Cross reference # with data boxes above
Inconclusive Bottleneck: Activation Range

Figure 3-11

Corridor Bottleneck Operations
US 26 Westbound Bottleneck Details
Figure 3-12: Regional Recurring Bottleneck Locations

<table>
<thead>
<tr>
<th>Recurring Bottleneck ID</th>
<th>Recurring Bottleneck Locations</th>
<th>Cause</th>
<th>Conestion Speed (MPH)</th>
<th>Conestion Duration (Hours)</th>
<th>See Bottleneck Detail Sheet on page #</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-5 Bottlenecks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>I-5 NB: Tennessean Boulevard Entrance Ramp (AM &amp; PM)</td>
<td></td>
<td>X</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>B2</td>
<td>I-5 NB: Lower Bonnie Ferry Road Exit Ramp (AM)</td>
<td></td>
<td>X</td>
<td>30</td>
<td>1.25</td>
</tr>
<tr>
<td>B3</td>
<td>I-5 NB: Westbound Elligson Road Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>I-5 SB: Hood Avenue Exit Ramp (PM)</td>
<td></td>
<td>X</td>
<td>10</td>
<td>2.75</td>
</tr>
<tr>
<td>B5</td>
<td>I-5 SB: Corman Drive Lane Drop (PM)</td>
<td></td>
<td>X</td>
<td>10</td>
<td>2.25</td>
</tr>
<tr>
<td>B6</td>
<td>I-5 SB: Nyberg Street Exit Ramp (PM)</td>
<td></td>
<td>X</td>
<td>25</td>
<td>2.5</td>
</tr>
<tr>
<td>B7</td>
<td>I-5 SB: I-205 Entrance Ramp (PM)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>I-205 Bottlenecks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>I-205 NB: Sandy Boulevard/Columbia Boulevard Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>B2</td>
<td>I-205 NB: Columbia Boulevard/Hey 30 Exit Ramp (PM)</td>
<td></td>
<td>X</td>
<td>35</td>
<td>Inconclusive</td>
</tr>
<tr>
<td>B3</td>
<td>I-205 NB: Westbound I-84 Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td>5</td>
<td>5.25</td>
</tr>
<tr>
<td>B4</td>
<td>I-205 NB: Division Street Entrance Ramp and Hey 26/Power Blvd. Entrance Ramp (AM &amp; PM)</td>
<td></td>
<td>X</td>
<td>10</td>
<td>2.75</td>
</tr>
<tr>
<td>B5</td>
<td>I-205 NB: Foster Road Exit Ramp (AM &amp; PM)</td>
<td></td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td>B6</td>
<td>I-205 NB: Sunnybrook Road Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td>30</td>
<td>2.25</td>
</tr>
<tr>
<td>B7</td>
<td>I-205 SB: Westbound I-84 Exit Ramp (AM &amp; PM)</td>
<td></td>
<td>X</td>
<td>5</td>
<td>4.25</td>
</tr>
<tr>
<td>B8</td>
<td>I-205 SB: Stark/Washington Street Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td>10</td>
<td>3.25</td>
</tr>
<tr>
<td>B9</td>
<td>I-205 SB: Hey 26/Division Street/Power Boulevard Entrance Exit Ramp (PM)</td>
<td></td>
<td>X</td>
<td>25</td>
<td>3.25</td>
</tr>
<tr>
<td>B10</td>
<td>I-205 SB: 212/214 Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>B11</td>
<td>I-205 SB: 99/Westcoast Boulevard Exit Ramp (AM)</td>
<td></td>
<td>X</td>
<td>20</td>
<td>1.25</td>
</tr>
<tr>
<td>B12</td>
<td>I-205 SB: Hey 43 Entrance Ramp (AM)</td>
<td></td>
<td>X</td>
<td>30</td>
<td>2</td>
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<tr>
<td>I-84 Bottlenecks</td>
<td></td>
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<td></td>
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<tr>
<td>B1</td>
<td>I-84 EB: I-5 SB Entrance Ramp (AM &amp; PM)</td>
<td></td>
<td>X</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>B2</td>
<td>I-84 EB: I-5 SB/NI Merge (PM)</td>
<td></td>
<td>X</td>
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</tr>
<tr>
<td>B3</td>
<td>I-84 EB: 39th Avenue Entrance Ramp (PM)</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>I-84 WB: I-5 Diverge (AM &amp; PM)</td>
<td></td>
<td>X</td>
<td>10</td>
<td>8</td>
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<td>B5</td>
<td>I-84 WB: 33rd Avenue Entrance Ramp (AM)</td>
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<td>B6</td>
<td>I-84 WB: Glisan Entrance Ramp (AM)</td>
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<td>Inconclusive</td>
</tr>
<tr>
<td>B7</td>
<td>I-84 WB: I-205 SB to I-84 WB Ramp</td>
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<td>Inconclusive</td>
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<tr>
<td>I-405 Bottlenecks</td>
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<td></td>
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</tr>
<tr>
<td>B1</td>
<td>I-405 NB: US 26/22nd Ave (PM)</td>
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<td>B2</td>
<td>I-405 SB: US 30 Entrance Ramp (PM)</td>
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<td>B3</td>
<td>I-405 SB: Everett Street Entrance Ramp to US 26 Ext Ramp Weave (PM)</td>
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<td>US 26 Bottlenecks</td>
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<td>US 26 EB: Oregon 217 Entrance Ramp (AM)</td>
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<td>B2</td>
<td>US 26 EB: Skyline/Scholls Ferry Entrance Ramp (AM &amp; PM)</td>
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<td>US 26 EB: I-405 Positioning/Leverage/Tunnel (AM &amp; PM)</td>
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<td>B5</td>
<td>US 26 EB: Ramp to I-405 NB (AM &amp; PM)</td>
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<td>5</td>
<td>8</td>
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<tr>
<td>B6</td>
<td>US 26 EB: I-405 Ramps/US 26 merge (PM)</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* Construction of NB Auxiliary Lane in 2011
** Construction of SB Auxiliary Lane in 2010

