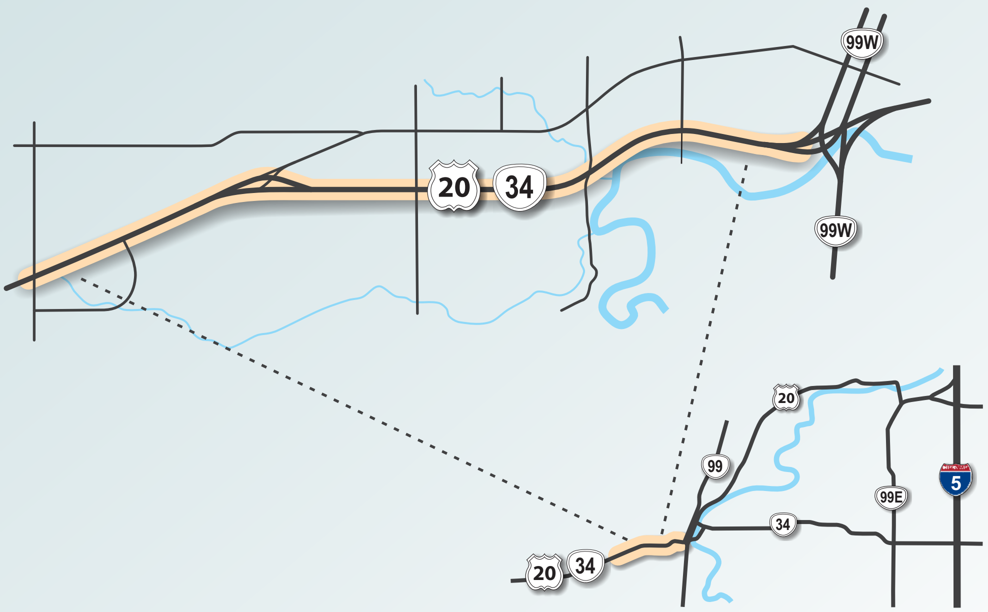
US 20/OR 34 Optimization Study

Final Report



February 2015

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4			

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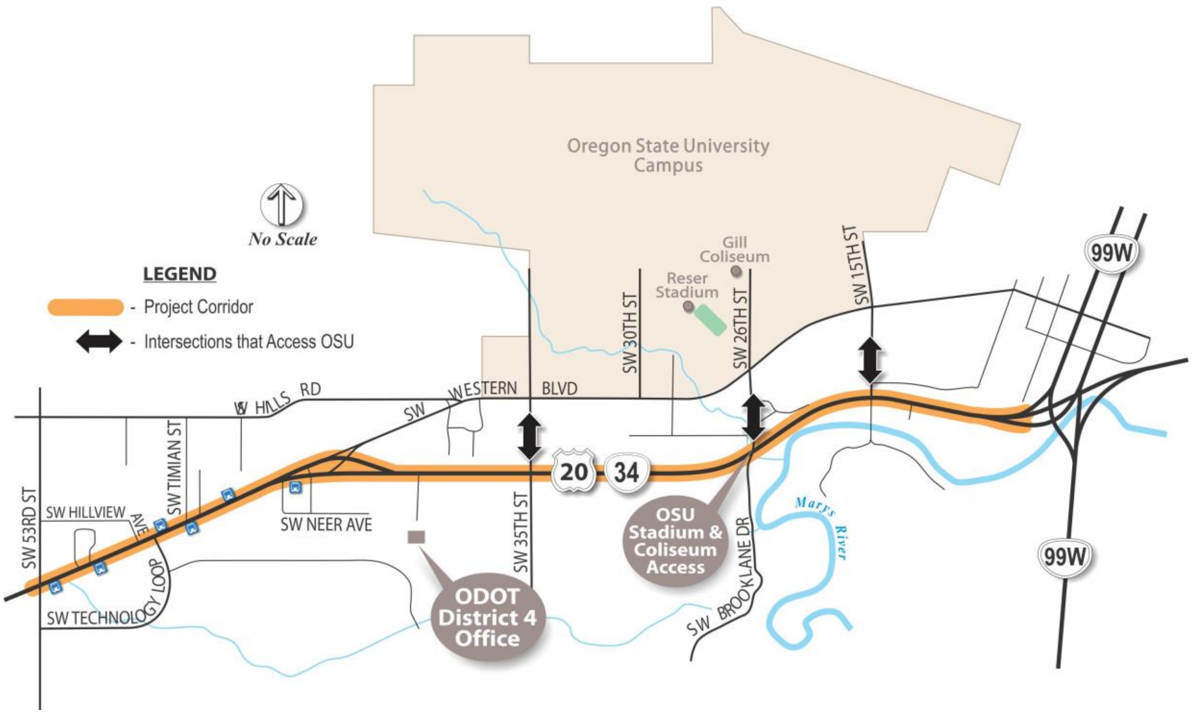
CHAPTER 1:
EXECUTIVE SUMMARY

About the Study

The US 20/OR 34 Optimization Study seeks to identify low cost, operational improvements to address safety and mobility within the study corridor over the next five years. The 2.2-mile corridor, extending from OR 99W to 53rd Street along the southern edge of Corvallis, is a critical segment of highway for commuter, freight, and recreational traffic.

Key Findings along the Corridor

- High percentage of heavy vehicle traffic, which is expected to increase with completion of the Pioneer Mountain to Eddyville project
- Recurring commuter traffic congestion that peaks on weekdays
- High bicycle and pedestrian crossing volumes
- Rear-end crashes represent the highest proportion of overall crashes (76%)



Key Corridor Needs

A review of existing conditions along the corridor identified the following project needs:

1. **The project needs to find ways to reduce rear-end crashes.** Rear-end crashes account for 76% of all crashes within the study area between 2008 and 2012. While this is a typical proportion within Oregon, the corridor would benefit from treatments focused on reducing this crash type.

2. **The project needs to find ways to enhance bicycle and pedestrian crossings within the corridor.** A shared use path that parallels the study corridor carries approximately 325 bicyclists and 50 pedestrians per day. North-south connections between the path and major trip generators (e.g. OSU Campus) exist, but provide limited support for crossing movements.

3. **The project needs to improve travel time associated with recurring congestion.** Recurring congestion along the corridor negatively impacts the travel times of commuters, campus visitors, and tourists traveling through the area. In addition to the impact on the regular auto traffic, the congestion impacts travel time reliability for both freight haulers and transit providers using the corridor.

4. **The project needs to identify strategies related to congestion that specifically target weekday commuting peaks.** Congestion along the corridor peaks during the weekdays, with lower levels experienced over the non-event weekends.

5. **The project needs to find ways to expedite truck movements through the study corridor.** Traffic volumes along the corridor include a high percentage of freight vehicles. With the completion of the US 20 – Pioneer Mountain to Eddyville project, the route will become a viable option for truck movement between the Willamette Valley and the Oregon Coast resulting in increased truck volumes in this stretch of the corridor.

The Goals and Objectives

The project team identified three primary goals and supporting objectives based on the established project needs. Chapter 3 includes specific targets for each of the objectives listed here. These goals and objectives are used to evaluate each potential strategy.

Goal 1: Improve Safety

Objectives:

- Reduce rear-end crashes
- Enhance pedestrian and bicycle facilities and clarify interaction between modes

Goal 2: Improve Commuter Mobility

Objectives:

- Enhance pedestrian and bicycle crossings with improved detection
- Improve travel time reliability during weekday commuter peaks

Goal 3: Improve Freight Mobility

Objectives:

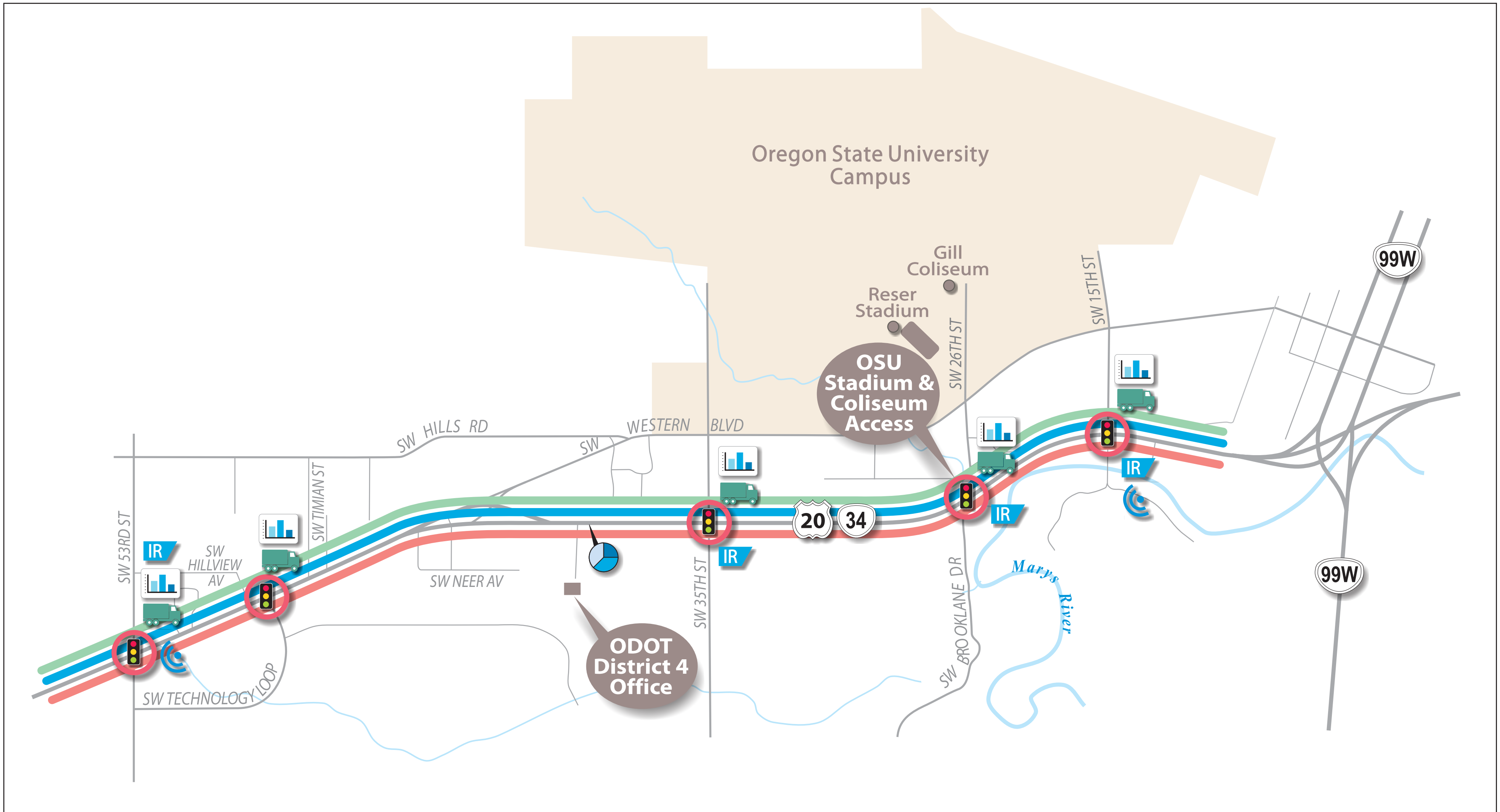
- Improve travel time reliability for freight during weekday freight peaks
- Reduce freight vehicle stops at traffic signals

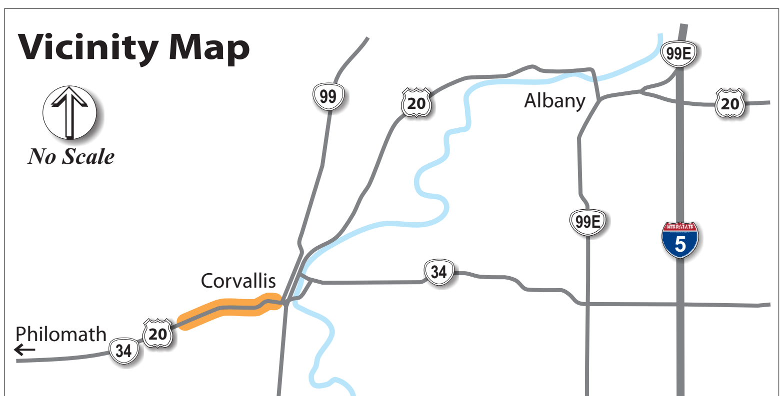
Recommended Strategies

The project recommends three strategies to achieve the corridor objectives. These strategies are selected because they provide the greatest benefit to each of the project goals and support a high return on investment, as shown through their benefit-cost (B/C) ratios. They include: adaptive signal timing, truck signal priority, and arterial performance measures and real-time equipment monitoring. The main benefits for the recommended strategies are due to travel time saving, a reduction in stops, and savings in data collection costs. A summary of where these strategies will apply along the corridor is shown in Figure 1-1, and Table 1-1 summarizes the cost and benefits of the three strategies.

The strategies have infrastructure needs that overlap, specifically in regards to detection and communication. It is most efficient to install all three strategies at once, however, it is recognized that limited capital funds may make that difficult. In lieu of this, preliminary design and systems engineering can be done together to determine optimal placement for detection for the three systems and communication requirements. This will allow the whole system to be designed at once to maximize efficiency in the system as a whole, even if they are constructed at different stages.

In addition to these strategies, other viable strategies are deferred to more germane planning efforts, including the OSU Campus Master Plan and Corvallis Transportation System Plan.





LEGEND

- Existing Signalized Intersection
- Proposed Adaptive Signals & Extent of Corridor Benefits
- Proposed Freight Signal Priority & Extent of Corridor Benefits
- Recommended Mid-Block Location for Additional Vehicle Detection & Data Collection
- Extent of Data Collection Benefits
- Recommended Intersection Locations for Additional Vehicle Detection & Data Collection
- Recommended Locations for Travel Time Data Collection
- IR - Recommended Locations for Bicycle Detection & Data Collection

Note: We recommend all proposed equipment be connected to a real-time monitoring system.

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Figure **1-1**

US 20/OR 34 Summary of The Three Recommended Strategies

Table 1-1: Summary of Recommended Strategies

1	**Adaptive Signal Timing**	**Estimated Initial Capital Cost: $390,000 to $870,000**	**B/C Ratio: 7.8 – 22.0**
	Summary: Install specialty signal software that monitors, responds to, and adjusts the signal timing based on traffic data and user-defined objectives.		
	Benefits: Reduces stops at signals between 5% - 35% Reduces travel time by about 5% Reduces fuel consumption and emissions Note: The wide range in cost and B/C ratios for this strategy represent the range in communication assumptions: no communication upgrades (low end) to installing fiber optic cable connections between the signals and the district office (high end)		
2	**Truck Signal Priority**	**Estimated Initial Capital Cost: $90,000**	**B/C Ratio: 5.0 – 8.3**
	Summary: Install specialty detection at traffic signals that will extend the green time of a signal movement when trucks are detected on the approach.		
	Benefits: Reduces heavy vehicle red-light violations by 80% Reduces heavy vehicle stops by 9% - 16% Reduces heavy vehicle delay by 13% - 21% Reduces noise pollution Reduces annual emissions by at least 32 – 57 metric tons CO_2 equivalent		
3	**Arterial Performance Measurement and Real-Time Equipment Monitoring**	**Estimated Initial Capital Cost: $360,000**	**B/C Ratio: 1.4 – 5.7**
	Summary: Install detection at the five signalized intersections within the study area and one mid-block location to collect arterial performances measures, including: traffic volumes, travel speeds, travel times, vehicle classification, vehicle occupancy, pedestrian and bicycle volumes, and delay for vehicles, pedestrians, and bicyclists.		
	Benefits: Reduces travel time up to 13% through signal timing updates[1] Provides robust data collection Provides ability to analyze before and after data Minimizes time between equipment failure and notification Improves efficiency for maintenance scheduling and routing		

[1]**Note:** If adaptive signal timing were implemented, minimal signal retiming would be necessary

Implementation Considerations

As each of the strategies is implemented, there are several considerations that should be used to inform project development and select a strategy consistent with available resources. The projects can be implemented in any order, as long as systems engineering is used to ensure that the strategies will work together if implemented at different times. Table 1-2 identifies key things to consider when determining which strategy to implement at a given time. More detail is provided in Chapter 6.

Table 1-2: Implementation Considerations

Considerations	Adaptive Signal Timing	Truck Signal Priority	Arterial Performance Measures/Real-time Equipment Monitoring
Is Systems Engineering Necessary?	Yes	Yes, if federal funding	Yes, if federal funding
Feasible to implement in stages?	No	Yes	Yes
Communication Necessary	Varies based on system selected	None	Can use existing center to field communication, but data transfer will be limited
New capital Necessary	New software and detection, possibly new communications	New detection	None, but additional detection for enhanced capabilities recommended
Upfront staffing needs	Significant	Moderate	Significant
Ongoing staffing needs	Moderate	Minimal	Minimal/Moderate

System Architecture

Figure 1-2 shows the high-level system architecture for the three recommended strategies. This diagram illustrates that ODOT already has some of the necessary field equipment for each strategy. A new processing system is necessary for the adaptive signal system, and the other two strategies can operate with either the existing traffic signal software, or with the adaptive signal software if that strategy is implemented. The diagram identifies additional field equipment for each strategy, as well as field equipment that can be shared between strategies. For the adaptive signal system, detection and communication are dependent on the selected system.

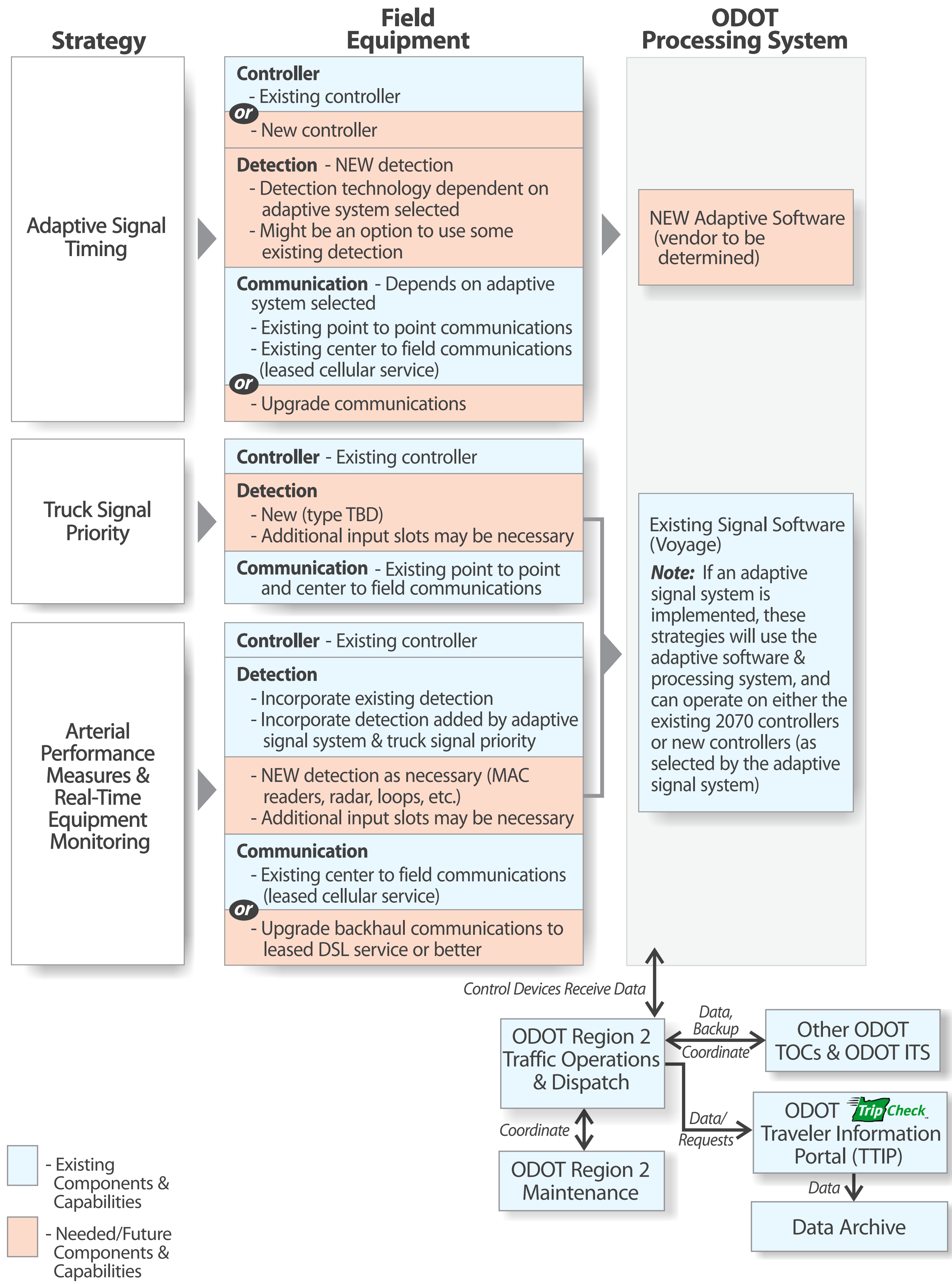

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Figure 1-2

Architecture Diagram
US20/OR34 Optimization Strategies

Next Steps

The project team identified additional considerations that should be evaluated as the project moves into design. These items are identified for each strategy.

Adaptive Signal Timing

Conduct a systems engineering analysis to meet FHWA requirements and identify software requirements, communication needs, detection configuration, and scope of study area (i.e. whether to extend further east). This should be coordinated with the ODOT statewide adaptive system engineering effort.

Truck Signal Priority

Consider detection and communications overlap with other strategies. Identify signal timing impacts (such as amount of green extension, etc.).

Arterial Performance Measurement and Real-Time Equipment Monitoring

Select performances measures for data collection, finalize implementation locations, and identify data management/archiving needs.

CHAPTER 2: EXISTING CONDITIONS

Chapter two documents the existing conditions along approximately 2.2 miles of US 20/OR 34, extending from Highway 99W to 53rd Street along the southern edge of Corvallis. This segment of highway is a critical route for commuter, freight and recreational traffic. The project focus is on the identification of cost-effective strategies that can be implemented along the corridor to improve travel conditions for all modes of use.

The existing conditions chapter describes key findings, general study area characteristics, traffic volumes, bike and pedestrian volumes, transit, congestion and delay, crash data, incident data, existing signage for OSU, and summarizes several additional resources with relevant information. This information will be used later in the project process to determine the best set of strategies for consideration.

2.1 Key Findings

The key findings from the existing conditions evaluation include:

- Heavy vehicle use along the project corridor is high, especially during the a.m. peak hour. An increase in the number of heavy vehicles using the corridor is expected once the Pioneer Mountain to Eddyville project is completed.
- Bicycle and pedestrian crossings of US20/OR34 are high throughout the corridor. Also, a large number of bicyclists and pedestrians utilize the shared-use path that runs parallel to US 20/OR 34.
- Recurring congestion associated with commuter traffic, rather than congestion caused by collisions or incidents, generates the greatest level of delay along the corridor.
- Congestion is higher on weekdays than on weekends.
- Rear-end crashes represent the highest proportion of overall crashes along the corridor (76 percent).