Source: Oregon Department of Transportation

Chapter 3: Bottlenecks and Solutions

Corridor Bottleneck Study for I-5, I-205, I-84, I-405, and US 26

Page 3-15
3.5 Steps in Developing Solutions

In an effort to develop a comprehensive list of bottleneck solutions, a review of existing literature was conducted to identify previously proposed improvements. Several documents were critical in this effort:

- I-205 Reconnaissance Study
- I-5 Corridor Plan
- 2035 Regional Transportation Plan
- ODOT Concepts and Studies

The analysis team worked with the design team to review these documents and other documents, and to develop a preliminary list of planned improvements that had the potential to address identified bottleneck area deficiencies. There were a total of 89 possible improvements identified from this work.

More detailed analyses and findings are presented in Technical Memoranda 4 and 5, included in Appendix A.

3.6 What Are Other Appropriate Solutions?

The goal was to identify projects that could provide measurable benefit with keeping the current financial constraints in mind. To facilitate that goal, the following guidelines were used to guide the project development process:

- Design exceptions would be considered as long as there is a measurable safety or operational benefit
- Focus on relatively low-cost projects or projects that can be phased at a $1.0 million to $20 million range
- Minimal to no additional right-of-way (ROW) required
- Focus on projects with political readiness

Design Panel Alternatives

An expert multidisciplinary design panel, composed of select Consultant and Agency specialists, was convened to review and identify new possible design and operations solutions to mitigate known bottlenecks along the I-5, I-205, I-84, I-405, and US 26 study corridors. This panel provided high-level prioritization of projects, which were then advanced into the next phase of evaluation.

The complete list of identified projects is provided in Technical Memorandum 7, included in Appendix A.

Geometric Evaluation

The design team screened the preliminary list of possible improvements to identify those that were geometrically constructible. Though design standards and policy limitations were involved in this screening process, it was assumed that design exceptions may be required for some of the proposed improvements.

More detailed analyses and findings are presented in Technical Memoranda 4 and 5, included in Appendix A.

3.7 Fatal Flaw Screening

Fatal flaw screening involved assessing the feasibility of implementing potential design and operations solutions surfaced under initial development of options and culminating from the design panel as well as promising ideas (see Technical Memoranda 4 and 5 in Appendix A). This feasibility review focused on obvious high-level fatal flaws such as, but not limited to: cost, right-of-way impacts, system integration, and political readiness, as outlined in Technical Memorandum 6, included in Appendix A.

The high-level fatal flaw feasibility review generally included the following:

1. High-level quantity estimation
2. High-level construction cost estimation
3. Examination of alternatives using screening criteria, accounting for the following characteristics:
   - Goals/objectives
   - Design principles/system needs
   - Geometric feasibility
   - Operational criteria
   - Impact/risk of impacts (right-of-way, environmental, traffic, etc.)
   - Constructability/staging
   - Cost

As a result of this process, not all bottlenecks (however severe they may be) have a recommended project.

What Projects Were Worth Further Evaluation?

The evaluation included analysis of traffic operations, safety, costs, constructability, and other user benefits to assess various performance measures, allowing for selection of potential solutions along the study corridors. This process identified a list of 18 potential solutions, and an evaluation matrix, to move forward into further traffic analysis and evaluation.

3.8 Refinement of Potential Solutions

The majority of the projects were identified for the I-5 and I-205 corridors. No projects were selected for advancement along the US 26 corridor. Table 3-1 indicates the refinement of the bottleneck locations the development of a potential solution to address the bottleneck. The table provides a list of potential projects, including a project description, estimated cost, traffic analysis tool used for evaluation, and comments regarding relevant findings of the feasibility review by corridor. Overall, there are four recommended actions:

- Bottleneck solution is recommended to move forward to develop a project. The project solution is recommended to move forward if analysis indicates that solution provided an operational or safety benefit and the estimated cost fits the $1.0 million to $20.0 million range.
- Recommendation for the solution is for additional analysis to determine the project. The additional analysis is required to develop a potential solution that will provide operational or safety benefit and an estimated cost that fits in the $1.0 million to $20.0 million range.
• Recommendation is that the bottleneck solution should be dropped.
• The final recommendation is that the solution has been constructed or is planned/programmed for construction.

This list of recommended projects is in Table 3-1, while a more detailed summary of methodology is presented in Technical Memorandum 8, included in Appendix A.

### I-5 Potential Solutions

A total of five (5) bottleneck locations are identified for analysis. From these locations a total of eight (8) potential solutions are identified. Five (5) potential solutions are recommended to move forward to be developed as projects. One (1) potential solution is recommended for further analysis to develop a potential project. One (1) bottleneck location has been constructed, and one (1) is recommended to be phased.

More detailed findings are presented in Technical Memorandum 8, included in Appendix A.

### I-205 Potential Solutions

A total of twelve (12) bottleneck locations are identified. From these locations a total of nine (9) potential solutions are identified. All nine (9) have potential solutions recommended to move forward to be developed as projects.

More detailed findings are presented in Technical Memorandum 8, included in Appendix A.

### I-84 Potential Solutions

A total of seven (7) bottleneck locations are identified for analysis. From these locations a total of three (3) potential solutions are identified. One (1) potential solution is recommended for further study. Two (2) bottleneck locations are scheduled to be constructed in 2013.

More detailed findings are presented in Technical Memorandum 8, included in Appendix A.

### I-405 Potential Solutions

A total of four (4) bottleneck locations are identified for analysis. From these locations a total of one (1) potential solution is identified.

More detailed findings are presented in Technical Memorandum 8, included in Appendix A.

### US 26 Potential Solutions

There are no recommended solutions identified for bottlenecks within the US 26 study corridor.

More detailed findings are presented in Technical Memorandum 8, included in Appendix A.

### 3.9 Potential Regional Projects

Potential Regional Projects (Figure 3-12) of this Atlas provides a list of potential projects by corridor. This figure summarizes the recommended projects from Table 3-1 and highlights the future action.
Table 3-1: Potential Regional Projects Summary