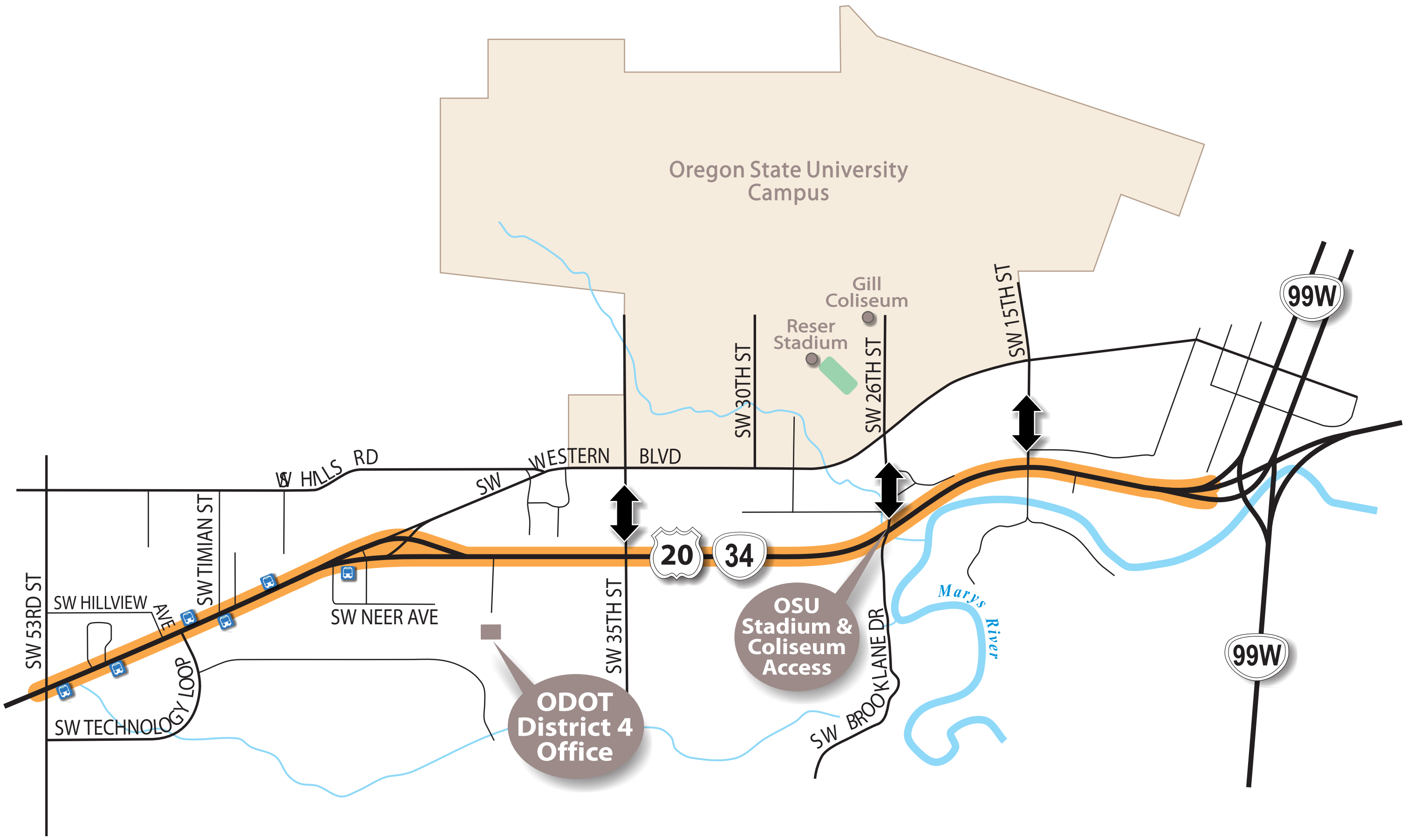
2.2 Study Area Characteristics

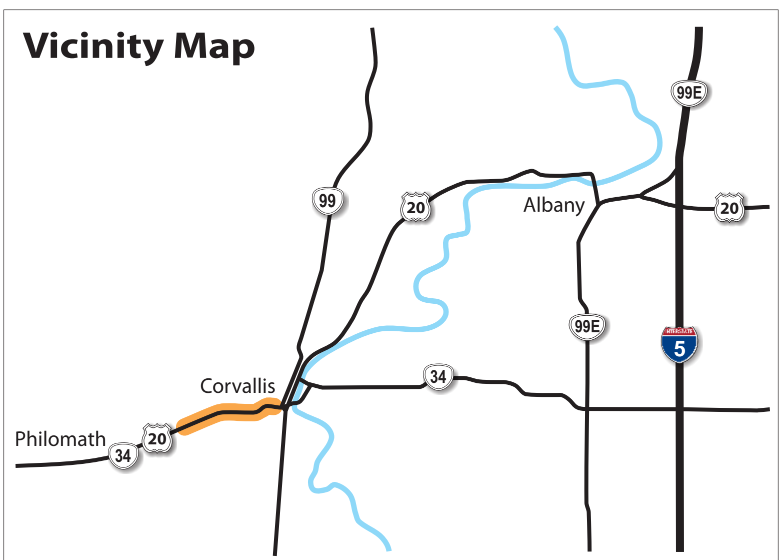
The study area includes approximately 2.2 miles of US 20/OR 34, also known as the Corvallis-Newport Highway, which runs through Corvallis, Oregon. US 20 and OR 34 overlap along this segment of highway, which extends from Highway 99W to SW 53rd Street. This highway serves as a primary route connecting I-5, Corvallis, Philomath and the Oregon Coast. US 20/OR 34 is part of the National Highway System and it is classified as a Statewide Highway Freight Route. The Corvallis Area Metropolitan Planning Organization (CAMPO) Regional Transportation Plan (RTP) classifies US 20/OR 34 as a principal urban arterial.

This segment of US 20/OR 34 is generally one lane in each direction, with a center turn lane in some sections, and includes five signalized intersections. The annual average daily traffic (AADT) ranges from approximately 13,800 vehicles per day near SW 53rd Street to 16,600 vehicles per day at SW 15th Street. The roadway is mostly flat with several horizontal curves and has a posted speed limit of 45 mph.

Oregon State University (OSU) is just north of US 20/OR 34, stretching from SW 11th Street at the east end to past SW 35th Street on the west end. There are three key intersections that provide access to the campus from US 20/OR 34: SW 15th Street, SW 26th Street, and SW 35th Street. SW 15th Street connects to the central campus area. SW 26th Street provides access to Reser Stadium and Gill Coliseum, both large sporting venues, and then continues into the heart of the campus. In the future, OSU hopes to use SW 14th and 15th Streets for bus access, and remove buses from SW 26th Street north of the stadium area (all of which would need to be coordinated with ODOT, and the City of Corvallis for impacts to the road network). SW 35th Street accesses the west end of campus. On the west side of SW 35th there is some planned student housing and a planned shared-use path north of Western Boulevard.

The study area is shown in Figure 2-1.





LEGEND

- Project Corridor
- Intersections that Access OSU
- Bus Stop

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No Scale

Figure 2-1

STUDY AREA

2.3 Traffic Volumes

There are no Automatic Traffic Recorders (ATRs) within the study corridor; however there are several ATRs in the surrounding areas that can provide some insight on seasonal and yearly travel trends along the project corridor. An ATR located approximately five miles to the east along OR 34 (ATR Station Riverside Drive 22-020) shows that traffic volumes remained relatively stable since 2005 (as shown in Figure 2-2). This location (east of Corvallis) has little seasonal fluctuation in traffic volumes.

Approximately 15 miles to the west of the project corridor, an ATR on OR 34 (ATR Station Alsea 02-003) shows overall traffic volumes decreased by about 15 percent since 2004 (as shown in Figure 2-3). Traffic volumes at this location (15 miles west of Corvallis) are much lower than to the east and show significant seasonal fluctuation. In August average daily traffic (ADT) is up 124%, and in March ADT drops to 82% based on 2012 data.

A third ATR is located on US 20 approximately 20 miles west of Philomath (ATR Station Burnt Woods 21-006). ADT at this location is generally around 5,000 vehicles, and volumes remain relatively stable over the last ten years (as shown in Figure 2-4). Similar to OR 34 near Alsea, this roadway also experiences significant seasonal fluctuations. In August the ADT is up 134%, and in January it drops to 75%.

Given the location and characteristics of the project corridor in relation to the three ATR sites, we believe traffic volumes likely remained stable or possibly declined slightly over the last eight to ten years. Because this section of highway servers commuters, school-related traffic, and regional trips to the coast, it likely experiences some seasonal fluctuation, but probably not as much as seen at the two ATR station west of Corvallis.

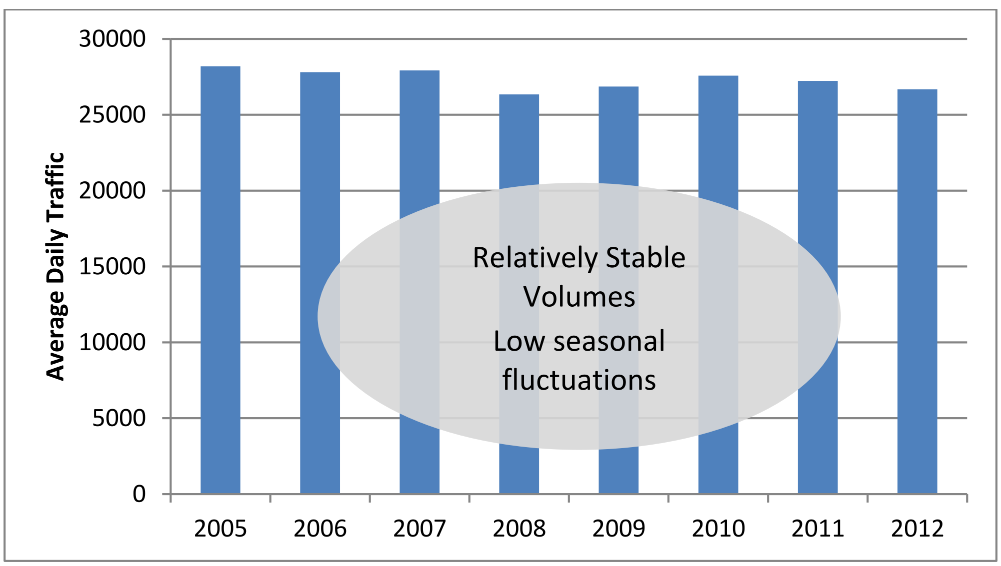


Figure 2-2: ATR Station Riverside Drive 22-020 Approximately Five Miles East of Corvallis

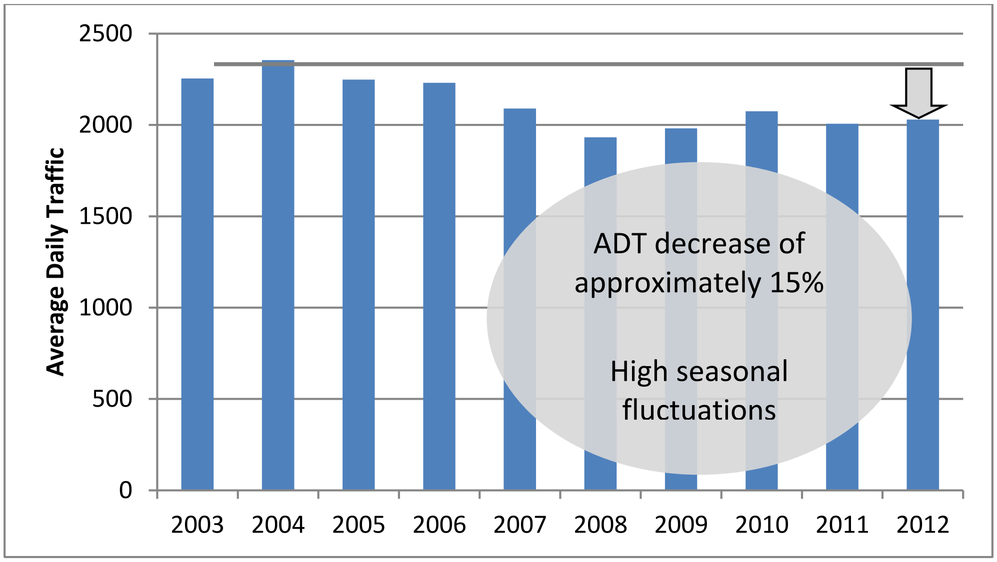


Figure 2-3: ATR Station Alsea 02-003 Approximately 15 Miles West of Corvallis on OR 34

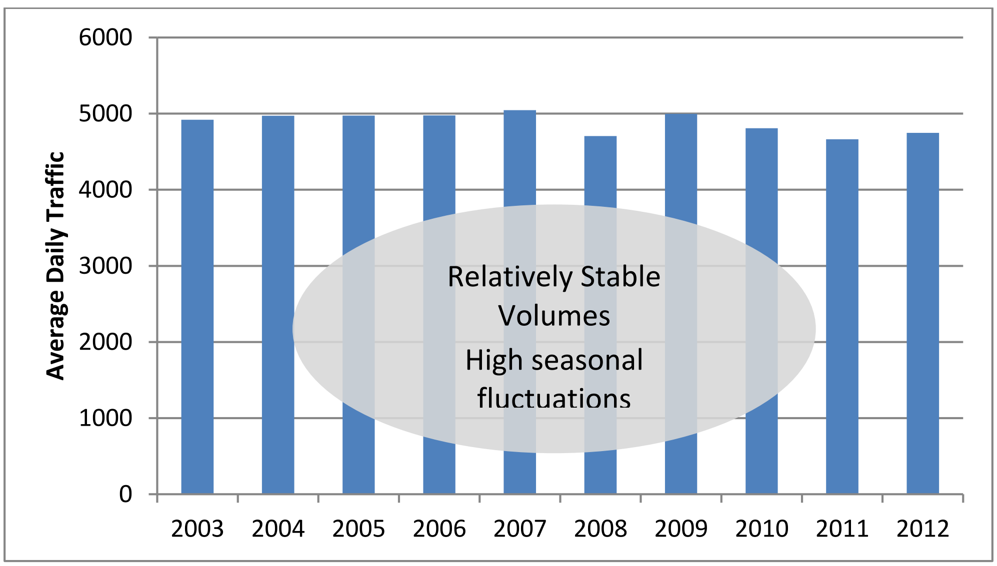


Figure 2-4: ATR Station Burnt Woods 21-006 Approximately 20 West of Philomath on US 20

2.3.1 Peak Hour Traffic Volumes

Several traffic counts were taken at intersections along the project corridor in May of 2012 in preparation for the Corvallis TSP update and in November of 2013 as part of the Base Transportation Model update. The daily traffic volume trends for US 20/OR 34 just east of SW 26th Street are shown in Figure 2-5. Eastbound volumes are heavier than westbound, and peak between 7-8 a.m., and again between 4-5 p.m.

The a.m. (7-9 a.m.) and p.m. (4-6 p.m.) peak hour traffic volumes are summarized in Figure 2-6. At the east end of the project corridor (near SW 15th Street), peak hour volumes along US 20/OR 34 are similar during the a.m. and p.m. peak hours and there is little difference between eastbound and westbound volumes. At the west end of the project corridor (near SW 53rd Street), there is a significant directional split with heavy eastbound traffic in the a.m. peak and heavy westbound traffic in the p.m. peak.

All traffic volumes are included in Appendix A.

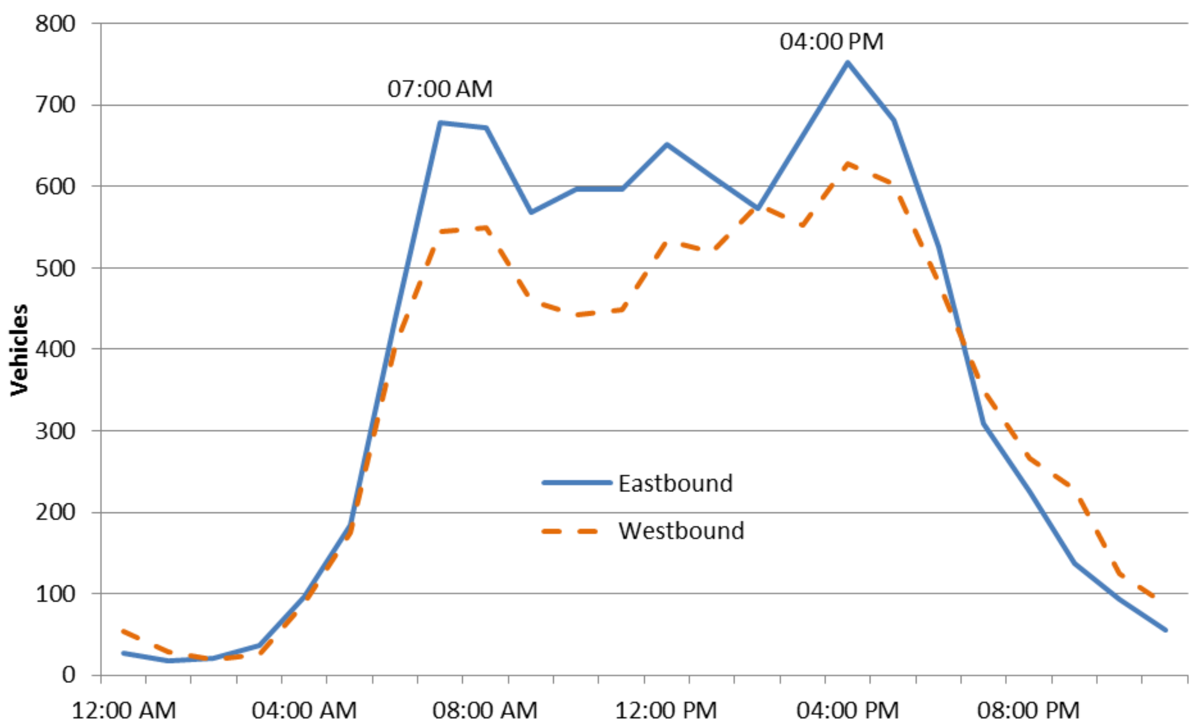
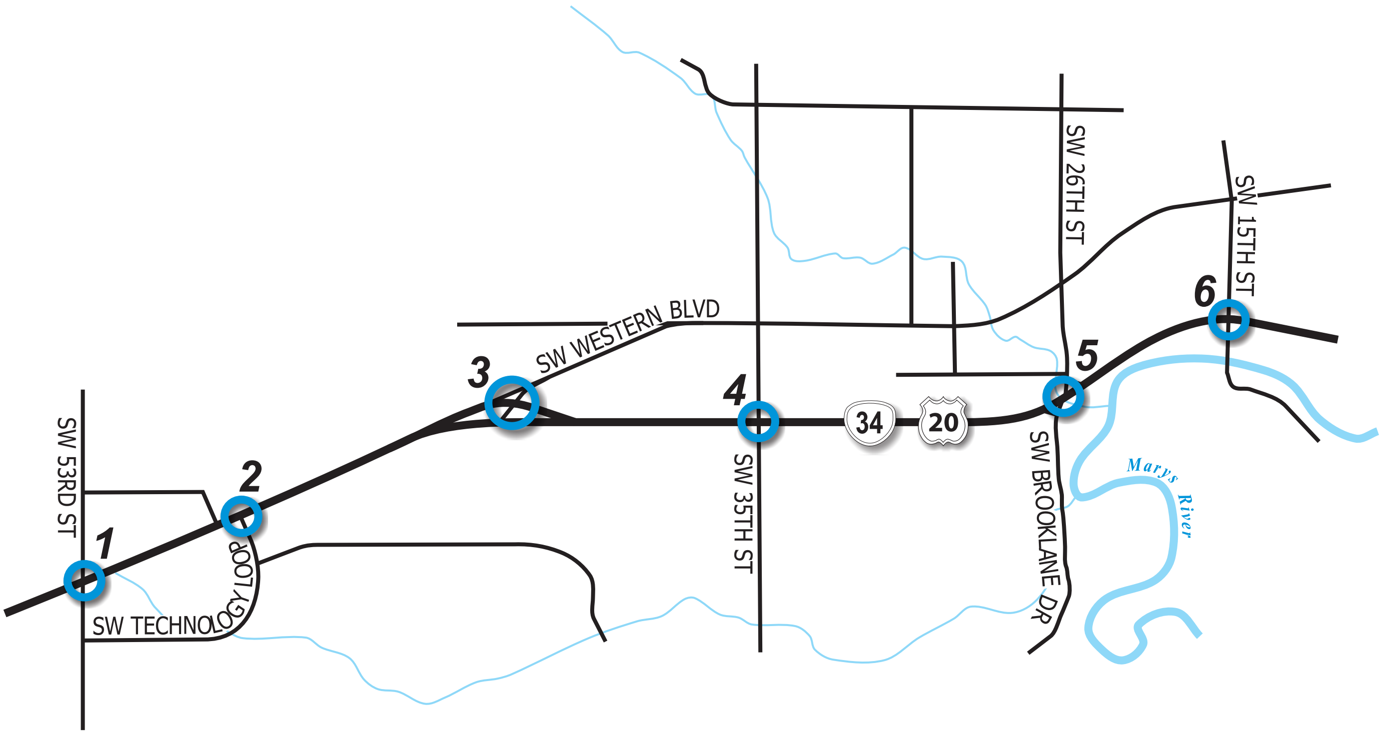
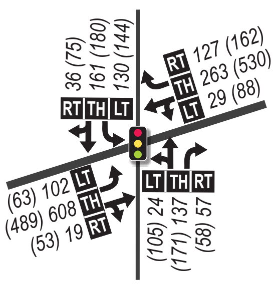


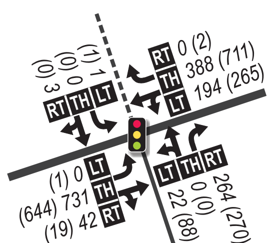
Figure 2-5: Traffic Volumes on US 20/OR 34 East of 26th Street



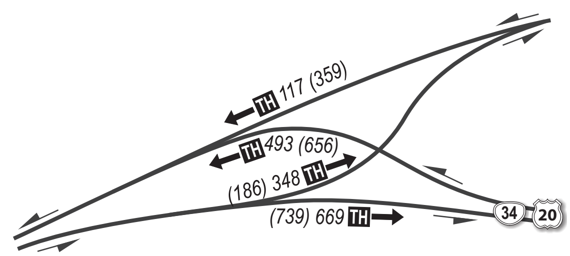
1. US 20-OR 34/SW 53RD ST.



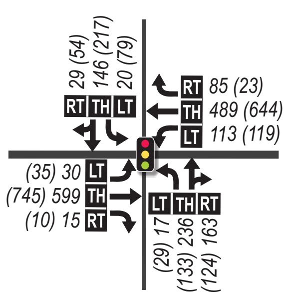
2. US 20-OR 34/SW TECHNOLOGY LOOP



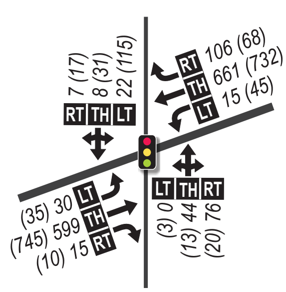
3. US 20-OR 34/SW WESTERN BLVD.



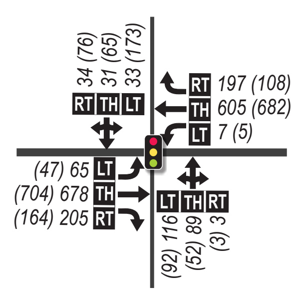
4. US 20-OR 34/SW 35TH ST.