<table>
<thead>
<tr>
<th>Map ID</th>
<th>Bottleneck ID</th>
<th>Tracking ID</th>
<th>Project</th>
<th>Description</th>
<th>Est. Cost</th>
<th>Traffic Analysis Findings/Comments</th>
<th>Potential Solutions Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-5 Recommended Projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northbound</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>I-5: B1</td>
<td>1a</td>
<td>I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.</td>
<td>Extend Terwilliger Blvd. entrance ramp/acceleration lane around curve to address poor sight distance, reduce speed differential and improve merging.</td>
<td>$30M - $40M</td>
<td>The initial proposed project will extend the current acceleration lane at the Terwilliger entrance-ramp around the horizontal curve to allow drivers to navigate the curve and then merge into mainline traffic in a tangent section of the freeway. This would provide drivers additional time and proper sight line to pick up gaps for the merging maneuver. The proposed project has the potential to reduce the number of crashes in the area because drivers would not be attempting to merge while navigating a long horizontal curve in a steep grade. The proposed project may not result in significant congestion relief in the peak hours due to downstream bottlenecks, but there would be operational and safety benefits associated with the enhanced design for the Terwilliger Blvd entrance-ramp merge junction. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.</td>
<td>Further Analysis</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>I-5: B2</td>
<td>2a</td>
<td>I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration</td>
<td>Convert the existing I-5 NB exit ramp to Lower Boones Ferry Road from a one-lane exit to a two-lane exit ramp</td>
<td>$1M - $2M</td>
<td>This is Phase 1 of the potential solution project for this bottleneck. The mainline traffic south of Nyberg St. Interchange would have the ability to exit to Lower Boones Ferry Road without having to make a lane change, thereby reducing the turbulence near the exit gore area in the two outside lanes. The duration of queuing is expected to be reduced by 30 minutes.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>I-5: B2</td>
<td>2b-1</td>
<td>I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension</td>
<td>Connect 2-lane entrance from Nyberg to existing NB auxiliary lane to Lower Boones Ferry. Extend auxiliary lane through Lower Boones Ferry interchange and connect to existing NB auxiliary lane. Construct merge lane for NB Lower Boones Ferry interchange entrance ramp.</td>
<td>$11.5M - $13.5M</td>
<td>Assuming Phase 1 (Map ID B) is built, this second phase of improvement is expected to provide further improvement of traffic operations and safety benefits in the project section. The length of queue is reduced and analysis of the peak periods does show some congestion relief. However, substantial operational benefits are expected in the adjacent hours to the peak periods.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>I-5: B2</td>
<td>2b-2</td>
<td>I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension</td>
<td>Construct auxiliary lane from NB Lower Boones Ferry Road entrance ramp to connect with existing auxiliary lane between Carman Drive and OR 217. Construct merge lane for NB Carman Dr. entrance ramp.</td>
<td>$17M - $21M</td>
<td>This is Phase 3 of the potential solution project for this bottleneck. There is a very high demand for volumes exiting to OR217 N and this improvement will provide those motorists a longer distance to find adequate gaps for lane changes and to position themselves in the appropriate lane earlier. This project is expected to result in overall operations and safety improvement.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>I-5: B2</td>
<td>2b-1 &amp; 2b-2</td>
<td>This Project is Phased into I-5 NB Projects B, C and D.</td>
<td>Refer to I-5NB: Projects B,C and D.</td>
<td>$18M - $22M</td>
<td>This project is broken into Phase 1, 2 and 3. Project cost exceeds CBOS criteria of $1 to $20 million range.</td>
<td>Project Phased</td>
</tr>
<tr>
<td>Southbound</td>
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<tr>
<td><strong>F</strong></td>
<td>I-5: BS</td>
<td>3</td>
<td>I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane</td>
<td>This project would extend the current lane drop just south of the Carman Dr. Exit Ramp to the Lower Boones Ferry Rd. OFF Ramp, where it would become a drop lane.</td>
<td>$1.25M</td>
<td>This is Phase 1 of the potential solution project for this bottleneck. This is expected to minimize queuing on I-5 from the OR217 merge by 1 mile, and reduce the queuing on OR217 approaching I-5. This is expected to result in a decrease of 1 hour of congestion along I-5.</td>
<td>Constructed August 2012</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td>I-5: B6</td>
<td>3a-1</td>
<td>I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane</td>
<td>The proposed project would extend the existing auxiliary lane from the Lower Boones Ferry Rd. exit-ramp to the Nyberg St. entrance-ramp.</td>
<td>$7.2M - $8.5M</td>
<td>This is Phase 2 of the potential solution project for this bottleneck. The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. This is expected to reduce congestion, improve lane balance and travel time reliability, and sustain stable traffic flow. Extension of the auxiliary lane is expected to result in a 20% reduction in mainline crashes.</td>
<td></td>
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</table>
Table 3-1: Potential Regional Projects Summary

<table>
<thead>
<tr>
<th>Map ID</th>
<th>Bottleneck ID</th>
<th>Tracking ID</th>
<th>Project</th>
<th>Description</th>
<th>Est. Cost</th>
<th>Traffic Analysis Findings/Comments</th>
<th>Potential Solutions Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>I-5: 86</td>
<td>3a 3</td>
<td>I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension</td>
<td>Extend I-5 SB auxiliary lane from Nyberg Rd exit ramp to I-205 exit ramp and maintain the SB auxiliary lane configuration from Nyberg Rd entrance ramp to I-205 exit ramp.</td>
<td>$10M - $18M</td>
<td>The additional auxiliary lanes are expected to reduce weaving behaviors and improve traffic operations. Of the volumes exiting to I-205, 36% are from OR217, 24% are from Carman and Lower Boones Ferry, and 30% are from Nyberg. With 90% of the traffic exiting at I-205 coming from the four entrance-ramps immediately north, this auxiliary lane would provide more direct connection without having to mix or interact with the rest of mainline traffic. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>Yes</td>
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<tr>
<td>I</td>
<td>I-205: 83</td>
<td>2</td>
<td>I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane</td>
<td>Construct a short auxiliary lane by extending the acceleration lane from I-84 westbound merging traffic on I-205NB to the Sandy Boulevard off-ramp.</td>
<td>$6.7M</td>
<td>The proposed project will construct an auxiliary lane by extending the acceleration lane from the I-84 WB entrance-ramp to the Sandy Blvd. exit-ramp. The spacing between the I-84 WB entrance-ramp and Sandy Blvd. exit-ramp is approximately 200'. With the addition of an auxiliary lane between these two ramps, the I-84 WB entrance-ramp traffic would not be required to merge into the I-205 mainline immediately as they currently do. This would allow vehicles on the I-84 WB entrance-ramp additional time to find gaps to access the I-205 mainline. As a result, this would help reduce the queueing and relieve congestion that the I-84 WB entrance-ramp currently propagates south to the I-84 EB entrance-ramp merge junction and would improve overall traffic safety in the project section.</td>
<td>Yes</td>
</tr>
<tr>
<td>J</td>
<td>I-205: 83</td>
<td>2a</td>
<td>I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension</td>
<td>Extend auxiliary lane from Sandy Blvd. exit ramp to Columbia Blvd. ramp in conjunction with the assumed auxiliary lane from I-84 WB entrance ramp to I-205 NB exit ramp to Sandy Blvd.</td>
<td>$6.5M</td>
<td>The proposed project will build upon Project Map ID I by creating an auxiliary lane from the I-84 WB entrance-ramp to the Columbia Blvd. /Killingsworth St. (US30 Bypass) exit-ramp. This project would eliminate Bottleneck 3. In addition, it will improve traffic safety and operations for Freight movements as the Columbia Blvd and US30 Bypass are major Freight Routes serving the north Portland industrial areas.</td>
<td>Yes</td>
</tr>
<tr>
<td>K</td>
<td>I-205: 84</td>
<td>1</td>
<td>I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension and 2-Lane Exit at Washington St.</td>
<td>This project would eliminate Bottleneck 3, reducing queueing during off-peak period. Vehicles would arrive at the downstream bottleneck earlier in the peak period, increasing congestion at Bottleneck 1.</td>
<td>$6.5M - $7.5M</td>
<td>The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queueing would be reduced in most lanes and completely reduced in the two leftmost lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>Yes</td>
</tr>
<tr>
<td>L</td>
<td>I-205: 84</td>
<td>1a</td>
<td>I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension</td>