5. US 20-OR 34/SW 26TH ST./ SW BROOKLANE DR.



6. US 20-OR 34/SW 15TH ST.



LEGEND

- # - Study Intersection
- Traffic Signal
- Lane Configuration
- (PM) AM - Peak Hour Traffic Volumes
- LT TH RT - Volume Turn Movement (Left•Thru•Right)

DKS

No Scale

Figure 2-6

EXISTING 2012 US 20/OR 34 AM/PM PEAK TRAFFIC VOLUMES

2.3.2 *Heavy Vehicle Volumes*

The heavy vehicle volumes associated with the 24-hour traffic counts shown in Figure 2-5 are shown in Figure 2-7[1]. Truck traffic peaks at different times than overall commuter traffic. In the westbound direction truck traffic peaks around 10 a.m., and in the eastbound direction it peaks around 2 p.m. At this location, the percent of truck traffic nears 20% at times.

Figure 2-8 shows the percentages associated with the traffic counts shown previously in Figure 2-6. All study intersections show a higher percentage of heavy vehicles during the a.m. peak hour.

It is anticipated that the number of heavy vehicles passing through the study corridor will increase due to the Pioneer Mountain to Eddyville project. This project, to the west of the study area, realigns approximately ten miles of US 20 between Philomath and Newport that currently restricts heavy vehicle trips It is estimated that completion of this project in fall of 2016 may increase the number of heavy vehicles using US 20/OR 34 by 100 vehicles or more per day.[2] This increase equates to at least six additional heavy vehicles per hour in each direction.

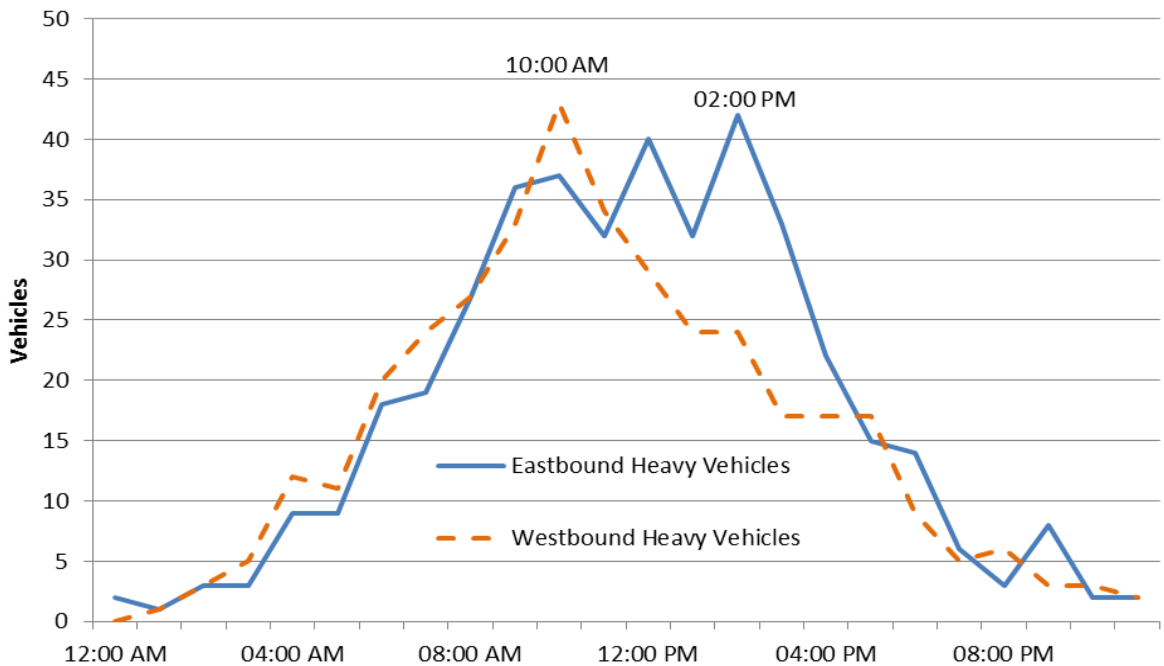
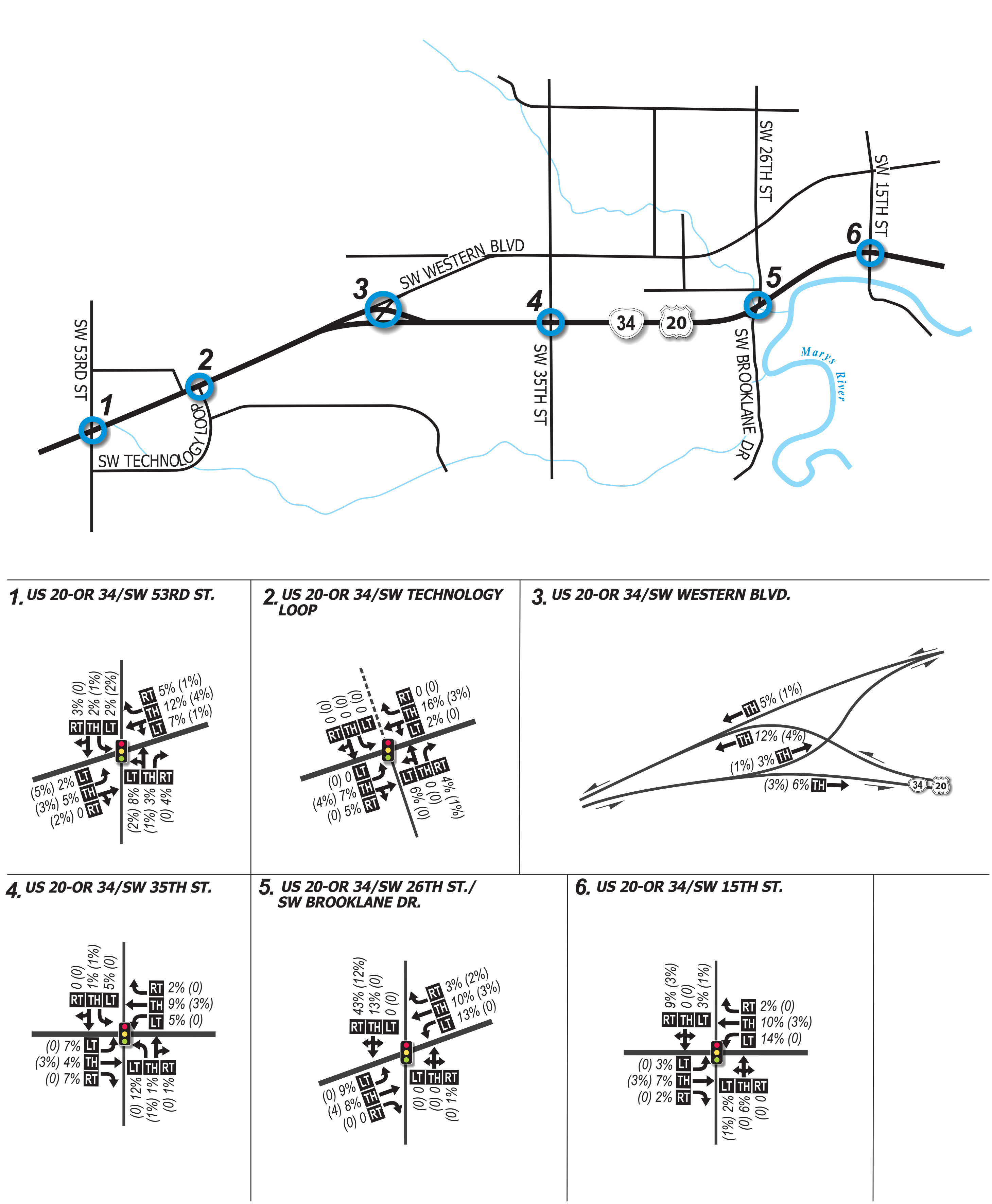


Figure 2-7: Heavy Vehicle Traffic Volumes on US 20/OR 34 East of 26th Street

[1] Traffic counts taken on May 22, 2012

[2] The US 20 Project (US20 PME: UPRR to Eddyville) website. Accessed June 24, 2014: http://www.oregon.gov/ODOT/HWY/REGION2/Pages/US20-PME-UPRR-to-Eddyville.aspx



LEGEND

- # Study Intersection
- Traffic Signal
- ← - Lane Configuration
- (PM) AM - Peak Hour Heavy Vehicle Percentage
- LT TH RT - Volume Turn Movement (Left•Thru•Right)

DKS

No Scale

Figure **2-8**

EXISTING 2012
US 20/OR 34 AM/PM PEAK
HEAVY VEHICLE PERCENTAGE

2.4 Bike and Pedestrian Volumes

From SW 15th Street to 500 feet west of SW 35th Street, a paved shared-use path parallels US 20/OR 34 to the south. This path is part of a larger network that provides key pedestrian and bicycle connections to Avery Park, OSU, downtown Corvallis, and Philomath to the west.

Figure 2-9 shows the daily profile of bike and pedestrian volumes collected on May 30, 2012, near SW 35th Street. In total, there were 324 bikes and 49 pedestrians counted over twenty hours, with peaks observed during the a.m. and p.m. peak hours.

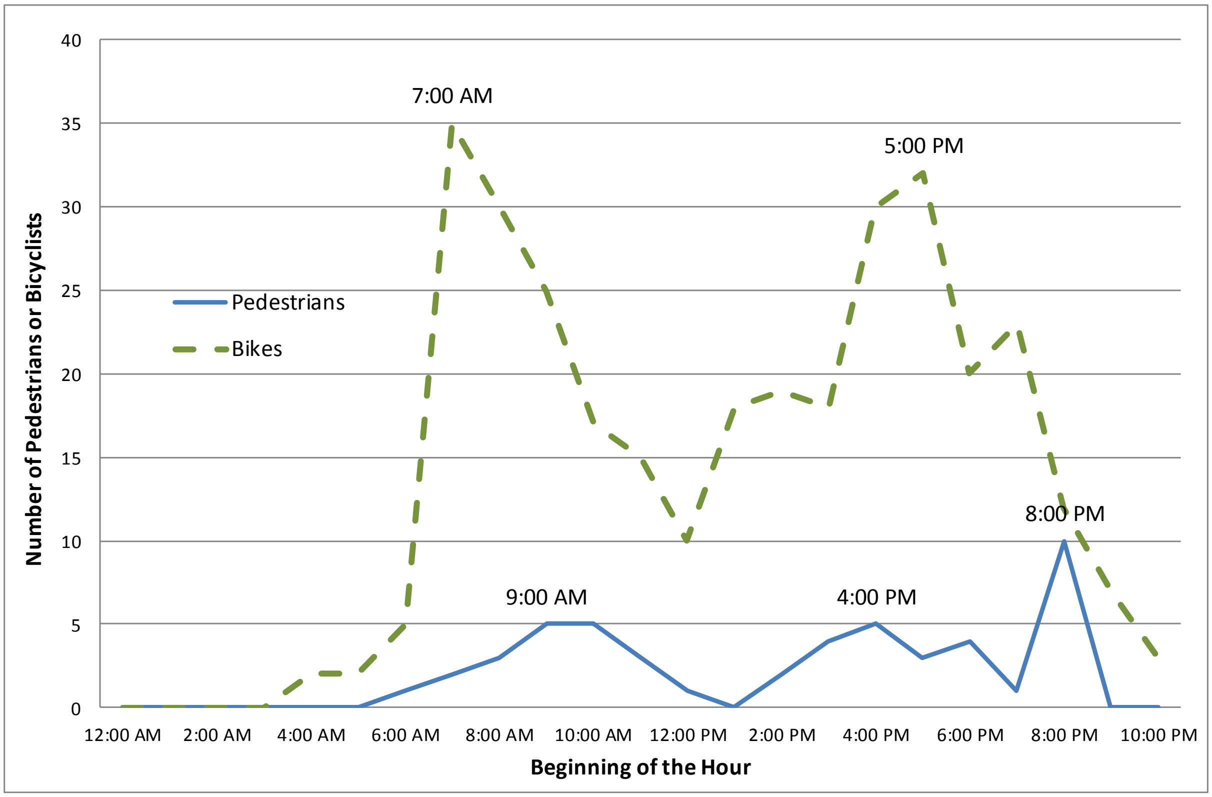
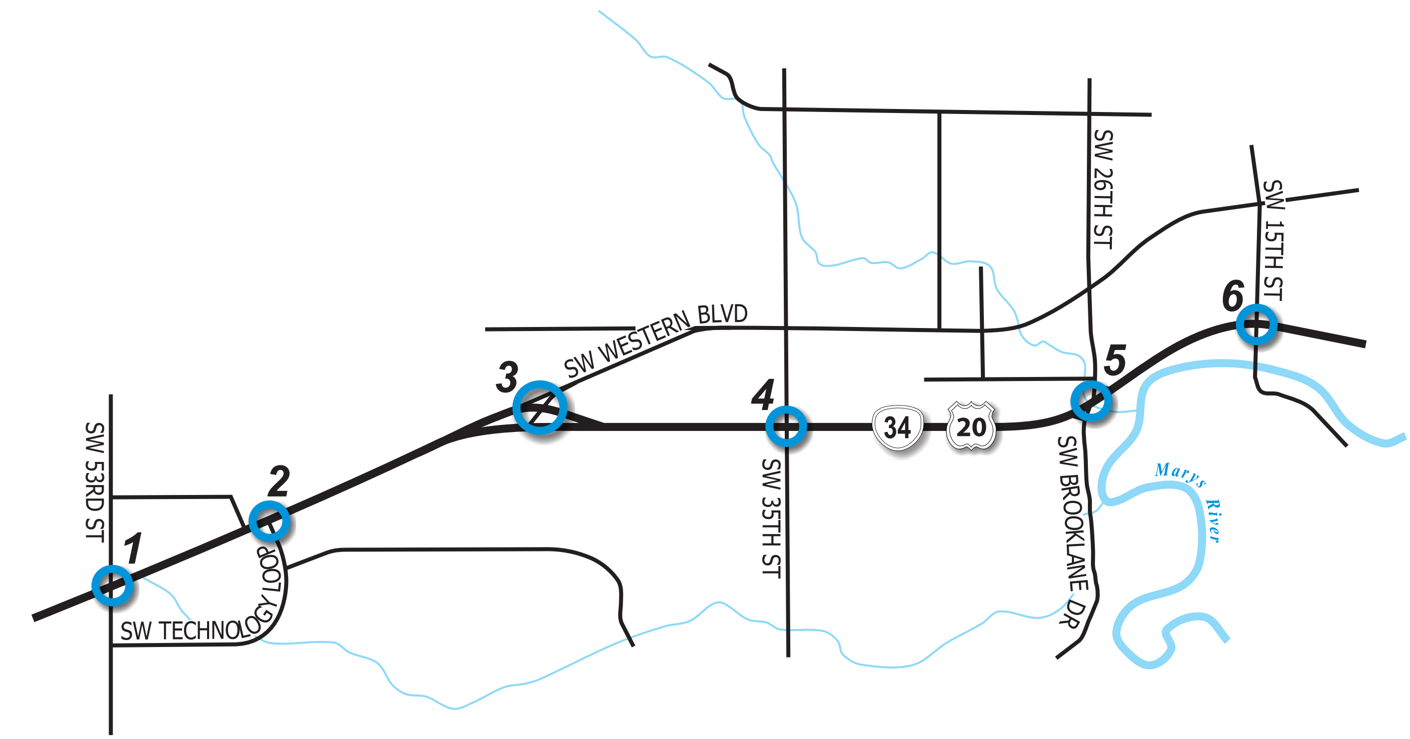
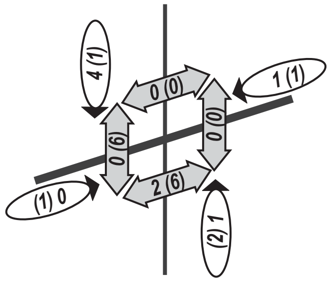


Figure 2-9: Bike and Pedestrian Volumes along Shared-Use Path (West of 35th Street)

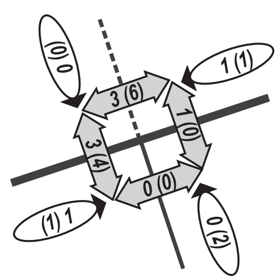
Figure 2-10 summarizes the bike and pedestrian volumes counted at each of the signalized intersections. As shown, there is a high volume of bike and pedestrian activity along the corridor, especially near the eastern end of the project (SW 35th Street to SW 15th Street) near Oregon State University (OSU) and Avery Park. It is important to account for the prevalence of these modes when identifying potential operational strategies to ensure this corridor remains an attractive option for these users.



1. US 20-OR 34/SW 53RD ST.

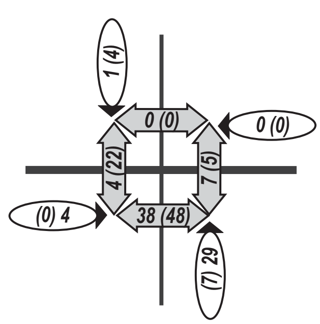


2. US 20-OR 34/SW TECHNOLOGY LOOP

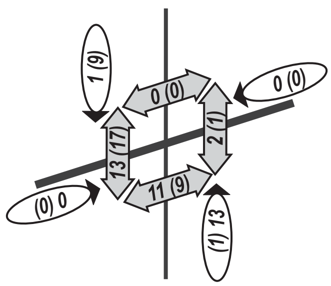


3. US 20-OR 34/SW WESTERN BLVD.

4. US 20-OR 34/SW 35TH ST.



5. US 20-OR 34/SW 26TH ST./ SW BROOKLANE DR.



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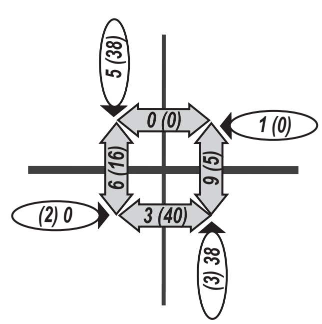

LEGEND

- # - Study Intersection
- AM (PM) - Pedestrian Peak Hour Volume
- AM (PM) - Bicycle Peak Hour Volume

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No Scale

Figure **2-10**

EXISTING 2012 US 20/OR 34 PEDESTRIAN & BICYCLE VOLUMES

As far as bike connectivity, there are a few existing challenges along the corridor:

- At SW Brooklane Drive the shared-use path on the south side of US 20/OR34 crosses Brooklane Drive about 100 feet south of the intersection. There is a ladder style cross walk marking the location, but since it is south of the intersection the bicyclist needs to maintain awareness of their visibility to vehicles and yield to them.
- At the US 20/OR 34 – SW Brooklane Drive intersection, northbound bicyclists have reported issues with the passive bicycle detection.
- At the merge of US 20/OR 34 with Western Boulevard, the bicyclists on US 20/OR 34 are in a dangerous position as traffic from Western Boulevard merges (via a yield controlled intersection) on the right side of the bicycle lane.
- West of where Western Boulevard joins US 20/OR 34, resident often place garbage cans or other items in the paved shoulder of the road, causing bicyclists to enter the traffic lane to avoid them.

2.5 Transit

The Corvallis Transit System (CTS) provides fareless public transit service to the City of Corvallis. There are three bus routes that serve the western end of the study area, between SW 53rd Street and Western Boulevard. East of the US 20/OR 34 and Western Boulevard merge, the bus routes all travel on Western Boulevard. The Philomath Connection (PC) travels through the study area on SW 53rd connecting Corvallis and Philomath (fare is required on the PC).

In general, the buses run on an hourly basis for about twelve hours during the weekdays and about ten hours on Saturday with no Sunday service.

There are four eastbound and two westbound bus stops on US 20/OR 34 between SW 53rd Street and Western Boulevard. None of the stops along US 20/OR 34 have shelters, and only two of the eastbound stops have sidewalks. At the eastbound bus stop near Western Boulevard, there is a wide shoulder large enough for a bus; however, there is no signage or indication that the area is designated as a bus pullout.

Table 2-1 provides more detail for each of the four routes including the general coverage area as well as frequency and hours of operation.

Table 2-1: Corvallis Transit Routes

Route	General Route and Stops along the Study Corridor	Frequency and Approximate Hours of Operation
3	Downtown to SW 53rd and OSU • 2 EB and 2 WB stops on US 20/OR 34	Mon-Fri: Hourly (7 a.m. to 7 p.m.) Saturday: Hourly (9 a.m. to 6 p.m.) No Sunday Service
8	Downtown to Technology Loop and OSU • 2 WB stops on US 20/OR 34	Mon-Fri: Hourly (7 a.m. to 6 p.m.) Saturday: Hourly (8 a.m. to 6 p.m.) No Sunday Service
C3	Counter-clockwise loop from Downtown, Harrison Blvd, SB, SW 53rd St, and OSU • 2 EB stops on US 20/OR 34	Mon-Fri: 1-2 hours (7 a.m. to 6 p.m.) Saturday: 4 routes total No Sunday Service
PC	Corvallis to Philomath • NB and SB stops at SW 53rd Street and US 20/OR 34 intersection	Mon-Fri: 1-2 ½ hours (6 a.m. to 7 p.m.) No Saturday or Sunday Service

2.6 Congestion and Delay

INRIX Analytic Tools were used to obtain congestion data along US 20/OR 34 for 2013 and 2014. INRIX collects data anonymously from vehicles equipped with GPS as well as from smartphone devices that are GPS-enabled.

Understanding congestion patterns and locations is important so that solutions can target the appropriate locations or be implemented during an event. We obtained congestion data for several scenarios including a typical weekday (both during school and during summer break), a typical weekend, and an Oregon State home football game.

While INRIX data can provide useful insight into traffic conditions along the US 20/OR 34 corridor, it is important to also be aware of its limitations. INRIX data is aggregated into Traffic Message Channels (TMCs), which are roadway segments of varying lengths. Data for this study corridor is broken into three segments, for a total of six TMCs (three in each direction). Without smaller and more precise segments, it is difficult to identify specific locations where congestion occurs. It is also important to remember that the project corridor has 5 signalized intersections that will introduce stops and vehicle delay for vehicles traveling along the corridor.

In general, the key findings obtained from the congestion data include:

- Weekdays are more congested than weekends
- Eastbound is generally more congested than westbound (which coincides with higher eastbound volumes as shown previously in Figure 2-5)
- Average vehicle travel speeds are lower than the posted speed of 45 mph

The figures 2-11 to 2-14 depict corridor travel speeds, with red indicating speeds slower than five miles per hour and bright green indicating where speeds are greater than 45 miles per hour. The scale bar is shown in each of the figures.

Figure 2-11 shows typical traffic speeds during a weekday in January (when OSU is in session). Archived weather data indicates there was no precipitation on that day. INRIX shows eastbound congestion spread throughout the day, with more consistent congestion aligned with the a.m. and p.m. commutes. Westbound shows some short periods of delay but much less than experienced in the eastbound direction. A similar evaluation was completed for a summer weekday (when school is out) and showed consistent trends as shown in Figure 2-12.

Figure 2-13 shows a typical weekend day (non-football weekend) during the month of October and shows little congestion in either direction. A congestion scan of a weekend during the summer months also shows little congestion along the corridor. This supports the notion that congestion along the project corridor is related more to commuter traffic rather than recreational trips through the region.

Figure 2-14 shows the traffic speeds on a Friday when there was an OSU home football game. As shown, there is moderate congestion throughout the day as commuters and football fans share the road. Traffic appears to be stopped along portions of US 20/OR 34 at the end of the football game. The majority of OSU football games are played on Saturdays when the typical commuter peaks are not present. A congestion scan of a Saturday home game shows increased congestion when compared to a non-game day, but much less than what is shown for the Friday night game.

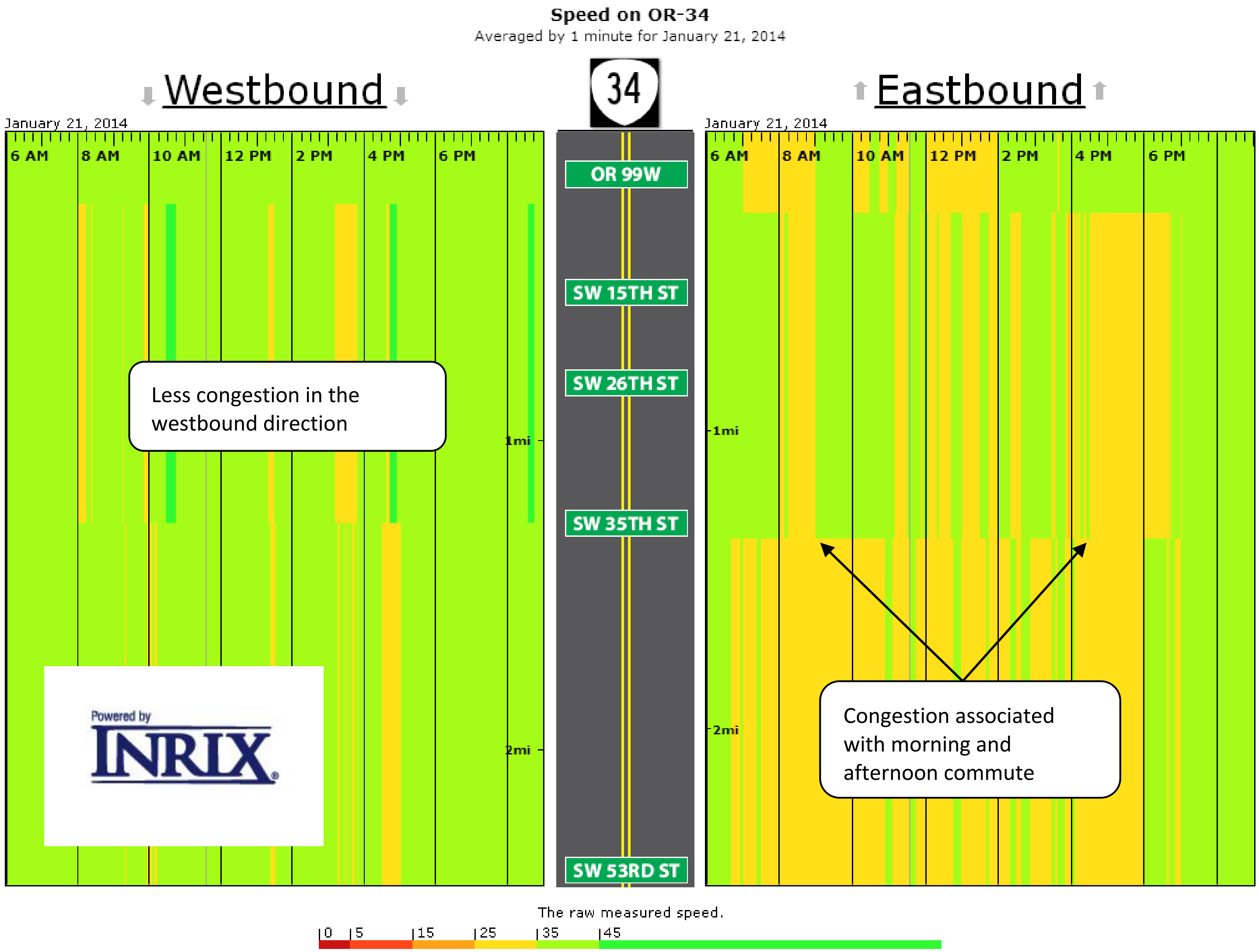

Figure 2-11: Congestion on a Typical Weekday (while OSU is in session), January 21, 2013

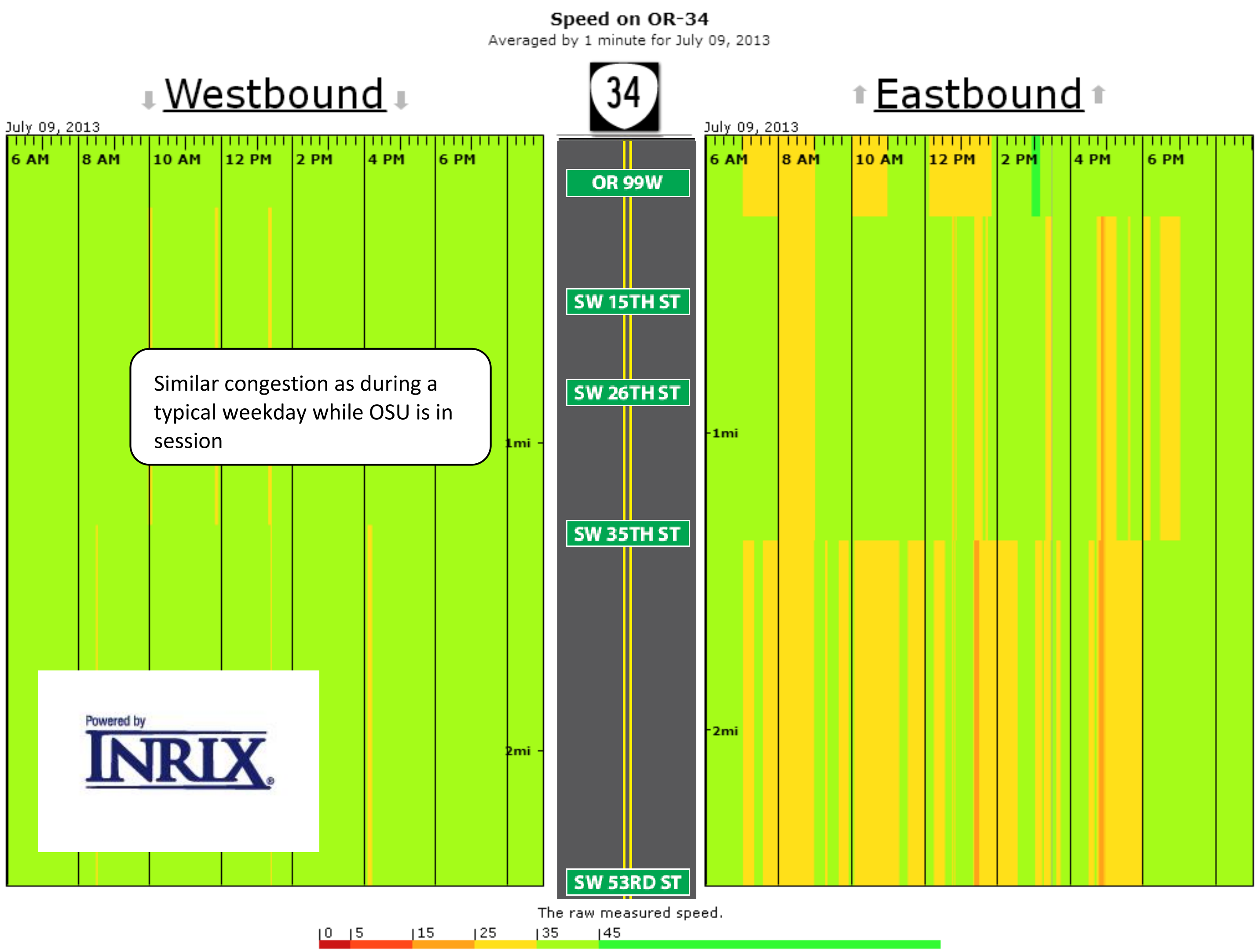

Figure 2-12: Congestion on a Typical Summer Weekday (OSU is not in session), July 9, 2013

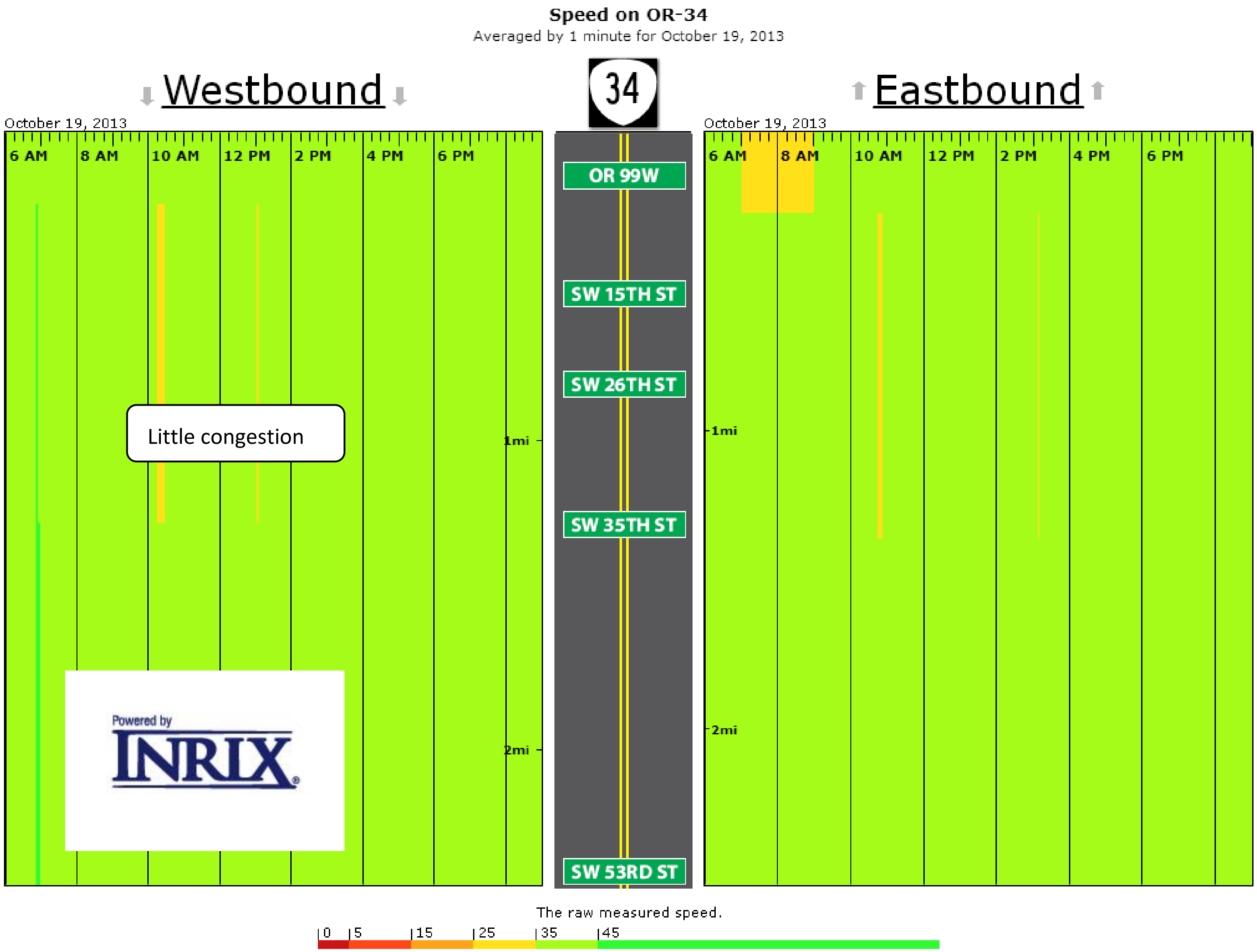

Figure 2-13: Congestion on a Typical (non-football) Weekend, October 19, 2013

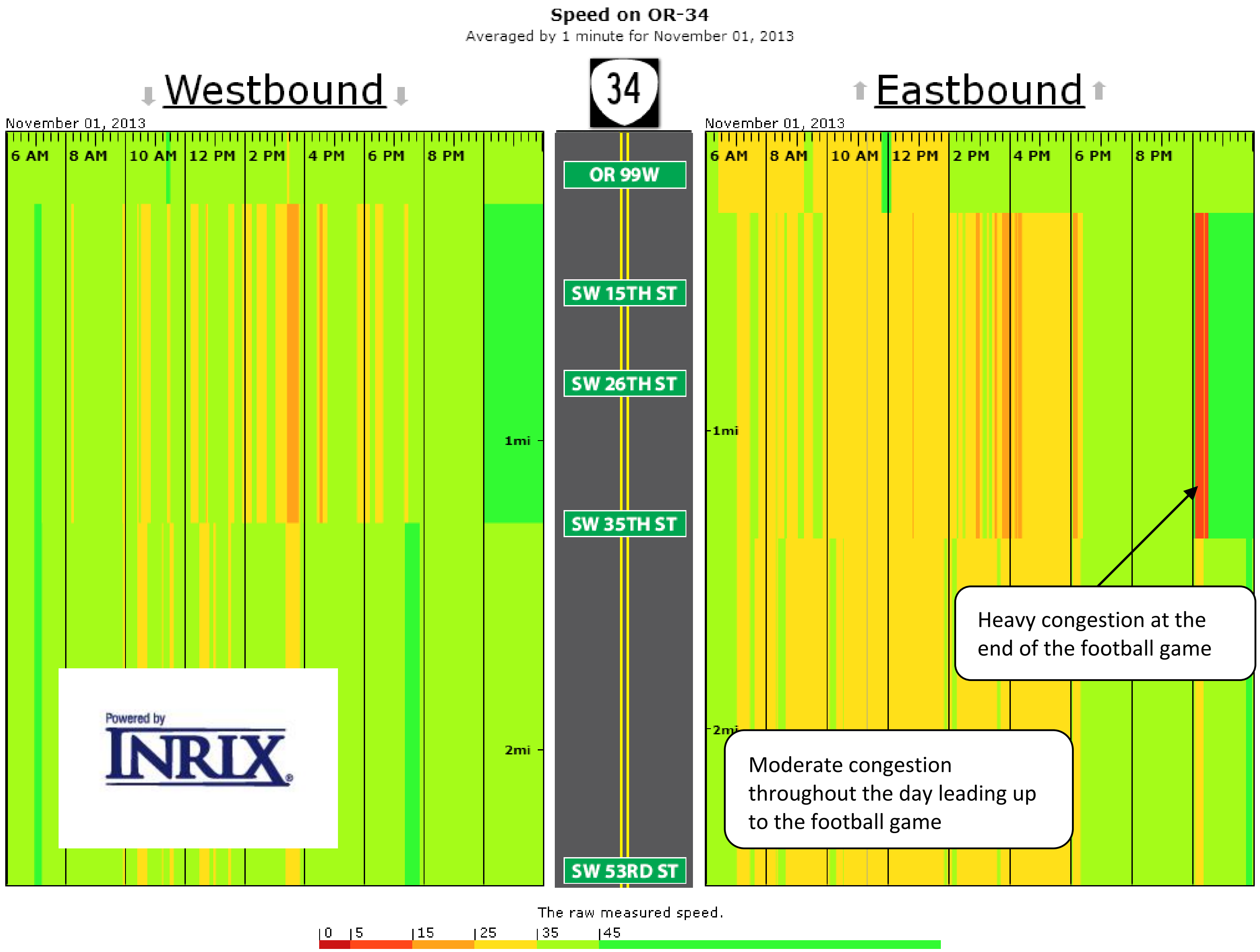

Figure 2-14: Congestion on a OSU football game day (Friday night), November 1, 2013

2.7 Planning Time Index

Planning time index is a measure of how much time is necessary to ensure on-time arrival 95% of the time, and is an indicator of how reliable travel time is along a corridor. For example, if a trip normally takes 20 minutes, a planning time index of 1.6 means that to ensure on-time arrival 95% of the time you need to allow 32 minutes for the trip (20 minutes x 1.6). The closer the planning time index is to 1.0, means the corridor has more reliable travel times.

One year of INRIX data (2013) from 6:00 a.m. to 9:00 p.m. was reviewed to determine trends and variability in travel times through the study corridor. In the eastbound direction, the average weekday planning time index was 1.46. This number was fairly consistent from month to month and throughout the week (Monday through Friday). On the weekends, the average planning time index was 1.21. The westbound direction showed lower planning index numbers, with a weekday average of 1.30 and a weekend average or 1.15. These values are summarized in Table 2-2.

Table 2-2: Planning Time Index for 2013 (6:00 a.m. – 9:00 p.m.)

Annual Averages	Eastbound	Westbound
Weekdays (Monday-Friday)	1.46	1.30
Weekends (Saturday-Sunday)	1.21	1.15
All days	1.41	1.28

It is worth repeating that while these planning time index numbers reveal overall reliability of travel time, the number of signalized intersections along the corridor may influence the values. The average travel time through the corridor is roughly 4 minutes, so stopping for a red light and waiting at the intersection for 60 seconds would increase your travel time by 25%.

2.8 Crash Analysis

Five years of crash data from the ODOT Crash Analysis and Reporting (CAR) Unit (2008 through 2012) was analyzed through the study area to determine crash trends and key safety concerns. Along the US 20/OR 34 study area there were 162 crashes on the mainline, and another 9 crashes on the side streets approaching US 20/OR 34 for a total of 171 crashes over the five years of data.

2.8.1 General Crash Trends

There were no fatal crashes over the analysis period. The crash severity for the 162 crashes along US 20/OR 34 is shown in Figure 2-15. Almost half of the crashes (49 percent) were property damage only (PDO), and 51 percent of crashes resulted in minor injuries (Injury Type B/C). There was only one crash that resulted in major injury (Injury Type A).

The Injury Type A crash was an angle crash that occurred in March of 2011 at the intersection of US 20/OR 34 and 15th Street. Conditions were dark and rainy, and a heavy vehicle was involved. The causes are listed as disregard for the traffic signal and traveling too fast for conditions.

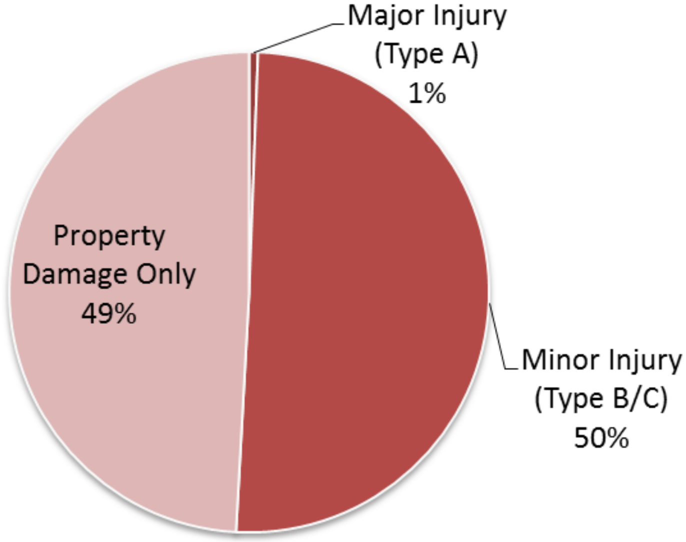

Figure 2-15: Crash Severity (2008-2012, 171 Total Crashes)

The most common type of crash was a rear end collision (76 percent). While that may seem like a high portion of crashes, it is only slightly higher than the typical portion of rear end crashes (64 to 68 percent)[3] on similar Oregon facilities.

The second most frequent type of crash occurred during turning movements (12 percent) followed by angle crashes (5 percent). One notable point is that all four of the pedestrian and bicycle related crashes that occurred on this corridor were from turning movements. These four crashes will be discussed in more detail in the next section of this memorandum. Figure 2-16 shows the distribution of crashes along US 20/OR 34 by type.

[3] Calibrating the Highway Safety Manual Predictive Methods for Oregon Highways. SPR 684. OTREC-RR-12-02. Table B.53. 2012

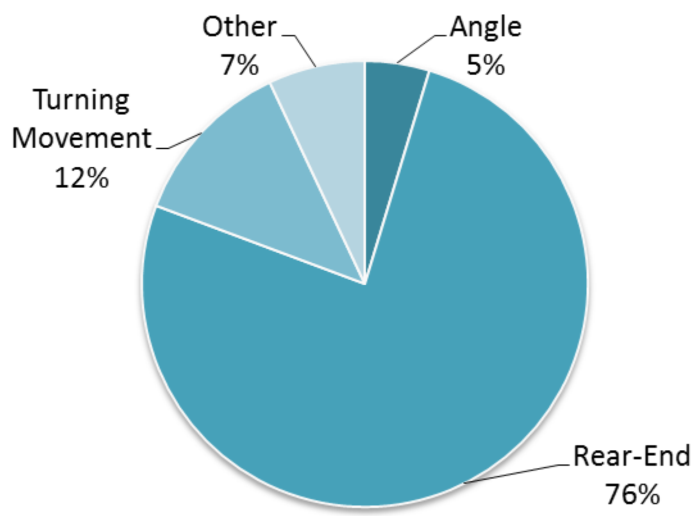

Figure 2-16: Crash Type (2008-2012, 171 Total Crashes)

Crashes peak in the morning between 8 a.m. and 9 a.m. and again in the afternoon/evening from 3 p.m. to 7 p.m. (as shown in Figure 2-17). On a monthly basis, July has the most crashes followed by October and March (as shown in Figure 2-18).