<td>Add an auxiliary lane from Powell Blvd. entrance ramp to Division St. entrance ramp and tie to the existing auxiliary lane between Division St. entrance ramp and Washington St. exit ramp.</td>
<td>$6.0M - $6.9M</td>
<td>This project is the first phase of a phased approach to developing an auxiliary lane on I-205 NB. The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queueing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>Yes</td>
</tr>
<tr>
<td>M</td>
<td>I-205: 84</td>
<td>1b</td>
<td>I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension</td>
<td>Extend auxiliary lane from Washington St. Exit Ramp to Glisan St. Exit Ramp.</td>
<td>$2.4M - $2.8M</td>
<td>The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queueing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements. The proposed improvement will enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queueing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>YES</td>
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</tbody>
</table>
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<tr>
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<th>Tracking ID</th>
<th>Project</th>
<th>Description</th>
<th>Est. Cost</th>
<th>Traffic Analysis Findings/Comments</th>
<th>Potential Solutions Identified</th>
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</thead>
<tbody>
<tr>
<td>N</td>
<td>I-205: B4</td>
<td>1c</td>
<td>I-205: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension</td>
<td>Extend auxiliary lane from Glisan St. Exit Ramp to I-84 WB exit ramp.</td>
<td>$2.2M - $2.5M</td>
<td>Assuming that Projects Map ID L and M are built, this would be the next low-cost incremental improvement for congestion relief in the area. The proposed project would extend the auxiliary lane from Glisan St. exit-ramp to I-84 WB exit-ramp. It proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time/distance to find gaps and safely weave over lanes. Of the volumes exiting at I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>Yes</td>
</tr>
<tr>
<td>O</td>
<td>I-205: B4</td>
<td>1d</td>
<td>I-205: Phase 4 - Division Street Entrance Ramp to Stark St./Washington St. Exit Ramp Auxiliary Lane Extension w/ 2-lane Exit at Washington Street</td>
<td>Extend the existing NB auxiliary lane from Stark St./Washington St. exit ramp to Glisan St. exit ramp.</td>
<td>$1.7M - $2.0M</td>
<td>Assuming Projects Map ID L, M, and N are built, this project would be the next and final low-cost phase. The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Of the volumes exiting at I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>Yes</td>
</tr>
<tr>
<td>P</td>
<td>I-205: B4</td>
<td>1e</td>
<td>I-205: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/ 2-lane Exit at Washington St.</td>
<td>Extend auxiliary lane from Division St. exit ramp to I-84 WB exit ramp. Add an auxiliary lane from Division St. Entrance ramp to Washington St. Exit Ramp. Convert the existing I-205 NB exit ramp to Washington St. from a one-lane exit to a two-lane exit ramp.</td>
<td>$7.6M - $8.0M</td>
<td>A follow-up phase to Project Map ID L, this project represents the ultimate improvement to address congestion relief for the area. Considering that funding may be a constraint, this project can be broken into three smaller projects: Project Map ID M, N, and O. This project would extend the auxiliary lane from Washington St. exit-ramp to I-84 WB exit-ramp and build an additional auxiliary lane from Division entrance-ramp to Washington St. exit-ramp with two-lane exit. The proposed improvement will provide drivers additional time and distance to safely make the necessary weaving maneuvers. Congestion would be completely reduced in all lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Southbound**