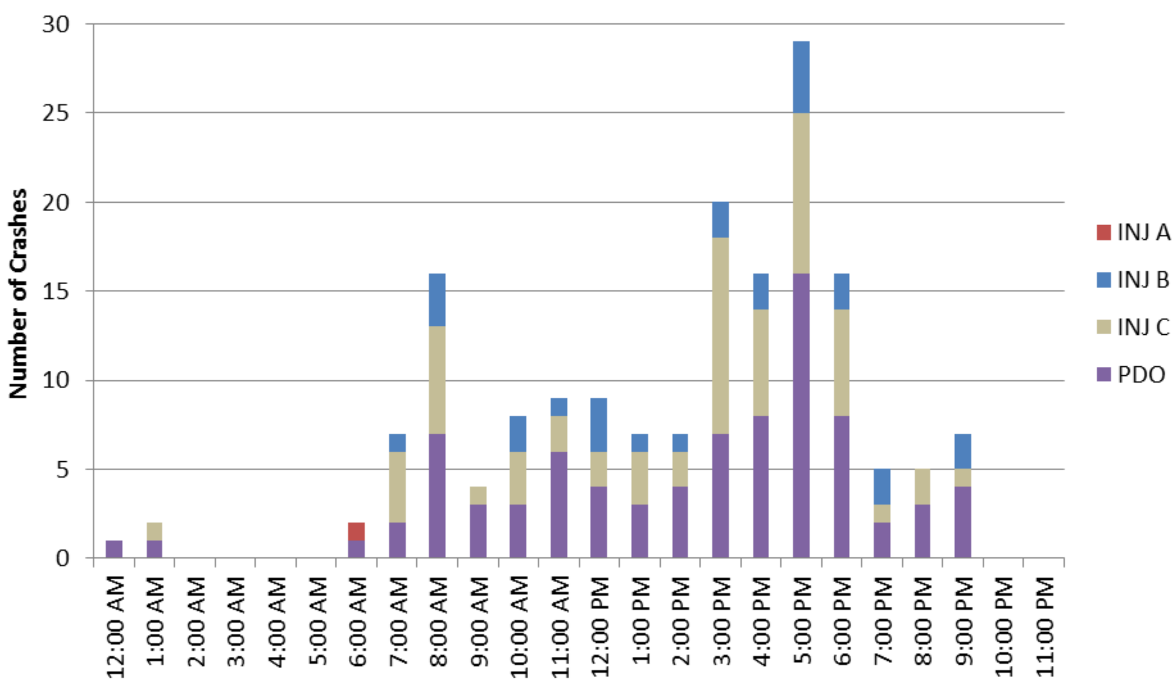

Figure 2-17: Hourly Crash Data (2008-2012, 171 Total Crashes)

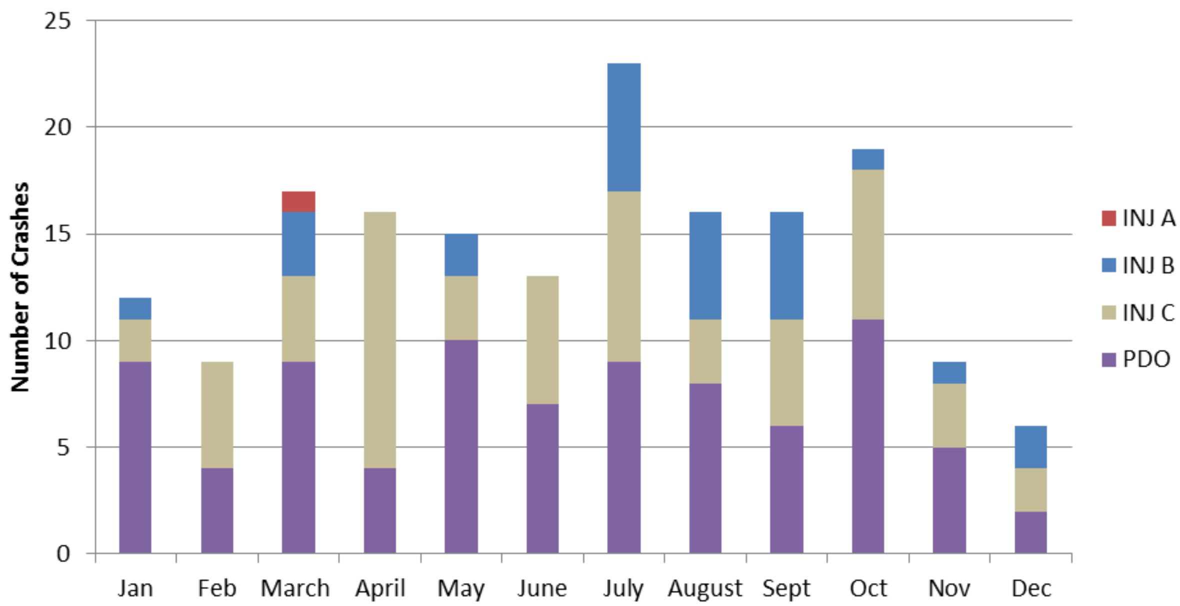

Figure 2-18: Monthly Crash Data (2008-2012, 171 Total Crashes)

Figure 2-19 shows that the number of yearly crashes increased until 2010, and then decreased in 2011 and 2012. Looking at traffic volume data from the two closest ATR stations, these fluctuations parallel the traffic volume trends over this time period. In 2008, traffic volumes were lowest out of the five years of crash data reviewed (likely due to the national economic downturn), then traffic volumes increased until 2010, and then decreased slightly again.

Figure 2-19: Annual Crash Data (2008-2012, 171 Total Crashes)

2.8.2 Pedestrian and Bicycle Related Crashes

During the five years of crash data analyzed, there were three bicycle related crashes and one pedestrian related crash in the study area. All four were at intersections, and resulted in minor injuries.

The pedestrian crash occurred in October of 2009 at 1 a.m. The pedestrian was crossing the south leg at the SW 15th Street intersection when a westbound vehicle turned left onto SW 15th Street and hit the pedestrian on the east side of SW 15th Street. The cause of this crash was listed as “non- motorist not visible”.

The three bicycle related crashes were all from right turning movements and occurred at SW 35th Street, SW Western Boulevard, and SW Technology Loop. All three bicycle crashes occurred during daylight conditions, and for two of the crashes (at SW 35th Street and Technology Loop) the vehicle was at fault.

At Technology Loop the bicycle related crash occurred in October of 2008 at 2 p.m. Conditions were dry and cloudy. The bicyclist was on US 20/OR 34 crossing the south leg of the intersection, when a northbound vehicle disregarded the traffic signal and turned right into the bicyclist on the east side of Technology Loop.

At SW 35th Street the bicycle related crash occurred in August of 2010 during clear dry conditions at 7 a.m. This crash was in the center of the intersection and was caused by an eastbound vehicle turning right that failed to yield to the bicyclist.

The crash at SW Western Boulevard was caused by the bicyclist illegally in the roadway (going the wrong way on a one way section) and occurred at 3 p.m. in February of 2011.

2.8.3 Intersection Crashes

Approximately half of all crashes (47 percent) along the study area occurred at an intersection. The intersection with the greatest number of crashes was US 20-OR 34/SW 15th Street with 18 crashes over the five year analysis period. Table 2-3 describes the crash activity at the six intersections along the study corridor.

Table 2-3: Intersection Crash Data (2008-2012)

Intersection	Intersection Control	No. of Crashes (5 Years)
US20-OR34/SW 53rd St	Traffic Signal	15
US20-OR34/SW Technology Loop	Traffic Signal	13
US20-OR34/SW Western Blvd	Westbound – Yield Control (for Western Blvd) Eastbound – Stop Control (for Western Blvd)	16
US20-OR34/SW 35th	Traffic Signal	11
US20-OR34/SW 26th St/SW Brooklane Dr	Traffic Signal	9
US20-OR34/SW 15th St	Traffic Signal	18

2.8.4 Serious Crashes in 2013

Because the full year of 2013 collision data is not available at this time from the ODOT CAR Unit, it was not included in the analysis presented above. However, ODOT staff is aware of a serious collision involving a bike that occurred in the project area in 2013. To better understand the existing conditions along the corridor, the portion of 2013 collision data that is available (9 months) was also examined.

The noted collision involving a bicycle occurred at the SW 15th Street intersection in July of 2013. It was determined that the bicycle was traveling north across US 20/OR 34 approximately 30 feet east of the intersection and failed to yield right-of-way to traffic along the highway. The eastbound vehicle struck the bicycle resulting in serious injuries to the bicyclist. The review of 2013 collision data also revealed that there was a fatal, single-vehicle accident that occurred at the SW 35th Street intersection. An eastbound vehicle collided with a signal pole with fatigue cited as a contributing factor.

2.9 Incident Data Analysis

ODOT incident data was obtained and reviewed to identify how incidents affect operations along the project corridor. Incident data contains the types of events experienced along the corridor, duration of the event, and whether or not the event resulted in traffic delays or lane closures.

Three years of ODOT incident data (2011-2013) was obtained and analyzed. In total, there were 65 incidents along the project corridor, with crashes (26 percent), struck animals (18 percent), and hazardous debris (15 percent) being the most common.

Only three of the incidents resulted a closure of the roadway, two of which were related to planned construction activities. Based on this information, it does not appear that incidents along the project corridor have a significant impact on traffic operations. This is consistent with INRIX congestion maps reviewed for days when incidents occurred that showed no significant impacts to traffic flow.

2.10 Existing Signage for Oregon State University

Oregon State University (OSU) Campus, which is a key traffic generator for the corridor, has three access points to US 20/OR 34:

- At SW 15th Street
- At SW 26th Street
- At SW 35th Street

However, signing that directs traffic to the OSU campus is only present at two of the access intersections (at SW 15th and SW 26th Streets). Each of these two intersections has one sign (eastbound and westbound) at the intersection that directs travelers to the OSU campus. SW 15th Street is signed as the “OSU Main Campus” while SW 26th Street is signed as “OSU Coliseum & Reser Stadium”. SW 35th Street provides access to the west end of the campus, but there are no existing signs directing traffic to the OSU Campus via SW 35th Street.

2.11 Existing ITS

Aside from traffic signals and detection, this corridor has little in the way of ITS equipment. The only existing fiber through this study area crosses US 20/OR 34 at SW 15th Street and SW 35th Street. The fiber from SW 35th Street then runs west along US 20/OR 34 for approximately 1,000 feet to the ODOT District 4 Office.

2.12 Additional Resources

Several other planning efforts have included all or part of the project corridor in their evaluation and provide valuable information about existing conditions along the corridor. These documents were reviewed with important findings summarized in the following sections.

2.12.1 Central Willamette Valley ITS Plan

The Central Willamette Valley ITS Plan defines advanced technologies that support regional transportation initiatives throughout the Central Willamette Valley, including this project corridor. The following key findings are relevant to this project:

- There is a planned CCTV camera at the US 20/OR 34 intersection with SW 35th Street
- There is an existing fiber optic communication cable crossing US 20/OR 34 at 15th Street and 35th Street.
- This corridor is identified as a “high priority” for fiber optic interconnect

- The ITS plan provides a regional toolbox for ITS strategies. These should be considered for this project as well.
- The ITS plan identifies the following ITS strategies specifically for this project corridor:
    - Enhanced traffic signal operations
    - Traffic monitoring
    - Truck signal priority
    - Automated transit stop announcement
    - Transit signal priority
    - Transit arrival signs
    - Electronic detour signs
    - Integrated corridor management

2.12.2 2014 Base Transportation Model Update

In March of 2014, an evaluation of existing intersection operations in the Corvallis area was completed as part of the Base Transportation Model (BTM) update.[4] The evaluation included three of the signalized intersections along the US 20/OR 34 corridor. Table 2-4 summarizes their intersection operations findings for the relevant intersections.

Table 2-4: Existing Intersection Operations

Intersection	Mobility Target	AM Peak		PM Peak	
		LOS	*V/C*	*LOS*	*V/C*
35th Street @ US 20/OR 34	V/C <0.85	D	**0.90**	C	0.80
26th Street @ US 20/OR 34	V/C <0.85	B	0.82	C	0.78
15th Street @ US 20/OR 34	V/C <0.85	C	**0.87**	C	0.82

As shown, the intersection of SW 35th Street and US 20/OR 34 exceeds ODOT mobility targets during the a.m. peak hour. The report identified potential solutions that include pursuing an exception to the 0.85 volume/capacity (v/c) ratio or installing a northbound right-turn lane. It also appears that the intersection of SW 15th Street and US 20/OR 34 exceeds the 0.85 v/c threshold; however the report does not suggest any mitigation strategies.

[4] *Summary of Existing Intersection Operating Conditions for Vehicles*, Kittelson & Associates, Inc. March 19, 2014.

2.13 Next Steps

The findings presented in this chapter are used to establish the goals and objectives for the project. These goals and objectives are then be used to identify potential strategies that will improve safety and mobility along the corridor for all users.

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CHAPTER 3: GOALS AND OBJECTIVES

Chapter 3 describes the corridor issues and needs, the goals for the project, and the specific objectives to achieve those goals.

3.1 The Problem

The project study area currently experiences unreliable travel times, congestion and delays caused by recurring commuter traffic peaks. This negatively impacts the travel of motorists, freight haulers, and transit users. In addition, the roadway infrastructure supports crossing the highway at controlled intersections, which may discourage increased use of the shared use path that parallels the roadway.

3.2 The Corridor Needs

Review of the existing conditions along US20/OR34 identified the following set of project needs:

- **The project needs to find ways to reduce rear-end crashes.** Rear-end crashes account for 76% of all crashes within the study area between 2008 and 2012. While this is a typical percentage within Oregon, the corridor would still benefit from treatment. By targeting the largest represented crash type, the project has the opportunity to achieve the greatest benefit from investment. These improvements would be in addition to upgrades made by ODOT in 2013/2014 along the corridor, including the addition of reflectorized back plates on traffic signal heads.
- **The project needs to find ways to enhance bicycle and pedestrian crossings within the corridor.** The shared use path that parallels the study corridor carries approximately 324 bicyclists and 49 pedestrians per day (based on a May 2012 study). North-south connections between the path and major trip generators (e.g. OSU Campus) exist, but provide limited support for desired movements. The intersection with 26th has received citizen feedback that it lacks appropriate dwell area and responsiveness to the bicycle demand.

- **The project needs to find ways to improve travel time associated with recurring congestion.** Recurring congestion along the corridor negatively impacts the travel times of commuters, campus visitors, and tourists traveling through the area. In addition to the impact on the regular auto traffic, the congestion impacts travel time reliability for both freight haulers and transit providers using the corridor.
- **The project needs to find ways to identify strategies related to congestion that specifically target weekday commuting peaks.** Congestion along the corridor peaks during the weekdays, with lower levels experienced over the weekends.
- **The project needs to identify strategies to expedite truck movements through the study corridor.** Traffic volumes along the corridor include a high percentage and number of heavy vehicles. This peaks during the a.m. peak hour with westbound trips reaching as high as 62 westbound vehicles at the intersection with Technology Loop in the a.m. peak hour. With the completion of the US 20 – Pioneer Mountain to Eddyville project, the route will become a viable option for freight movement between the Willamette Valley and the Oregon Coast resulting in increased truck volumes in this stretch of the corridor.

3.3 The Goals and Objectives

Review of the project needs have identified three primary goals: improve safety, improve commuter mobility for all modes, and improve freight mobility. A set of objectives is provided for each of these goals to identify specifically how they will be achieved. The goals and objectives will be use as screening criteria for evaluating the relative benefits of potential improvement strategies, and may also serve to track success of implementation.

- **Goal 1: Improve Safety**
    - **Objective:** Reduce rear-end vehicle crashes by 10 percent within five years of implementing strategies that target a reduction in rear-end crashes.
    - **Objective:** Enhance pedestrian and bicycle facilities and clarify interaction between the modes.
- **Goal 2: Improve Commuter Mobility for all Modes**
    - **Objective:** Enhance pedestrian and bicycle crossings with improved detection.
    - **Objective:** Improve travel time reliability by 15 percent during weekday commuter peaks.
- **Goal 3: Improve Freight Mobility**
    - **Objective:** Improve travel time reliability for freight by 15 percent during weekday freight peaks.

- **Objective:** Reduce the number of stops for freight vehicles at traffic signals by 5 percent during weekday commuter peaks.

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CHAPTER 4:
INITIAL STRATEGIES

Chapter 4 documents the screening criteria and process used to determine which strategies offer the greatest potential benefit to the US 20/OR 34 study corridor in Corvallis, Oregon. Using the screening process, the project team narrowed the strategies to five that offer the greatest potential benefit to travel in the corridor. The five strategies will be carried forward through a benefit cost analysis during the next phase of the project.

4.1 Preliminary Review

Forty-one strategies were initially screened to determine which have the greatest potential to improve safety and operations along the US 20/OR 34 in the study area. These strategies were grouped into seven categories:

1. Traffic Signal/Intersection Operations Strategies
2. Transit Operations Strategies
3. Roadway Operations Strategies
4. Demand Management Strategies
5. Traveler Information Strategies
6. Incident Management Strategies
7. Pedestrian and Bicycle Enhancement Strategies

Table 4-1 provides the list of strategies considered. Based on initial considerations by the project team and professional judgment regarding which strategies best apply to the project corridor, half of the strategies (those noted in bold and italicized print in Table 1) were carried forward through the high level screening processes documented in this chapter. A detailed description of the forty-one strategies is provided in Appendix B.

Table 4-1: Complete List of Strategies Considered for the US 20/OR 34 Study Corridor

Category	Strategies	
Traffic Signal/Intersection Operations	**Adaptive Traffic Signal System**	**Flashing Yellow Arrow**
	Truck Signal Priority	Central Traffic Signal System
	Transit Signal Priority	Red Light Cameras
	Weather Responsive Signal Timing	Intersection Safety Warning
	Arterial Performance Measures/Real Time Equipment Monitoring	
Transit Operations	**Transit Stop Improvements**	Transit Arrival Signs
	Automated Transit Stop Announcement	
Roadway Operations	**Access Management**	Changeable Lane Assignments
	Event Management	Corridor Operations Team
	Electronic Detour Signs	Connected Vehicle Technology
	Road Weather Information System (RWIS)	
	Improvements at the SW 53rd Street and US 20/OR 34 Intersection	
	Improvements at the SW 35th Street and US 20/OR 34 Intersection	
	Improvements at the SW 26th - Brooklane Drive and US 20/OR 34 Intersection	
	Improvements at the SW 15th Street and US 20/OR 34 Intersection	
	Roadway Lighting and Lighting Control System	
Demand Management	**Support Demand Management Strategies**	
Traveler Information	**Traffic Surveillance**	**Integrated Corridor Management**
	Dynamic Message Signs	**Evaluate Guide Signage**
	Enhanced Traveler Information Services	Highway Advisory Radio (HAR)
	Dynamic Parking Management Signs for OSU	
Incident Management	Incident Response Vehicles	Oregon's "Move It" Law - Signing

	Computer Aided Dispatch Integration	Dry Run Towing or Hourly Towing Contracts
	Automated Detour Routes	Automated Incident Detection
Pedestrian and Bicycle Enhancements	**Bicycle Improvements at US 20/OR 34 and Brooklane Drive**	
	Bicycle Improvements at the US 20/OR 34 and Western merge	
	Enhanced Pedestrian Crossings	
Note: Bold strategies represent those carried forward for high level screening		

4.2 Initial Considerations

As part of the preliminary evaluation, several key considerations were identified. These were critical points of discussion during the preliminary screening conversations and provided additional information valuable in selecting strategies for further evaluation.

Non-Recurring Congestion

Several members of the project team were specifically interested in how the proposed strategies would manage non-recurring congestion within the corridor. The facility is one lane in each direction, so any lane blocking activity would significantly impact corridor operations. However, review of the data during the Existing Conditions Analysis (see TM #1) did not yield any recorded incidents to support this concern. Review of the ODOT incident database showed only three lane blocking incidents along the corridor between 2011 and 2013. Of these incidents, two were planned construction. Given this data, the corridor does not indicate a need for measures that specifically target relief for lane blocking events.

Bicycle and Pedestrian Users

A high volume of pedestrian and bicycle users were noted in the surrounding corridor areas during the existing conditions review. The shared use path between SW 15th Street and SW 35th Street carries around 325 bicyclists and 50 pedestrians on a normal weekday in the spring. These users then access destinations within Corvallis by crossing the project corridor at signalized locations. This high usage and the need to support mobility for all modes led the team to focus on strategies that would also support pedestrian and bicycle movements throughout the corridor.

Event Management

The project corridor is adjacent to the Oregon State University (OSU) campus, which regularly experiences an increase in event related traffic for student orientation, parent’s weekend, sporting events, graduation, and more. These events impact the operations on US 20/OR 34 with large increases to demand. After discussions with the project team, it was brought to the team's attention that a separate Event Management Plan is being developed by OSU to evaluate traffic operations as part of regularly scheduled campus events. The TAC recommended that any event management strategies be removed from consideration and forwarded to the Event Management Plan team for consideration in their project.

Existing Signal Timing Upgrades

Within the last six months ODOT has invested time and resources into improving signal operations along the project corridor. Updates include installation of 2070 controllers at all study intersections, implementation of signal coordination along the corridor, and communication upgrades to connect the signals to a central system for remote monitoring and control by ODOT Region 2. Prior to obtaining this knowledge, the project team was looking at options that would include upgrading for central communications. Given this information, one or more proposed strategies (listed in Appendix B) were no longer relevant. The upgrades also help support new strategies that can be implemented at a lower cost to ODOT.

Anticipated Changes in Usage

To the west of the project area, the Pioneer Mountain to Eddyville project is realigning approximately ten miles of US 20 that currently restricts heavy vehicle trips between Philomath and Newport. It is estimated that completion of this project in the Fall of 2016 may increase the number of heavy vehicles using US 20 by 100 vehicles per day or more. This increase in freight movements along the project corridor will impact operations and was considered in strategy development and recommendations for further evaluation.

Combining these considerations, 21 strategies (out of the original 41) were carried forward through the high level screening process described in the next section of this memorandum.

4.3 High-Level Screening Process

After narrowing the initial list of 41 strategies to 21 strategies, a more detailed review and screening processes was applied to narrow down to five strategies the best meet the needs of the US 20/OR 34 corridor.

4.3.1 Screening Criteria

The following criteria were used to assess which strategies have the greatest potential benefit to the US 20/OR 34 study corridor:

- **Number of modes that benefit.** Each strategy was evaluated based on the number of travel modes it impacted. Modes considered included:
    - Passenger Vehicles
    - Freight
    - Transit
    - Pedestrians

- Bicyclists

Each mode was equally weighted to determine which strategies would benefit the broadest group of users.

- **Relative cost**. Each strategy was rated on a scale of 1 to 5, with 1 representing the lowest cost. These costs are a rough estimate of the initial capital cost (including design) and one year of operations/ maintenance.
  - 1 represents a cost greater than $1,000,000
  - 2 represents a cost between $500,000 and $1,000,000
  - 3 represents a cost between $250,000 and $500,000
  - 4 represents a cost between $100,000 and $250,000
  - 5 represents a cost less than < $100,000

- **Project dependencies, feasibility, or limitations.** For some strategies there are dependencies, institutional or technical feasibility issues, or limitations that are noted.

- **Frequency strategy is used**. Although some strategies offer high benefits, they might only be in use a small fraction of the time in the course of a year. This screening criterion identifies how frequently, on an annual basis, the benefit from each strategy is likely to be recognized.
  - 1 represents a strategy in use less than 5% of the time
  - 2 represents a strategy in use between 5% and 50% of the time
  - 3 represents a strategy in use more than 50% of the time

- **Portion of the corridor that benefits**. Some of the strategies benefit an isolated location along the corridor, while others benefit the flow of traffic through the entire corridor. This screening criterion captures the extent that benefit is recognized.
  - 1 represents a strategy that benefits an isolated location
  - 2 represents a strategy that benefits a portion of the corridor
  - 3 represents a strategy that benefits the entire corridor

- **Delay Targeted.** Strategies can target recurring congestion, nonrecurring congestion, both or neither. This criterion identifies the key type of congestion relief the strategy targets.

- **Meeting project objectives.** Whether the strategy meets the project objectives, and how many objectives it meets. The project objectives were defined in the "Needs, Goals, and Objectives, Technical Memorandum #2" submitted to ODOT on July 31, 2014.

4.3.2 Existing Infrastructure

A screening criterion of the detailed review process evaluates relative cost of the project. While this is a high level cost estimate, it is important to understand how the existing infrastructure will support or limit the ability for new strategies to be implemented. Infrastructure components considered in analysis include:

- Recent upgrades to 2070 traffic signal controllers
- Recent installation of traffic signal head reflective back plates
- Existing communications
- Recent connection of study corridor traffic signals to a central monitoring system

The existing communications network is detailed in Table 4-2. The three traffic signals at the east end (15th, 26th, and 35th) are connected wirelessly and then back to the district office via cellular service, and similarly the two signals at the west end of the corridor (Technology Loop, and 53rd) are linked wirelessly and then back to the district office from Technology Loop.

Table 4-2: Existing Traffic Signal Communications Network

Intersection along US 20/OR 34	Communication	Wireless link to:	Communication back to ODOT Region 2
SW 15th Street	Wireless	SW 26th Street	Cellular
SW 26th Street – Brooklane Drive	Wireless	SW 35th Street	N/A
SW 35th Street	Wireless	N/A	N/A
Technology Loop	Wireless	N/A	Cellular
SW 53rd Street	Wireless	Technology Loop	N/A

4.4 Recommended Strategies

Table 4-3 summarizes the evaluation and scoring of the 21 strategies based on the screening criteria, and Table 4-4 provides more detail about the evaluation. A higher total score represents a strategy that better meets the screening criteria. Out of the 21 strategies screened, five strategies were recommended to be carried forward as the best potential options for meeting the performance goals and objectives of the US 20/OR 34 study corridor:

- Adaptive Traffic Signal System
- Truck Signal Priority
- Arterial Performance Measurement and Real-Time Equipment Monitoring
- Improvements at the intersection of SW 53rd Street and US 20/OR 34
- Improvements at the intersection of SW 26th Street and US 20/OR 34

A more detailed explanation of each of these strategies is included in Table 4-4.

Table 4-3: Summary of Screening Process – Strategies for US 20/OR 34

Category	Strategies	Number of Modes that benefit	Relative Cost 1=high cost 5=low cost	Frequency 1=low 3=high	Portion of the corridor that benefits	Type of Delays Targeted	No. of Objectives Met	Total	Comments
Traffic Signal/ Intersection Operations	***Adaptive Traffic Signal System***	2	1	3	3	2	4	***15***	***Advance***
	Truck Signal Priority	1	4	2	3	1	4	***15***	***Advance***
	Transit Signal Priority	1	5	2	2	1	1	12	Advance with other efforts
	Arterial Performance Measures & Real-Time Equipment Monitoring	5	3	3	3	1	2	***19***	***Advance***
	Flashing Yellow Arrow	1	5	2	3	2	2	15	No Action. Speed is too high; not permitted within ODOT guidelines.
Transit Operations	Transit Stop Improvements	2	2	1	2	1	5	13	Advance with other efforts
Roadway Operations	Access Management	4	4	1	2	1	2	14	Advance with other efforts
	Event Management Plans	2	4	1	3	1	0	11	Advance with other efforts
	Improvements at the intersection of SW 53rd Street and US 20/OR 34	4	4	3	1	1	4	***17***	***Advance***
	Improvements at the intersection of SW 35th Street and US 20/OR 34	4	5	3	1	1	2	16	Advance with other efforts
	Improvements at the intersection of SW 26th Street and US 20/OR 34	4	4	3	1	1	2	**15**	**Advance**
	Improvements at the intersection of SW 15th Street and US 20/OR 34	4	3	3	1	1	2	14	Advance with other efforts
	Roadway Lighting and Lighting Control System	5	3	2	3	0	1	14	Advance with other efforts
Demand Management	Support Demand Management Strategies	3	4	2	3	1	1	14	Advance with other efforts
Traveler Information	Evaluate Guide Signage	1	5	3	3	1	0	13	Advance with other efforts
	Dynamic Message Signs	2	4	2	3	1	1	13	No Action
	Integrated Corridor Management	3	3	2	3	2	1	14	No Action
	Traffic Surveillance	2	4	3	3	2	2	16	No Action – The strategy would be under-utilized (ODOT does not have staff to monitor)
Incident Management	None	-	-	-	-	-	-	-	No Action
	Bicycle Improvements at US20/OR34 and Brooklane Drive	1	5	2	1	0	2	11	Advance with other efforts

Category	Strategies	Number of Modes that benefit	Relative Cost 1=high cost 5=low cost	Frequency 1=low 3=high	Portion of the corridor that benefits	Type of Delays Targeted	No. of Objectives Met	Total	Comments
Pedestrian and Bicycle Enhancements	Bicycle Improvements at US20/OR34 and Western Merge	1	5	2	1	0	2	11	Advance with other efforts
	Enhanced Pedestrian Crossings	1	4	2	2	0	2	11	Advance with other efforts

Table 4-4: Detailed Review of the High Level Screening for the US 20/OR 34 Optimization Strategies

Strategy Number	Strategy	Description and Purpose	Primary mode(s) that benefit: Vehicles	Freight	Transit	Pedestrians	Bicyclists	Number of modes benefited	Project Dependencies, Feasibility or Limitations (if applicable)	Relative Cost Scale: 5=low, < $100K 1=high, > $1M	These cells will NOT appear in final memo, they are just for DKS purposes Cost assumptions scale 5< 100K 4 = 100 to 250 3 = 250 to 500 2 = 500 to 1M 1 > 1M	comm assumption	unit cost	units	cost est	contingency		Frequency the benefit of the strategy is realized Scale: 1= low < 1% of the time 3 = high frequency >50% of the time	Portion of the corridor that benefits 1=isolated location 3=entire corridor	Delay Targeted: Recurring	Non-Recurring	Number of delay types targeted	Goal 1: Improve Safety: Reduce rear end crashes	Enhance bicycle and ped dwell areas, and clarify interaction between modes	Goal 2: Improve Commuter Mobility: Enhance ped and bicycle facilities	Improve travel time reliability during weekday commuter peaks	Goal 3: Improve Freight Mobility: Improve travel time reliability during weekday freight peaks	Reduce stops at traffic signals	Number of objectives met	Recommended for Further Evaluation
Traffic Signal/Intersection Operations																50%														
1	**Adaptive Traffic Signal System**	Evaluate an adaptive signal timing system for the corridor. *Note: The system recently had 2070 controllers installed and began running coordinated signal timings.*	✓	✓				2	•Systems Engineering Study required •Hard wire communication preferred/required instead of wireless and cellular, depending on adaptive system.	1	Cost assumes adaptive system - $30,000 per intersection for detection, license fees, plus $50/ft for new comm for 10,000 ft, and $50,000 for systems engineering study	fiber	30000	5	$ 700,000	$ 350,000	$ 1,050,000	3	3	✓	✓	2	✓			✓	✓	✓	4	YES
2	**Truck Signal Priority**	Provide green extension capability at signals when trucks are detected to decrease the number of stops for trucks, and to expedite travel through the corridor.		✓				1	•Requires additional mainline detection (dual loops about 650' in advance of the intersection). •Signals run in coordination from 7am-6pm weekdays, which limits the benefits of truck signal priority. The signals do run free on weekends.	4	Cost assumes dual loops on mainline in advance of each signal plus $5000 for software configuration	existing	15000	5	$ 75,000	$ 37,500	$ 112,500	2	3	✓		1	✓			✓	✓	✓	4	YES
3	**Transit Signal Priority**	Provide priority (green extension capability) for transit at signals to expedite travel through the corridor.			✓			1	•Requires additional mainline detection at the traffic signal that can communicate with transit vehicles.	5	Cost assumes new readers at traffic signals. Cost of transit vehicle communicator NOT included	existing	10000	5	$ 50,000	$ 25,000	$ 75,000	2	2	✓		1				✓			1	Advance with Other Efforts
4	**Arterial Performance Measures & Real-Time Equipment Monitoring**	Configure and install detection and communication at intersections and mid-block to collect arterial performance measures. Monitor traffic signal equipment and detection in real-time, so that an operator is flagged when unusual conditions occur or equipment malfunctions. Performance measures may include: traffic volumes, speeds, travel times, vehicle classification, pedestrian and bicycle volumes, delay for vehicles, and delay for pedestrians and bicyclists. This strategy can also address enabling automatic data uploading to Portal (the regional traffic database maintained by Portland State University). Note, this strategy does not require an operator to continuously observe the system. The system could automatically contact (text or email) an operator when abnormal conditions occur.	✓	✓	✓	✓	✓	5	•Requires additional detection at intersections and mid-block. •May require new signal cabinets depending on available inputs. •May require upgrading communications to copper, fiber, or leased services to establish reliable communications to the central traffic signal system •Benefits of the real time equipment monitoring strategy may be limited if staffing is not available to respond to equipment issues. •Consider adding maintenance staff or having "on-call" staff to respond to issues.	4	Cost assumes: $30,000 per intersection for additional detection, and larger cabinet, plus $1500/yr for leased services and a connection cost of $10,000	leased services	41500	5	$ 207,500	$ 103,750	$ 311,250	3	3	✓	✓	2				✓	✓		2	YES
5	**Flashing Yellow Arrow**	Install permissive, flashing yellow arrows for left turns from the highway to reduce congestion and delay.	✓					1	•Existing speed, 45 mph, is on the threshold of ODOT's recommended limit for installing FYA. •Requires a sight distance study.	5	Cost assumes: $2500 per intersection for new 4 section signal head (2) plus $5000 for rewiring and design fees.	existing	7500	5	$ 37,500	$ 18,750	$ 56,250	2	3	✓	✓	2	✓			✓			2	NO
Transit Operations																														
6	**Transit Stop Improvements**	Install improvements at existing transit stops such as marked crossings, benches, shelters, pads, or pull outs at bus stops	✓		✓			2	•Requires coordination with transit agencies •Pull outs in particular might be controversial for transit providers since buses need to merge back into mainline traffic.	2	Cost Assumes:		60000	6	$ 360,000	$ 180,000	$ 540,000	1	2	✓		1	✓	✓		✓	✓	✓	5	Advance with Other Efforts
Roadway Operations																														
7	**Access Management**	Evaluate access points along the roadway and consider consolidating, closing, or restricting access point movements (such as medians or channelized movements).	✓	✓		✓	✓	4	•There could be legal obstacles for closing/altering existing access. •Applicable to the west end of the project area	4	Cost assumes: access management study $50,000 treatments $100,000	existing	150000	1	$ 150,000	$ 75,000	$ 225,000	1	2	✓		1	✓			✓			2	Advance with Other Efforts
8	**Event Management Plans**	Implement traffic management strategies during events. This strategy may include some or all of the following components: permanent or portable dynamic message signs, special signal operations, temporary shoulder use, changeable lanes, and additional temporary signage or traffic control. *NOTE: OSU is currently conducting an event management study specific to post football game traffic. This strategy will NOT address traffic generated from OSU football games.*	✓	✓				2	•Other than OSU football games, the key event generators are likely Benton County Fairground events, Willamette County Music Festival, and other OSU events such as graduation and move-in day.	4	Cost Assumes: event management study $50,000 signal timing plans $75000 other equipment or staffing $30000	existing	155000	1	$ 155,000	$ 77,500	$ 232,500	1	3		✓	1							0	Advance with Other Efforts
9	**Improvements at the SW 53rd Street and US 20/OR 34 Intersection**	Install the following improvements at SW 53rd Street: •Tighten the turning radii for the NE corner •Add lane markings for EB and WB through bike lanes and for the EBR turn lane •Close access on NW corner •Assess lighting and install street lights to meet current standards •Consider a queue warning system, particularly for the WB movement •Install countdown pedestrian heads	✓	✓		✓	✓	4	•ODOT received complaints from the public about this intersection, with people generally stating they felt the intersection is "dangerous". •At this intersection there is only one receiving lane for each approach, which limits geometric improvements. • 5 Year Crash History - 15 crashes, 80% rear ends	4	Cost Assumes: $100,000 for NE corner work $15000 for striping $12,000 for 2 new lights $30,000 for queue warning system $4000 for new ped heads	existing	161000	1	$ 161,000	$ 80,500	$ 241,500	3	1	✓		1	✓	✓		✓	✓		4	YES
10	**Improvements at the SW 35th Street and US 20/OR 34 Intersection**	Install the following improvements at SW 35th Street: •Add bicycle detection to EB left turn lane •Assess lighting and install street lights to meet current standards •Install countdown pedestrian heads	✓	✓		✓	✓	4	•At this intersection there is only one receiving lane for each approach, which limits geometric improvements. • 5 Year Crash History - 11 crashes, 64% rear ends, 27% turning movements	5	Cost Assumes: $8000 for radar detection $12,000 for 2 new lights $4000 for new ped heads		24000	1	$ 24,000	$ 12,000	$ 36,000	3	1	✓		1				✓	✓		2	Advance with Other Efforts
11	**Improvements at the SW 26th - Brooklane Drive and US 20/OR 34 Intersection**	Install the following improvements at SW 26th Street - Brooklane Drive: •Add street lighting on the SW corner near the path crossing •Install sharrows for the NB bicycle movement and detection that distinguishes bicycles •Consider adding a separate SB left turn lane, which would require roadway widening •Install countdown pedestrian heads	✓	✓		✓	✓	4	•At this intersection there is only one receiving lane for each approach, which limits geometric improvements. • 5 Year Crash History - 9 crashes, 89% rear ends	4	Cost Assumes: $25,000 for sharrows, signing, and bike detection for NB approach $6,000 for 1 new light $4000 for new ped heads $100,000 new SB left turn lane		135000	1	$ 135,000	$ 67,500	$ 202,500	3	1	✓		1		✓		✓	✓		3	YES
12	**Improvements at the SW 15th Street and US 20/OR 34 Intersection**	Install the following improvements at SW 215th Street: •Assess street light levels and add street lighting to meet standards (likely on the SW and NE corners) •Consider a separate NB and SB left turn lanes (protected/permissive with a flashing yellow arrow) •Install countdown pedestrian heads	✓	✓		✓	✓	4	•At this intersection there is only one receiving lane for each approach, which limits geometric improvements. • 5 Year Crash History - 18 crashes, 44% rear ends, 27% angle, and 22% turning movements.	3	Cost Assumes: $200000 for new SB and NB left turn lanes $12,000 for 2 new lights $4000 for new ped heads		216000	1	$ 216,000	$ 108,000	$ 324,000	3	1	✓		1				✓	✓		2	Advance with Other Efforts
13	**Roadway Lighting and Lighting Control System**	Conduct a lighting analysis along the corridor and install or upgrade lighting to meet current lighting standards. The lighting would be connected to a central control system that could be automated and operate the lights remotely.	✓	✓	✓	✓	✓	5	•As a policy, ODOT supports lighting at intersections along ODOT owned roadways (which is included in strategies 9 thru 12). Lighting along an ODOT roadway between intersections is the responsibility of the City.	3	Cost Assumes: $50,000 for lighting analysis $8,000 per new light $20,000 for software enhancements		8000	20	$ 230,000	$ 115,000	$ 345,000	2	3			0		✓					1	Advance with Other Efforts
Demand Management																														
14	**Support Demand Management Strategies**	Promote travel that reduces overall demand on the system such as: bus transit, carpool, non-peak hour commuting, bicycle incentive programs, transit incentive programs, and other demand management strategies.			✓	✓	✓	3	•Strategy cost is on an annual basis	4	annual cost - assumes 1 FTE plus budget to promote DM				$ 150,000	$ 75,000	$ 225,000	2	3	✓		1				✓			1	Advance with Other Efforts
Traveler Information																														
15	**Evaluate Guide Signage**	Review and improve signage along US 20/OR 34 that directs traffic to locations such as I-5, OSU, and other destinations.	✓					1		5					$ 50,000	$ 25,000	$ 75,000	3	3		✓	1							0	Advance with Other Efforts

Table 4-4: Detailed Review of the High Level Screening for the US 20/OR 34 Optimization Strategies

Strategy Number	Strategy	Description and Purpose	Primary mode(s) that benefit: Vehicles	Freight	Transit	Pedestrians	Bicyclists	Number of modes benefited	Project Dependencies, Feasibility or Limitations (if applicable)	Relative Cost Scale: 5=low, < $100K 1=high, > $1M	These cells will NOT appear in final memo, they are just for DKS purposes: Cost assumptions scale 5< 100K 4 = 100 to 250 3 = 250 to 500 2 = 500 to 1M 1 > 1M	comm assumption	unit cost	units	cost est	contingency		Frequency the benefit of the strategy is realized Scale: 1= low < 1% of the time 3 = high frequency >50% of the time	Portion of the corridor that benefits 1=isolated location 3=entire corridor	Delay Targeted: Recurring	Non-Recurring	Number of delay types targeted	Goal 1: Improve Safety: Reduce rear end crashes	Enhance bicycle and ped dwell areas, and clarify interaction between modes	Goal 2: Improve Commuter Mobility: Enhance ped and bicycle facilities	Improve travel time reliability during weekday commuter peaks	Goal 3: Improve Freight Mobility: Improve travel time reliability during weekday freight peaks	Reduce stops at traffic signals	Number of objectives met	Recommended for Further Evaluation
16	**Dynamic Message Signs**	Install dynamic message signs to display a variety of traveler information. Uses may include: travel times, parking information, incident information, detours, event information and directions.	✓	✓				2		4	Used RITA ITS cost data base	existing	30000	4	$ 120,000	$ 60,000	$ 180,000	2	3		✓	1	✓						1	NO
17	**Integrated Corridor Management**	Institute an integrated corridor management (ICM) plan to better manage recurring and non-recurring congestion. The integrated corridor management plan may include real time signal timing adjustments, route/mode diversion, real-time information, surveillance, and other ICM tools.	✓	✓	✓			3	•Requires other strategies be in place including: real time equipment monitoring, surveillance, central signal system, and dynamic message signs •Assumes communication is already installed.	3	•Used RITA ITS cost data base, annual ICM costs for a longer corridor run about $1.5M. **•This cost assumes all the equipment is in place (other projects must be implemented first)** •Cost represents the annual cost to run the ICM	fiber or leased (covered in other projects)			$ 200,000	$ 100,000	$ 300,000	2	3	✓	✓	2				✓			1	NO
18	**Traffic Surveillance**	Monitor traffic operations in real-time using video cameras along the corridor that are controlled from a traffic management center (TMC). This strategy could be used in conjunction with providing real time information for both traveler information and incident management. *Note: The Central Willamette Valley ITS Plan indicates a camera is planned at US 20/OR 34 and 35th Street. Additional locations should be considered.*	✓	✓				2	•Assumes cameras are mounted on 45' poles. If cameras can be mounted to traffic signals, the cost will decrease.	4	Assumes each installation includes 1 PTZ camera ($5000) on a 45' pole and foundation ($20,000)+$5000 for other costs • Also assumes new comm using leased services at $1500/yr, plus a tie-in fee of $10,000	leased services	41500	4	$ 166,000	$ 83,000	$ 249,000	3	3	✓	✓	2				✓	✓		2	NO

Table 4-4: Detailed Review of the High Level Screening for the US 20/OR 34 Optimization Strategies

Strategy Number	Strategy	Description and Purpose	Primary mode(s) that benefit: Vehicles	Freight	Transit	Pedestrians	Bicyclists	Number of modes benefited	Project Dependencies, Feasibility or Limitations (if applicable)	Relative Cost Scale: 5=low, < $100K 1=high, > $1M	These cells will NOT appear in final memo, they are just for DKS purposes Cost assumptions scale 5< 100K 4 = 100 to 250 3 = 250 to 500 2 = 500 to 1M 1 > 1M	comm assumption	unit cost	units	cost est	contingency		Frequency the benefit of the strategy is realized Scale: 1= low < 1% of the time 3 = high frequency >50% of the time	Portion of the corridor that benefits 1=isolated location 3=entire corridor	Delay Targeted: Recurring	Non-Recurring	Number of delay types targeted	Goal 1: Improve Safety: Reduce rear end crashes	Enhance bicycle and ped dwell areas, and clarify interaction between modes	Goal 2: Improve Commuter Mobility: Enhance ped and bicycle facilities	Improve travel time reliability during weekday commuter peaks	Goal 3: Improve Freight Mobility: Improve travel time reliability during weekday freight peaks	Reduce stops at traffic signals	Number of objectives met	Recommended for Further Evaluation
Incident Management																														
	None																													
Pedestrian and Bike Enhancements																														
19	**Bicycle Improvements at US 20/OR 34 and Brooklane Drive**	Consistent with ODOT's recommendation - Install video detection for the northbound approach that can distinguish bicycles, and replace the northbound bicycle lane at the intersection with sharrows and signage that encourage bicyclists to use the full lane. Additional lighting should also be considered.					✓	1		5	Cost Assumes: $25,000 for sharrows, signing, and bike detection for NB approach $6,000 for 1 new light $4000 for new ped heads				$ 35,000	$ 17,500	$ 52,500	2	1			0		✓	✓				2	Advance with Other Efforts
20	**Bicycle Improvements at the US 20/OR 34 and Western merge**	Improve bicycle markings and signing for the westbound bicycle movement on US 20/OR 34 that merges with Western Boulevard.					✓	1		5	Cost Assumes: $20,000 for enhanced signing and striping				$ 20,000	$ 10,000	$ 30,000	2	1			0		✓	✓				2	Advance with Other Efforts
21	**Enhanced Pedestrian Crossings**	Review pedestrian crossings along the corridor and recommend specific location improvements (such as RRFBs, pavement markings, illumination, raised medians, pedestrian ramps, etc.)				✓		1		4					??	#VALUE!	#VALUE!	2	2			0		✓	✓				2	Advance with Other Efforts

4.5 Strategies for Additional Plan Consideration

Several strategies offer benefits to the corridor, but are better suited to advance through other efforts such as the Corvallis Transportation System Plan (TSP) update, or Event Management Plans. In particular, projects that require coordination with the City of Corvallis or public engagement would best be advanced through the TSP effort. Table 4-5 lists the strategies recommended to other concurrent/upcoming processes.

Table 4-5: Strategies Recommended for Advancement with Other Planning Efforts

Category	Strategies
Traffic Signal/Intersection Operations	Transit Signal Priority
Transit Operations	Transit Stop Improvements
Roadway Operations	Access Management
	Event Management Plans
	Improvements at the SW 35th Street and US 20/OR 34 Intersection
	Improvements at the SW 15th Street and US 20/OR 34 Intersection
	Roadway Lighting and Lighting Control System
Demand Management	Support Demand Management Strategies
Traveler Information	Evaluate Guide Signage
Incident Management	None
Pedestrian and Bicycle Enhancements	Bicycle Improvements at US 20/OR 34 and Brooklane Drive
	Bicycle Improvements at the US 20/OR 34 and Western Merge
	Enhanced Pedestrian Crossings

4.7 Next Steps

During the next chapter, a benefit cost analysis will be presented for each of the five recommended strategies carried forward:

- Adaptive Traffic Signal System
- Truck Signal Priority
- Arterial Performance Measurement and Real-Time Equipment Monitoring
- Improvements at the intersection of SW 53rd Street and US 20/OR 34
- Improvements at the intersection of SW 26th Street and US 20/OR 34

CHAPTER 5: IMPLEMENTATION PLAN

Chapter 5 evaluates five low-cost, short-term (five years or less) strategies for the US 20/OR 34 study corridor targeted at improving congestion and safety. Each strategy is evaluated based on project goals and objectives, potential benefits, and annual costs. After evaluating all five strategies, three are recommended for implementation:

- Adaptive Signal Timing
- Truck Signal Priority
- Arterial Performance Measurement and Real-Time Equipment Monitoring

The two strategies evaluated but not recommended for implementation as part of this optimization study are the intersection improvements specific to SW 53rd Street and SW 26th Street-Brooklane Drive. Although those projects do offer some benefits, they are localized and provide a fraction of the benefit to the US 20/OR 34 corridor when compared to the recommended three projects. In particular, the improvements at the US 20/OR 34 and SW 26th Street-Brooklane Drive intersection target the side street through movement and not the mainline. These two local intersection projects are better suited for consideration in the upcoming Corvallis Transportation System Plan (TSP) or similar project.