| Q      | I-205: B8/B9  | 1           | I-205 SB: I-84 EB Entrance ramp to Stark St./Washington St. exit Ramp - Auxiliary Lane | Add an auxiliary lane from I-84 EB entrance ramp to Washington St. entrance ramp and tie to the existing auxiliary lane between Washington St. and Division St. | $7.0M - $8.5M | Approximately 25% of traffic from I-84 EB Entrance-ramp is destined for Division/Powell and this project would provide direct connection to this exit. Congestion/queuing would be reduced in all lanes and completely reduced in the two leftmost lanes. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements. | Yes |
### Table 3-1: Potential Regional Projects Summary

<table>
<thead>
<tr>
<th>Map ID</th>
<th>Bottleneck ID</th>
<th>Tracking ID</th>
<th>Project</th>
<th>Description</th>
<th>Est. Cost</th>
<th>Traffic Analysis Findings/Comments</th>
<th>Potential Solutions Identified</th>
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</thead>
<tbody>
<tr>
<td>I-84 Recommended Projects</td>
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<tr>
<td>Eastbound</td>
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<tr>
<td>R</td>
<td>I-84: B2</td>
<td>2a</td>
<td>I-84 EB: Grand Ave. Entrance Ramp Extension</td>
<td>Lengthen the EB entrance ramp to 12th Ave. U’xing structure</td>
<td>$4.4M - $5.2M</td>
<td>Initial analysis is inconclusive. Project needs further analysis to evaluate improvement to address safety/operational issues. Further analysis needed could include HSFM and before/after crash analysis for similar acceleration lane extension projects.</td>
<td>Further Analysis</td>
</tr>
<tr>
<td>S</td>
<td>I-84: B3</td>
<td>1</td>
<td>I-84 EB: Halsey St. Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane</td>
<td>The project will construct a new exit-only lane by extending the current Halsey St. exit-only lane on I-84 eastbound to the I-205 northbound exit ramp.</td>
<td>$5.9M</td>
<td>The new exit-only lane to I-205 northbound will improve safety by reducing traffic queuing and congestion on I-84 WB. It will also improve traffic flow for I-84 WB through traffic including freight movements destined to Troutdale or locations further east within the hour, with a peak of 90% between 6AM and 9AM.</td>
<td>Construction 2013</td>
</tr>
<tr>
<td>T</td>
<td>I-84: B4</td>
<td>4a</td>
<td>I-84 WB: I-5 NB and I-5 SB Diverge Re-striping</td>
<td>Re-stripe lane markings to provide two dedicated exit lanes to I-5 SB and one dedicated exit lane to I-5 NB. Add additional signage.</td>
<td>$0.5M</td>
<td>Over the past five years (2007-2011), there have been 237 collisions on I-84 westbound between the Convention Center/Rose Quarter exit ramp and 33rd Avenue. Of these, 31 occurred between the Grand Avenue overpass and the ramp for Convention Center/Rose Quarter. Of the 237 collisions that have occurred between the Convention Center/Rose Quarter ramp and 33rd Avenue, 95% have been rear-end or sideswipe collisions resulting from traffic merging and weaving to get into the correct lanes and from the speed reductions and congestion that result from these actions. The re-striping and signage upgrade will improve traffic flow and help reduce motorist confusion in this area and the collisions that result by providing clearly marked dedicated exit-only lanes.</td>
<td>Construction 2013</td>
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<tr>
<td>I-405 Recommended Projects</td>
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<td>Southbound</td>
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<td>U</td>
<td>I-405: B2</td>
<td>2a</td>
<td>I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement</td>
<td>Convert the EB-SB entrance ramp from a two-lane entrance to a one-lane entrance ramp</td>
<td>$0.5M - $1.0M</td>
<td>This project is expected to provide improved traffic operations and safety benefits by eliminating the inside lane merge. This will result in smoother traffic flow as vehicles entering from the entrance-ramp will stay in the auxiliary lane longer and wait for adequate space before making the lane change onto the mainline. A couple of similar type of projects that have been constructed in the region over the past 6-8 years are: (1) Milwaukee Expressway [OR224, Hwy172]/SE 82nd Ave. entrance-ramp merge junction on I-205 southbound, and (2) OR99W/SW Barbur Blvd and the truck climbing lane entrance-ramp merge junction on I-205 northbound located approximately 1/2 mile north of the Haines Rd. interchange.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
3.10 Regional Project Modeling

CBOS is a comprehensive effort to identify and evaluate recurring bottlenecks on the five major freeway corridors in the Portland Metro area. An important issue to examine and understand is the potential of these bottleneck improvements to create induced traffic. ODOT’s primary goal of CBOS is to improve the safety and operations of the existing freeway by reducing the congestion at recurring bottlenecks without increasing the overall capacity of the freeway corridor.

FHWA states that "induced travel is often misused to imply that increases in highway capacity are directly responsible for increases in traffic. In fact, the relationship between increases in highway capacity and traffic is very complex, which encompasses various traffic behavior responses, residential and business location decisions, and changes in regional population and economic growth".¹

Oregon land use planning laws requires local jurisdictions to establish and identify the amount and location of specific land uses based on population and employment projections of the region. In the Portland Metro area, METRO develops the population and employment targets based on its Metroscope model. These targets are incorporated into the Regional Transportation Plan (RTP) and transportation decisions are made based on those projections. These decisions are then reflected in the local Comprehensive Plans and Transportation System Plans.

The regional travel demand model is a four-step trip based travel behavior model that is consistent with the RTP and is utilized to project traffic volumes and travel times on the transportation network. The model offers an understanding of travel behavior and improvement project impacts. Travelers generally divert to alternative routes to avoid congestion and bottlenecks that will delay their trips. The travel demand model is sensitive to the capacity constraints and will reallocate trips based on capacity and travel time to reach the travelers destination. When the freeway is congested, the model will reroute trips to the local system. Vice versa, if a bottleneck is removed on the freeway, trips that would have taken the freeway will be rerouted back to the freeway.