While the intersection projects at SW 53rd Street and SW 26th Street-Brooklane Drive are not recommended for inclusion as part of this corridor optimization project, the intersections will realize benefits from the three recommended corridor-wide strategies.

This memorandum is organized into the following sections: Project Background, Analysis Methodology, and a Summary of Findings (which includes a cut sheet summary for each of the five strategies).

5.1 Analysis Methodology

The five strategies are evaluated using three key categories of criteria:

1. Goals/Objectives
2. Benefits
3. Cost

These categories are used to compare and contrast each option, prioritize and ultimately recommend a subset set for implementation.

5.1.1 Project Goals and Objectives

Each strategy is evaluated based on the number of project objectives it helps to achieve. It is important to understand that this is a qualitative evaluation as opposed to the quantitative analysis used to calculate a benefit cost ratio. A qualitative benefit can be described and observed, but not necessarily measured with facts and numbers.

The goals and objectives for the US20/OR 34 corridor include:

- **Goal 1: Improve Safety**
    - **Objective:** Reduce rear-end vehicle crashes by 10% within five years of implementing strategies that target a reduction in rear-end crashes.
    - **Objective:** Enhance pedestrian and bicycle facilities and clarify interaction between the modes.
- **Goal 2: Improve Commuter Mobility for all Modes**
    - **Objective:** Enhance pedestrian and bicycle crossings with improved detection.
    - **Objective:** Improve travel time reliability by 15 percent during weekday commuter peaks.
- **Goal 3: Improve Freight Mobility**
    - **Objective:** Improve travel time reliability for freight by 15 percent during weekday commuter peaks.
    - **Objective:** Reduce the number of stops for freight vehicles at traffic signals by 5 percent during weekday commuter peaks.

Strategies are qualitatively rated based on the number of relevant objectives. These results are displayed graphically using the following system:

0 of 2	1 of 2	2 or 2

5.1.2 Benefits Analysis

The quantitative benefits analysis, used to calculate the average annual benefit for each strategy, is based on information gathered from a variety of sources including:

- US DOT Research and Innovative Technology Administration (RITA)
- Federal Highway Association (FHWA) Crash Modification Factor (CMF) Clearinghouse
- Value of Time-Travel: Estimates of Hourly Value of Time for Vehicles in Oregon 2011
- Tool for Operations Benefit/Cost (TOPS-BC)

Detailed calculations for each strategy are provided in Appendix C.

RITA

The RITA database includes an online compilation of published studies around the world citing benefits and costs applicable to a variety of operations strategies. This database was queried to identify applicable reports and findings to support the quantification of benefits from the five evaluated strategies. Benefits are often provided in terms of reductions in travel time, delay, crashes, and more. These can then be converted to monetary benefits by combining the results with published data from other sources (see following sections).

CMF Clearinghouse

The Crash Modification Factor (CMF) Clearinghouse website is a database funded and maintained by the FHWA. The database includes CMFs and supporting documentation for a variety of countermeasures. Each CMF is rated on a scale of one to five, with a five star rating being the most reliable type of study. The star rating is determined based on five factors: study design, sample size, standard error, potential bias, and data source. For this project, only CMFs rated as a four or five were used to calculate benefit cost ratios.

The CMF can be applied to the crash data in the study area to determine how many crashes a particular strategy reduces. Monetary benefits (crash savings) for each strategy are then calculated by monetizing each crash that is prevented. ODOT develops Oregon specific costs associated with crashes based on level of severity. Using the same methodology as the Highway Safety Manual, ODOT incorporates the human capital crash cost as well as the cost associated with the reduction in quality of life due to the crash. The most recent costs, using 2012 dollars are shown in Table 5-1). [5],[6]

Table 5-1: Cost of Crashes

Crash Severity	Cost (each crash)
Fatal and Injury A	$1,170,000
Injury B and C	$70,600
Property Damage Only (PDO)	$19,400

Value of Time-Travel: Estimates of Hourly Value of Time for Vehicles in Oregon 2011

This report documents the typical hourly cost for vehicle travel in Oregon, associated with two different vehicle types.7 The average hourly value takes into account numerous factors including: vehicle occupancy, average wages and value of fringe benefits, median household income, percent of miles on-the-clock versus percent of miles during personal time, and freight payload value. These costs are used to quantify benefits associated with reduced delay and travel time and are shown in Table 5-2.

Table 5-2: Value of Time

Vehicle Class	Average Hourly Value
Auto/Passenger Truck	$23.68
Heavy Trucks	$31.80

TOPS-BC

The TOPS-BC is a spreadsheet-based application created by FHWA designed to assist in conducting benefit-cost analysis for transportation system management and operations (TSMO) strategies. Although the strategies for US 20/OR 34 are not included in the TOPS-BC tool, the spreadsheet does establish lifecycle expectancies for equipment which was used to calculate the annual average cost of the project.

5.1.3 Costs Components

Strategy costs are evaluated based on two components:

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[5] American Association of State Highway and Transportation Officials (AASHTO). Highway Safety Manual. 1st Edition. 2010. Table 7-1.

[6] Email from Zahidul Siddique (ODOT), February 10, 2015.

[7] The Value of Time-Travel: Estimates of the Hourly Value of Time for Vehicles in Oregon 2011. Oregon Department of Transportation Programs and Economic Analysis Unit. November 2012.

- **Initial capital investment** (equipment, design and build costs)
- **Annual maintenance and operations** (staffing hours, equipment maintenance, annual upgrades, replacement costs, etc.)

These two values are combined into an annual average cost, which is then used to calculate the benefit cost (B/C) ratio. The annual average cost incorporates the initial capital cost, scaled to represent one year of cost based on the useful life of equipment, plus the annual maintenance and operations cost. These costs are provided as separate line items for each strategy. Detailed calculations for each are provided in Appendix C.

One key consideration when establishing the initial capital investment and annual maintenance and operations costs are the communication requirements of each strategy. Communications are critical to transfer information from a central command center, such as the traffic operation center, to field devices. Factors such as reliability needs, data size and data type guide which communication options are available for each strategy. Two basic levels of communications were evaluated and paired to each strategy based on anticipated needs:

- **Existing cellular and wireless service**. The traffic signals along this corridor currently use wireless service to communication with each other. Cellular service is also provided to communicate back to ODOT Region 2 headquarters via a 3G cellular network. Strategies identified as using this existing communication would not incur additional communication cost and are noted in the respective estimates.
- **Leased service.** This is option data transfer capability and reliability over the cellular option. Leased services could range from DSL (about 600 KB per second upload speed) to Ethernet (about 3-5 MB per second upload speed). Typical uses for leased services include adaptive signal timing systems (system needs vary, but leased services supports a good portion of potential options), and possibly the arterial performance measurement project to transfer larger amounts of data. Cost includes an initial connection fee (approximately $5,000 per location) plus a monthly service fee ($150 per month).

Fiber communications are typically considered as a third communication option. However, after discussion with ODOT personnel, fiber along this corridor is not an option at this time due to feasibility issues.

The communication assumption for each strategy is noted in Figure 5-2 through Figure 5-6.

5.2 Summary of Findings

We recommend implementing three of the five strategies evaluated in this memorandum:

- Adaptive Signal Timing
- Truck Signal Priority

- Arterial Performance Measurement and Real-Time Equipment Monitoring

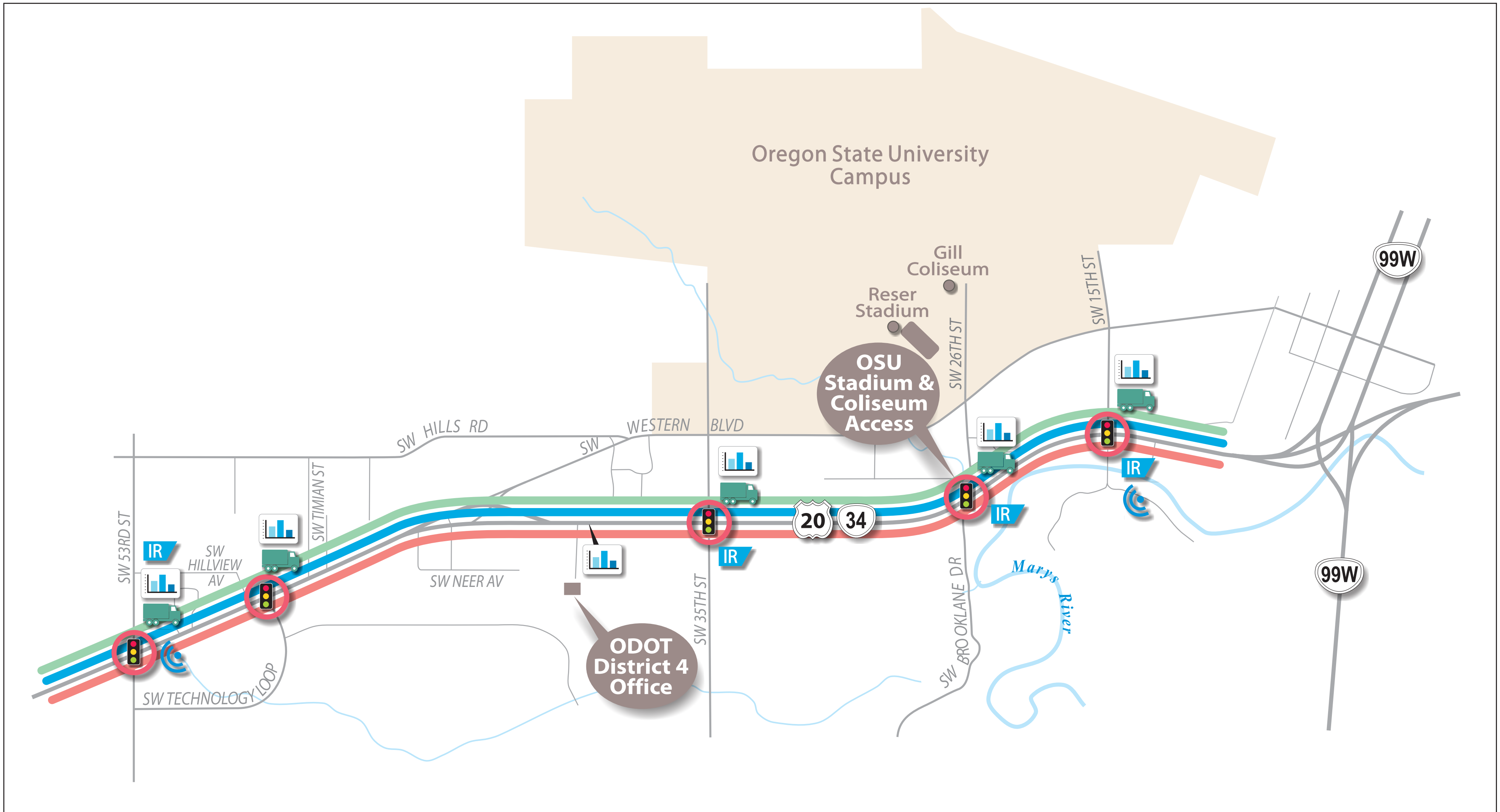
These three strategies all have benefit cost ratios well above one, which indicates a return on investment greater than the project cost. These three strategies also benefit the entire length of corridor using technology-based solutions.

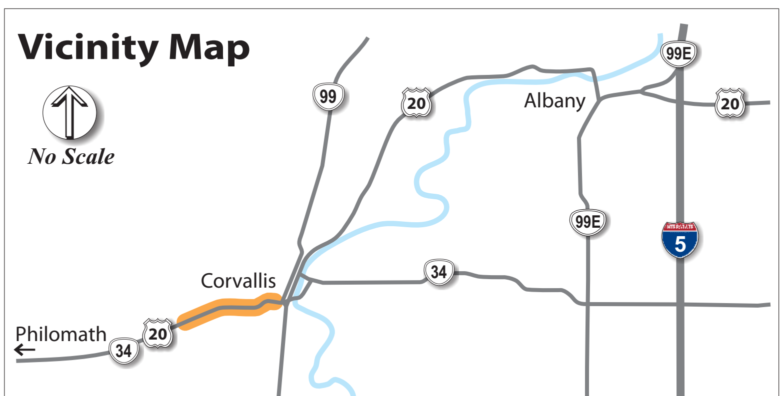
We do not recommend advancing the intersection improvements specific to SW 53rd Street and SW 26th Street as part of the US 20/OR 34 Optimization Study. The evaluation found that these two projects offered localized benefits that are more qualitative by nature and are not accurately captured with a B/C ratio. Also, at SW 26th Street, the improvements are more focused on cross street traffic than optimizing operations on US 20/OR 34, which do not seem appropriate to recommend as part of the US 20/OR 34 Optimization Study. However, these intersection projects should be consider as part of the upcoming Corvallis TSP process.

The evaluation findings of the five strategies is summarize in Table 5-3. Figure 5-1 shows the location of each of the three recommended strategies and the geographic extent of the benefits for each strategy.

Table 5-3: Summary of the Five Evaluated Strategies for US 20/OR 34

Strategy	Benefit/ Cost Ratio Range		Initial Capital Cost (Avg. Annual Cost)	Goal 1: Safety	Goal 2: Commuter Mobility	Goal 3: Freight Mobility	Recommend Strategy?
Adaptive Signal Timing	**7.8**	**22.0**	$390,000 ($36,000) To $870,000 ($55,000)	■□	■□	■■	Yes
Truck Signal Priority	**5.0**	**8.3**	$90,000 ($12,000)	■□	■□	■■	Yes
Arterial Performance Measurement and Real-Time Equipment Monitoring	**1.4**	**5.7**	$360,000 ($33,000)	□□	■□	■□	Yes
Intersection Improvements at 53rd Street	**0.0** Plus qualitative benefits	**0.5**	$200,000 ($11,000)	■■	■□	□□	No
Intersection Improvements at 26th Street	N/A qualitative benefits only		$50,000 ($5,000)	■□	■□	□□	No





LEGEND

- Existing Signalized Intersection
- Proposed Adaptive Signals & Extent of Corridor Benefits
- Proposed Freight Signal Priority & Extent of Corridor Benefits
- Extent of Data Collection Benefits
- Recommended Intersection Locations for Additional Vehicle Detection & Data Collection
- Recommended Locations for Travel Time Data Collection
- IR - Recommended Locations for Bicycle Detection & Data Collection

Note: We recommend all proposed equipment be connected to a real-time monitoring system.

DKS

Figure 5-1

US 20/OR 34 Summary of The Three Recommended Strategies

5.3 Detailed Evaluation of the Five Strategies

The following paragraphs provide the evaluation details for each of the five strategies and how each strategy meets objectives for this project. Figure 5-2 through Figure 5-6 provide more detail for each of the five strategies including specific benefits, cost components, communication assumption, and other considerations or dependencies. Appendix C provides the supporting calculations used for the benefit cost analysis.

5.3.1 Adaptive Signal Timing

The adaptive signal timing strategy installs specialty signal software that monitors, responds to, and adjusts the signal timing in the project study corridor based on traffic data and user-defined objectives. It is associated with reductions in travel time, stops, and congestion. This advancement will contribute to achieving the following project objectives:

- **Objective 1a: Reduce rear-end vehicle crashes by 10% within five years of implementing strategies that target a reduction in rear-end crashes.** Although studies have not quantified the exact impact adaptive signal systems have on safety, based on the research available there is an identified reduction in stops (between 5% and 35%) and congestion. It follows that a reduction in stops and congestion would likely lead to a reduction in rear-end crashes as well.

- **Objective 2b: Improve travel time reliability by 15% during weekday commuter peaks.** Adaptive signal timing is estimated to have a 5% percent reduction in travel time and between a 5% to 10% reduction in stops during weekdays. These are expected to improve travel time reliability within the corridor for weekday commuter peaks.

- **Objective 3a: Improve travel time reliability for freight by 15% during weekday commuter peaks.** The expected reduction in travel time and stops cited under the previous objective will also apply to freight travel time reliability.

- **Objective 3b: Reduce the number of stops for freight vehicles at traffic signals by 5% during weekday commuter peaks.** Adaptive signal timing is estimated to have a 5% to 10% reduction in stops during weekdays, and even greater during weekends.

Additional benefits include:

- Reduction in maintenance and signal retiming costs.
- Reduction in fuel consumption and emissions.

The strategy has a **benefit/cost ratio of between 9.2 and 16.9,** which indicates a return on investment that far exceeds the average annual cost of the strategy.

5.3.2 Truck Signal Priority

Truck signal priority establishes detection at signalized locations within the study corridor that will extend the green time of a signal movement when trucks are detected on the approach. This will reduce the number of stops/starts for trucks along the corridor and improve their travel time. These benefits align with the following project objectives:

- **Objective 1a: Reduce rear-end vehicle crashes by 10% within five years of implementing strategies that target a reduction in rear-end crashes.** During the five years of crash data studied there were seven crashes along the corridor that involved heavy vehicles (approximately 4% of all crashes) and six of the crashes were intersection related. Of those seven crashes, two were rear-ends, four were angle or turning movements, and one was from a backing movement.

  Truck signal priority is shown to reduce heavy vehicle red-light violations by 80%[8]. A reduction to red-light running can be assumed to reduce the number of angle and rear-end crashes experienced at each signalized location. Also, the extension of green time is designed to assist trucks located in a dilemma zone (location where stopping distance is not ideal) to proceed through the light safely.

  Although these studies do not offer a specific quantitative reduction in rear-ends, we can qualitatively conclude that this strategy is likely to reduce the number of rear-end collisions caused by trucks braking unexpectedly and colliding with vehicles in front or behind them, as well as other intersection related crashes. As this benefit could not be quantified, the benefit/cost calculate does not account for this reduction in rear-end crashes.

- **Objective 2b: Improve travel time reliability by 15% during weekday commuter peaks.** Truck signal priority is expected to reduce heavy vehicle stops by between 9% and 16%.[9] This is anticipated to benefit the general traveling public by reducing the loss time at signalized intersections resulting from heavy vehicles accelerating from a resting position.

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[8] Zimmerman, K and Bonneson, J. "In-Service Evaluation of the Detection-Control System for Isolated High-Speed Intersections." 2006.

[9] Mahmud, Maisha. Evaluation of Truck Signal Priority at N Columbia Blvd and Martin Luther King Jr Blvd Intersection. Portland State University, Advisor: Chris Monsere. August 2014

- **Objective 3a: Improve travel time reliability for freight by 15% during weekday commuter peaks.** Truck signal priority is expected to reduce heavy vehicle delay in the range of 13% to 21%.[10] This is anticipated to benefit travel time reliability for the freight industry.

- **Objective 3b: Reduce the number of stops for freight vehicles at traffic signals by 5% during weekday commuter peaks.** As previously mentioned, truck signal priority is expected to reduce heavy vehicle stops by between 9% and 16%.

Additional benefits include:

- Reduces noise pollution due to truck braking.
- Reduces emissions by at least 32 to 57 metric tons CO_2 equivalent ($MTCO_2e$) annually (due to reducing the additional fuel required to start a heavy vehicle from a complete stop). Emission savings are likely higher when accounting for the reduction in heavy vehicle idle time while stopped.

This strategy has a **benefit/cost ratio of 5.0 to 8.3**, which indicates a return of benefits almost five to eight times that of the average annual cost of the strategy.

5.3.3 Arterial Performance Measurement and Real-Time Equipment Monitoring

The arterial performance measurement and real-time equipment monitoring strategy will install detection at the five signalized intersections within the study area and one mid-block location. This detection will be used to collect arterial performance measures, such as:

- Traffic volumes
- Travel speeds
- Travel times
- Vehicle classification
- Vehicle occupancy
- Pedestrian and bicycle volumes
- Delay for vehicles, pedestrians and bicyclists

This data can be used by ODOT to monitor the operations of the project corridor and update operations (such as signal timings if adaptive signals are not installed) as needed to improve travel times and reduce delay. Equipment monitoring will also be provided to each signal so

[10] Mahmud, Maisha. Evaluation of Truck Signal Priority at N Columbia Blvd and Martin Luther King Jr Blvd Intersection. Portland State University, Advisor: Chris Monsere. August 2014

that an operator is flagged when unusual conditions occur or equipment malfunctions. This will improve maintenance response times and reduce delay added to the system from unreported system errors.

This strategy contributes to the following project objectives:

- **Objective 2b: Improve travel time reliability by 15% during weekday commuter peaks.** Travel time reliability benefits may be realized through regular updates to signal timing operations based on collected data. One study showed that timing plans that were at their optimal operation level when implemented, result in a 13% increase in travel time after two years if left unmodified.[11]
  Note: If adaptive signal timing were implemented, minimal signal retiming would be necessary.

- **Objective 3a: Improve travel time reliability for freight by 15% during weekday commuter peaks.** See Objective 2b benefits above.

Additional benefits include:

- A robust set of data collected by the system and a better understanding of how the corridor is used.
- Ability to justify and prioritize additional projects and provide a before and after benefit comparison with the collected data.
- Minimizes the time between equipment failure and notification.
- Improves efficiency for maintenance scheduling and routing.

This strategy has a **benefit/cost ratio of 1.4 to 5.7,** which represents a return of benefits over five times that of the average annual cost of the strategy.

5.3.4 Intersection Improvements at 53rd Street

A set of improvements for the intersection of US20/53rd Street to benefit safety and operations were evaluated. These include:

- Add striping and detection for a westbound through bicycle lane to the left of the right turn lane. West of the intersection there is a wide shoulder that can act as a continued bicycle lane. Adding a bicycle lane in the eastbound direction would require roadway widening, and there is no marked bicycle lane east of the intersection, so the eastbound bicycle lane would require more extensive improvements beyond the intersection.

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[11] Mashayekh, Y. and Hendrickson, C. (2013) Benefits of Proactive Monitoring of Traffic Signal Timing Performance Measures - Case Study of a Rapidly Developing Network. Green Streets, Highways, and Development 2013: pp. 202-211.

- Add striping for an eastbound right turn lane.
- Analyze lighting and install streetlights (likely two) to meet current standards.
- Tighten the turning radii for the NE corner (while maintaining the necessary radius to accommodate WB-40 sized trucks). Existing conditions show about six trucks during the a.m. peak and two trucks during the p.m. peak making the right turn from westbound to northbound.
- Close access on NW corner immediately adjacent to the intersection.[12]
- Remove striping as necessary.

Applicable project objectives include:

- **Objective 1a: Reduce rear-end vehicle crashes by 10% within five years of implementing strategies that target a reduction in rear-end crashes.** Installation of an eastbound right lane will reduce rear end collisions (in the eastbound direction) by 6%[13] and all crashes (in the eastbound direction) by up to 14%[14].

- **Objective 1b: Enhance pedestrian and bicycle dwell areas and clarify interaction between the modes.** Installation of the westbound bike lane will create a distinct and separate space for westbound bicycles at the intersection.

- **Objective 2a: Enhance pedestrian and bicycle crossings with improved detection.** Bicycle detection will be added for the westbound approach.

Additional benefits include:

- Reduces pedestrian crossing distance on the east leg by tightening the NE corner, which improves safety for pedestrians and can allow additional green time allocated to the mainline movement.

The benefits associated with this strategy are primarily qualitative. Reducing rear end collisions is the only quantitative benefit. As such, the benefit/cost ratio is low, between 0.0 and 0.4.