The CBOS improvement projects were coded into the 2010 and 2035 AM and PM travel demand models and compared to No-Build conditions to determine the travel impacts and to answer the question of induced demand. The majority of the projects are auxiliary lane extensions with the purpose of improving safety through breaking up recurring bottlenecks and better facilitating freeway entering/exiting traffic. The following projects were modeled:

<table>
<thead>
<tr>
<th>I-5 Projects</th>
<th>Location</th>
<th>Type of Improvement</th>
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</thead>
<tbody>
<tr>
<td>Project B</td>
<td>I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration</td>
<td>2-Lane Exit at Lower Boones Ferry Road</td>
<td></td>
</tr>
<tr>
<td>Project C</td>
<td>I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange</td>
<td>Auxiliary Lane Extension</td>
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</tr>
</tbody>
</table>

For varying reasons, the following projects were not modeled:

<table>
<thead>
<tr>
<th>I-5 Projects</th>
<th>Location</th>
<th>Type of Improvement</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Project A</td>
<td>I-5 NB: Terwilliger Blvd. Entrance Ramp</td>
<td>Recommended for further analysis</td>
<td></td>
</tr>
<tr>
<td>Project E</td>
<td>I-5 NB: Nyberg Rd. Interchange to Carman Dr. Interchange</td>
<td>Project phased into I-5ND projects B,C and D</td>
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</table>

¹ Induced Travel: Frequently Asked Questions, FHWA’s Planning web page: http://www.fhwa.dot.gov/planning/itfaq.cfm
The trip demand modeling results verified the assumption that the CBOS auxiliary lane improvements help the recurring bottlenecks. The Key Points are summarized below:

- For freeway sections where there are series of auxiliary lane improvements, the trip difference is more apparent, as consistent with the goal of relieving localized bottlenecks. There is generally 1-6% trip increases on the freeway section within the project area and extended to one interchange downstream.
  - Auxiliary lanes used between consecutive entrance and exit ramps allow traffic to speed up and slow down in designated lanes while reducing interference to the throughway.
  - Auxiliary lanes improve the safety and freeway operations at interchanges, better facilitating vehicles existing and entering the freeway mainline.
- The auxiliary lane improvements generally benefit local roadways surrounding the area. Longer-distance trips are staying on the freeway a little longer by 1-2 interchanges, providing relief to the local facilities. This is seen in the trip differences on local roads, exit ramps and entrance ramps.
  - For I-5 S, more trips are now able to get to Tualatin-Sherwood Road and not using the local roadways as a cut-through route.
  - For I-5 N, more trips are now able to get to Upper Boones-Ferry Road/Carmen and not getting off at Nyberg and using the local roadways as a cut-through route.
  - For I-205 N impacts, trips on I-84 W and I-84 E destined to the airport area are no longer exiting early to avoid the congestion at the connections to I-205.
- Generally, local roads parallel or adjacent to the freeway project area are seen to have a positive impact from trip changes.
- The modeling results indicated that that for the areas of the auxiliary lane improvements there was no significant increase in trips outside of the improvement area on I-5 or I-205.

- The 2035 model indicated that on I-5 to the north and south of the auxiliary lanes area the net change in trips would be no greater than roughly 50 trips during the AM and PM peak hour. This is less than 0.1% of the total trips on I-5.
- The 2035 model indicated that on I-205 to the north and south of the auxiliary lanes area the net change in trips would be no greater than 50 trips during the AM and PM peak hour. This is less than 0.01% of the total trips on I-205.

For each freeway facility, latent travel demand is not seen on a corridor-wide basis. Nor is there any inclination for mode shift since this typically occurs where travel is improved for longer distance (corridor-wide travel time improvement).

The modeling results are consistent with the purpose of the CBOS improvement projects, which is to enhance traffic safety and operations at freeway entrance and exit ramp junctions which are experiencing safety and operational issues. By breaking up the recurring freeway bottlenecks, freeway traffic will experience improved operations and will also be using the exit and entrance ramps that are more direct to reach their destination and reducing the cut-through traffic on the local roadway network.

The ultimate goal is to improve safety and CBOS was developed in accordance with the guidelines established in the FHWA Localized Bottleneck Reduction (LBR) program. CBOS and the FHWA LBR program share the same common theme, that is, reducing potential crashes within weaving and merging areas has a positive safety impact and is highly cost effective.²

### 3.11 What Do You Need to Know About the Recommended Projects?

The project sheets in Chapter 4 include a project description and schematic, along with summaries of traffic operations, safety, costs, constructability, and other user benefits. Also included on the project sheets is an assessment of impacts associated with each solution. Project sheets include aerial imagery, which provides a concept-level sketch of the identified solution. Also listed are the potential follow-up phases, where applicable.

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² FHWA – “Recurring Traffic Bottlenecks: A Primer”, Report No FHWA-HOP-12-012, pg. 16.