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[12] Note that there are plans to build a Walgreens and other retail use on the NW lot at 53rd Street and US 20/OR 43. Plans from 2010 show the access closest to the intersection as closed. After discussion with ODOT (Jamie Hollenbeck) on 10/15/2014, closing this access would not require costs beyond the construction cost of installing curb and sidewalk (as shown in the Walgreens development plan).

[13] CMF ID: 3071 (three star rating – only used qualitatively) Wei, L. and Tarko, A., "Safety Effect of Arterial Signal Coordination." Presented at the 90th Meeting of the Transportation Research Board, Washington, D.C., (2011).

[14] CMF ID: 285 (four star rating) Harwood, D. W., Bauer, K. M., Potts, I. B., Torbic, D. J., Richard, K. R., Rabbani, E. R., Hauer, E., Elefteriadou, L., and Griffith, M. S., "Safety Effectiveness of Intersection Left- and Right-Turn Lanes." Washington, D.C., 82nd Transportation Research Board Annual Meeting, (2003)

Crash History at SW 53rd Street

In evaluating the improvements at the SW 53rd Street intersection, it is beneficial to understand the crash history at that intersection. Five years of crash data was analyzed for this corridor, from 2008 through 2012. There were 15 intersection related crashes over that time period, as detailed in Table 5-4. The majority of crashes occurred in the westbound approach (60%), and 80% of crashes at this intersection were rear-ends. Two crashes occurred during either dusk or dawn, both resulting in property damage only (PDO). One crash involved a heavy vehicle. That crash was in the eastbound direction during daylight conditions and occurred from a backing movement, resulting in PDO.

Table 5-4: Crash Data for SW 53rd Street at US 20/OR 34 (2008-2012)

Approach	Crashes by direction	Type	Severity	Lighting	Heavy Vehicle Involved?
Westbound ←	7	All rear-ends	5 PDO, 2 Injury	6 daylight, 1 dusk (PDO)	No
Eastbound →	5	4 rear-ends, 1 backing	3 PDO, 2 injury (both from rear-ends)	4 daylight, 1 dawn (rear-end PDO)	Yes – semi-tow (backing PDO)
Westbound to Northbound	1	Turn movement	PDO	Daylight	No
Westbound to Southbound	1	Turn movement	Injury	Daylight	No
Southbound	1	Rear-end	Injury	Daylight	No
TOTAL CRASHES	**15**				

5.3.5 Intersection Improvements at 26th Street

A set of improvements for the intersection of US20/26th Street to benefit safety and operations were evaluated. These treatments were designed to achieve project objectives and respond to citizen comments at this location. They include:

- Install street lighting on the SW corner near the path crossing
- Consider moving the crosswalk on the south leg of the intersection further to the south towards the trail connection (out of the intersection)
- Install bicycle detection and sharrows for the northbound bicycle movement
- Install countdown pedestrian heads

Applicable project objectives include:

- **Objective 1b: Enhance pedestrian and bicycle dwell areas and clarify interaction between the modes.** This objective is accomplished by the installation of sharrows for the northbound bicycle movements on the south leg of the intersection.
- **Objective 2a: Enhance pedestrian and bicycle crossings with improved detection.** Bicycle detection is recommended for installation on the south leg of the intersection.

The benefits associated with this strategy are qualitative only. As such, no benefit-cost ratio is computed.

Crash History at SW 26th Street

In evaluating the improvements at the SW 26th Street intersection, it is beneficial to understand the crash history at that intersection. Five years of crash data was analyzed for this corridor, from 2008 through 2012. There were nine intersection related crashes over that time period, as detailed in Table 5-5. The crashes occurred almost equally in the westbound and eastbound approaches, with none in the northbound or southbound approaches. The prominent crash type at this intersection is rear-end, with slightly over half the crashes resulting in injury. One crash did involve a heavy vehicle. The crash was a rear-end collision in the eastbound direction that resulted in an injury during daylight conditions.

Table 5-5: Crashes at the SW 26th Street and US 20/OR 34 Intersection (2008-2012)

Direction	Crashes by direction	Type	Severity	Lighting	Heavy Vehicle Involved?
Westbound ←	4	All rear-ends	1 PDO, 3 Injury	4 daylight	No
Eastbound →	5	4 rear-ends, 1 turning	3 PDO, 2 injury (both from rear-ends)	4 daylight, 1 dusk (turning PDO, also wet)	Yes – semi-tow (rear injury)
TOTAL CRASHES	**9**				

Figure 5-2: Adaptive Signal Timing

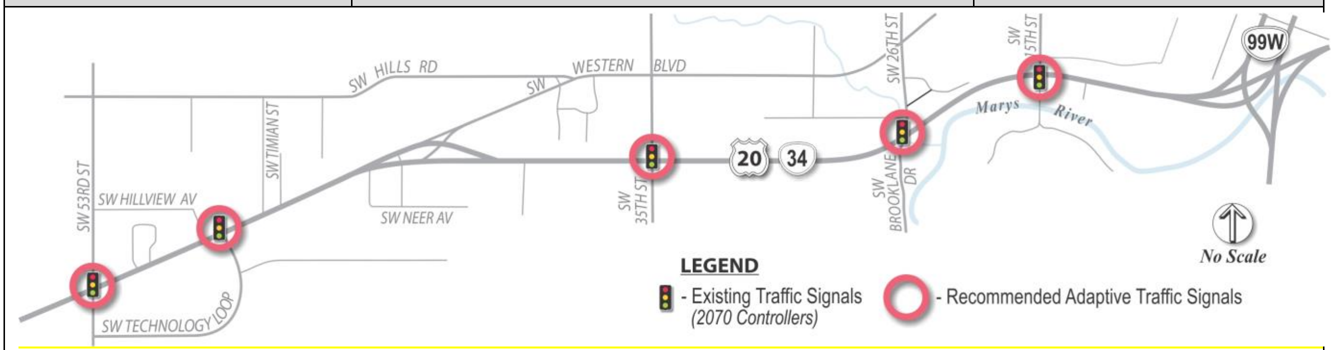
Strategy: Adaptive Signal Timing

Goal 1: Safety	Goal 2: Commuter Mobility	Goal 3: Freight Mobility	B/C Ratio **7.8 to 22.0**

Description:

Evaluate and implement adaptive signal timing at the five signalized intersections along the study corridor.

Average Annual Benefit	**Average Annual Cost**	
	$36,000 to $55,000	
$430,000 to $790,000	**Initial Capital Cost** (includes: equipment, license fees, design, and construction. Assumes use of existing 2070 controllers) $390,000 With communication upgrades (fiber to 35th and Technology Loop): $870,000	**Annual O&M Cost** $10,000



Weekday Benefits:

- Travel Time Reduction = 5%
- Reduction in Stops = 5% to 10%

Weekend Benefits:

- Travel Time Reduction = up to 15%
- Reduction in Stops = 10% to 35%

Additional benefits during both weekday and weekends:

- Reduction in maintenance and retiming costs
- Reduction in emissions and fuel consumption

Considerations

- New 2070 controllers, with adaptive timing capabilities, were recently installed at the five signalized study intersections
- Weekdays after 6:30 pm and weekends currently run free. Switching from free running to adaptive timing provides a larger incremental benefit than switching from coordinated timings to adaptive timings.

Strategy: Adaptive Signal Timing	
Dependencies • Depending on the adaptive system, new communications may be required. Some adaptive systems could function using the existing cellular communications. The specific adaptive system for this corridor would be determined during the systems engineering phase of the project.	
System Requirements/Communications **Assumption:** Leased communication services (although some adaptive systems can operate on existing wireless and cellular communications).	**Other:** Systems Engineering Analysis required

Figure 5-3: Truck Signal Priority

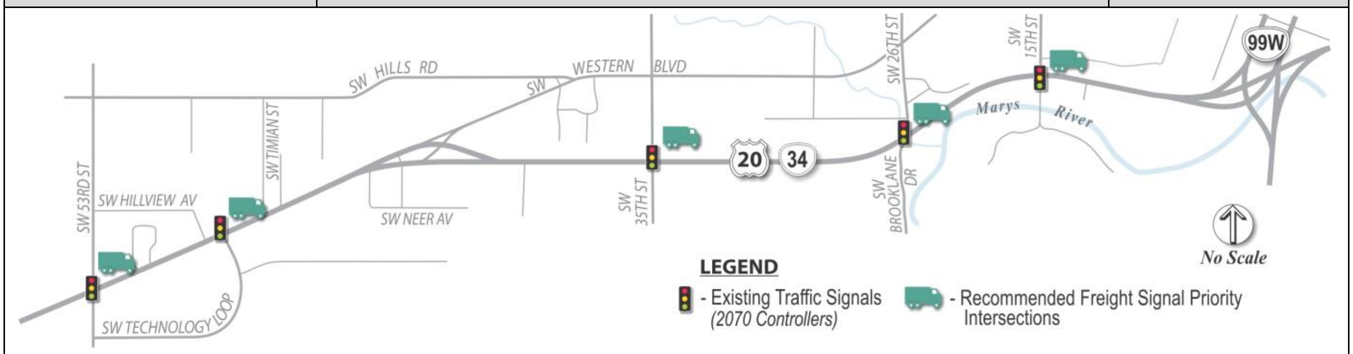
Truck Signal Priority

Goal 1: Safety	Goal 2: Commuter Mobility	Goal 3: Freight Mobility	B/C Ratio
			5.0 to 8.3

Description:

Provide green extension capability at the five study area traffic signals when trucks are detected to decrease the number of stops for trucks, and to expedite travel through the corridor.

Average Annual Benefit	Average Annual Cost $12,000	
$60,000 to $100,000	**Initial Capital Cost** (includes: additional detection, software, expanded inputs in controller cabinet, design, and construction. Assumes use of existing 2070 controllers) $90,000	**Annual O&M Cost** $5,000



Benefits:

- Reduces heavy vehicle stops (9% to 16%)
- Reduces heavy vehicle travel delay (13% to 21%)
- Reduces heavy vehicle red light violations → reduces related crashes
- Reduces noise pollution due to truck braking
- Reduces emissions by at least 32 to 57 metric tons CO_2 equivalent ($MTCO_2e$) annually (due to reducing the additional fuel required to start a heavy vehicle from a complete stop). Emission savings are likely higher when accounting for the reduction in heavy vehicle idle time while stopped.

Considerations

- The newly installed 2070 controllers are capable of handling the additional inputs required for heavy vehicle detection.
- Freight traffic is expected to increase (by 100 vehicles a day or more) along the corridor due to completion of the Pioneer Mountain to Eddyville project by fall of 2016.

Truck Signal Priority	
Dependencies: SDLC expanders may be necessary depending on how many inputs are available.	
System Requirements/Communications Assumption: Existing communications could be used, and this strategy can function with the existing 2070 controllers.	**Other:** Before implementing this strategy it is important to determine whether adaptive signal timing will also be implemented and coordinate between the two.

Figure 5-4: Arterial Performance Measurement and Real-Time Equipment Monitoring

Strategy: Arterial Performance Measurement and Real-Time Equipment Monitoring

Goal 1: Safety	Goal 2: Commuter Mobility	Goal 3: Freight Mobility	B/C Ratio
			1.4 to 5.7

Description:

Configure and install detection and communication at the five study area intersections and one mid-block location to collect arterial performance measures. Monitor traffic signal equipment and detection in real-time, so that an operator is flagged when unusual conditions occur or equipment malfunctions. Performance measures may include but are not limited to: traffic volumes, speeds, travel times, vehicle classification, vehicle occupancy, pedestrian volumes, bicycle volumes, delay for vehicles, delay for bicyclists, delay for pedestrians.

Note: The specific performance measures to be collected will be determined during the next phase of this project and those will dictate options for detection. These costs assume a variety of loop, radar, infrared, and MAC address reader detection.

Average Annual Benefit	**Average Annual Cost**	
	$33,000	
$50,000 to $190,000	**Initial Capital Cost** (includes: additional detection, communication upgrades, expanded inputs in controller cabinet, design, and construction) $360,000	**Annual O&M Cost** $10,000

Benefits:

- Cost savings for data collection. The following are estimated savings for the ANNUAL equivalent data:
  - Intersection peak hour counts = $820,000, Tube Counts = $73,000, Travel times = $36,500
- Minimize time between equipment failure and notification and improve maintenance scheduling efficiency.
- Prioritize projects with collected data and complete benefit/cost analysis with comprehensive data.
- Better understanding of the corridor

Considerations	**Dependencies**
• The newly installed 2070 controllers have an SDLC port, which allows for an additional 64 inputs.	• Communications may need to be upgraded

Strategy: Arterial Performance Measurement and Real-Time Equipment Monitoring

System Requirements/Communications Assumption

This strategy assumes use of existing communication services.

Modifications to TransSuite software may be necessary for easy data extraction (accounted for in the cost estimate).

Figure 5-5: Intersection Improvements at 53rd Street

Strategy: Intersection Improvements at 53rd Street

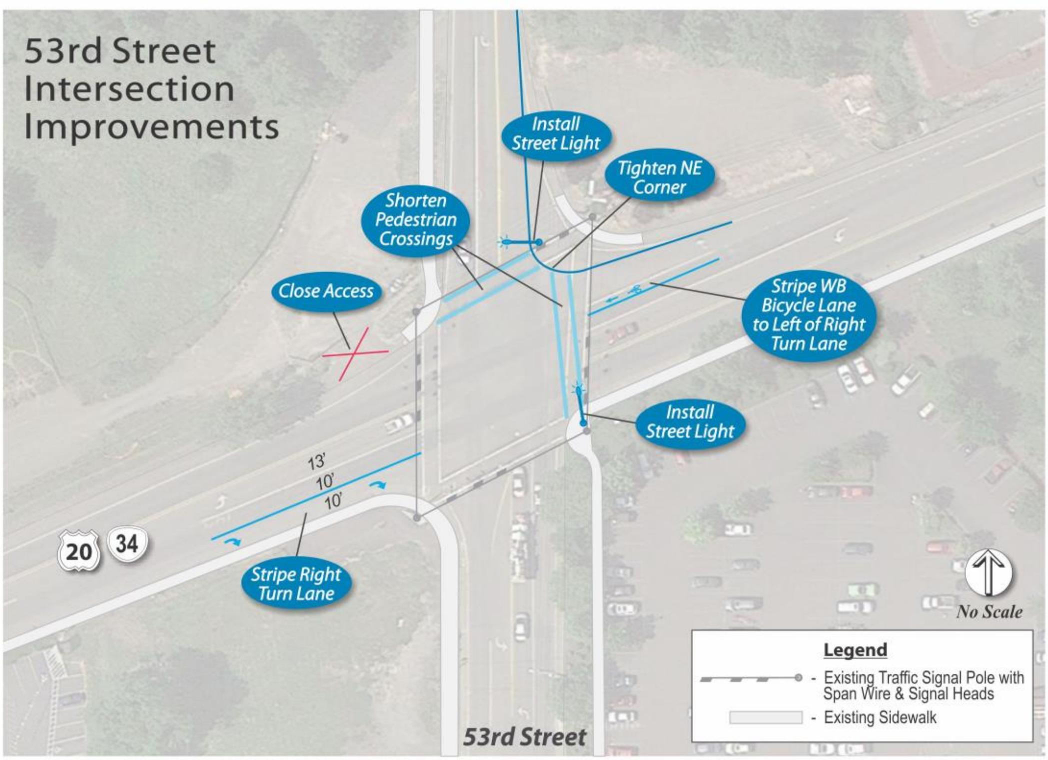
Goal 1: Safety	Goal 2: Commuter Mobility	Goal 3: Freight Mobility	B/C Ratio **0.0 to 0.4** **Plus Qualitative**

Description: Install some or all of the following improvements:

- Add striping and detection for the through westbound bicycle lane to the left of the right turn lane
- Add striping for the eastbound right turn lane
- Analyze lighting and install street lights (likely two) to meet current standards
- Tighten the turning radii for the NE corner, remove and apply striping as necessary
- Close access on NW corner

Average Annual Benefit	**Average Annual Cost**	
	$11,000	
$2,000 to $5,000 plus qualitative benefits	**Initial Capital Cost** (includes: design and construction of all improvements listed above) $190,000	**Annual O&M Cost** $2,000

Graphic



Strategy: Intersection Improvements at 53rd Street

Quantitative Benefits:

- **EB right turn lane marking –** Reduce rear end collisions by 6%, or all types of collisions by up to 16%.
- **Lighting –** Reduce nighttime injury crashes by up to 38% (likely less than that at this intersection since there is some street lighting present). Note - there were NO nighttime injury crashes at this intersection during the five years of crash data that was studied.

Qualitative Benefits: The following improvements offer benefits that are qualitative in nature, meaning they create a more desirable facility that is pedestrian and bicycle friendly with a safer feel, but there are no vetted statistics to show a specific reduction in crashes or improved vehicle throughput associated with each improvement.

- **Marked westbound bike lane and detection to the left of the right turn lane –** This improvement is noted as a "required" design guidance by the National Association of City Transportation Officials (NACTO). There were no bicycle related crashes at this intersection, however, two of the intersection related bicycle crashes (at SW 35th Street and Technology Loop) occurred when right turning vehicles hit a bicyclist. This improvement would help prevent that type of crash.
- **Close access on NE corner –** An access this close to a signalized intersection does not meet current access spacing standards according to the Oregon Highway Plan (spacing should be at least 990 feet for this facility).
- **Tighten NE corner and shorten east leg crosswalk –** A shorter crosswalk will allow for more green time on the mainline when demand is low on the side street and there is a pedestrian actuation. It can also make the intersection feel safer, by narrowing total pavement width.

Strategy NOT recommended:

- **Queue Warning System (WB) – NOT Recommended.** Studies show that a queue warning system can reduce rear end INJURY crashes by 16%. However, it would likely increase rear end PDO crashes by 16%. Based on existing crash data, this improvement does not results in a net benefit.

Considerations

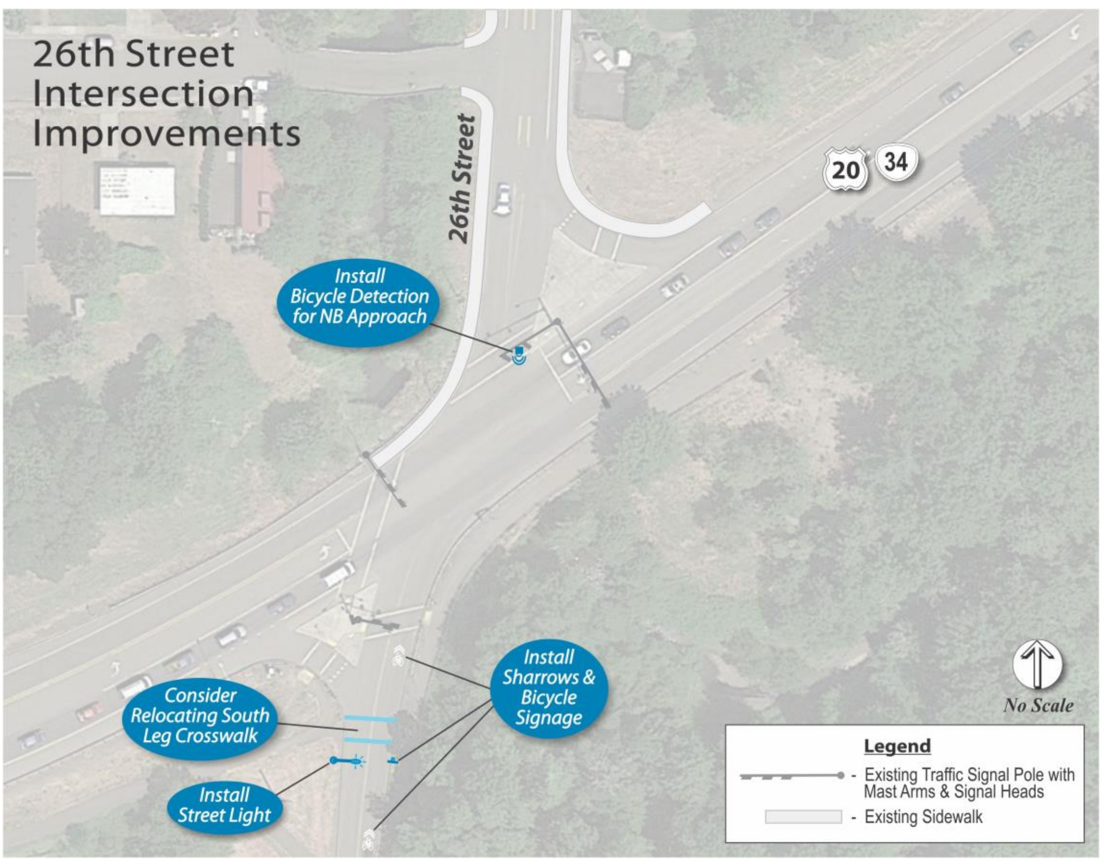
- Noted intersection of public complaints

System Requirements/Communications Assumption

Maintain existing communications

Figure 5-6: Intersection Improvements at 26th Street

<table>
<tr><th colspan="4">Strategy: Intersection Improvements at 26th Street – Brooklane Drive</th></tr>
<tr><td>Goal 1: Safety</td><td>Goal 2: Commuter Mobility</td><td>Goal 3: Freight Mobility</td><td rowspan="2">B/C Ratio
n/a
Qualitative</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="4">Description: Install some or all of the following improvements:
• Add street lighting on the SW corner near the path crossing
• Consider moving the south leg cross walk to the trail connection (out of the intersection)
• Install bicycle detection and sharrows for the NB bicycle movement
• Remove and restripe as necessary</td></tr>
<tr><td rowspan="2">Average Annual Benefit
n/a</td><td colspan="3">Average Annual Cost
$5,000</td></tr>
<tr><td colspan="2">Initial Capital Cost (includes: design and construction of all improvements listed above) $40,000</td><td>Annual O&M Cost
$2,000</td></tr>
</table>



Strategy: Intersection Improvements at 26th Street – Brooklane Drive

Quantitative Benefits:

- **Lighting -** Reduce nighttime injury crashes by up to 38% (likely less than that at this intersection since there is some street lighting present). Note - there was one nighttime crash at this intersection, but it resulted in property damage only (PDO) so this CMF does not apply here.

Qualitative Benefits: The following improvements offer benefits that are qualitative in nature, meaning they create a more desirable facility that is pedestrian and bicycle friendly with a safer feel, but there are no vetted statistics to show a specific reduction in crashes or improved vehicle throughput associated with each improvement.

- **Bicycle detection for NB approach –** Improves efficiency and reduces delay for bicycle travel. Detection can also be used to extend the green phase for bicyclist to provide adequate crossing time.
- **Sharrows and bicycle lane use signs for NB approach –** Improves safety for bicyclists by providing clear guidance to both drivers and bicyclists as to the expected location of bicyclists.

Considerations	**Dependencies**
• Need to provide clear guidance to bicyclists as to how detection is actuated. • Noted intersection of public complaints	
System Requirements/Communications Assumption Maintain existing communications	**Agency Resources and Partnerships necessary:**

5.4 Conclusion

Based on the findings of the evaluation of the five strategies, three are recommended for implementation with this project:

- Adaptive Signal Timing
- Truck Signal Priority
- Arterial Performance Measurement and Real-Time Equipment Monitoring

Each of these three strategies demonstrates corridor wide benefits with B/C ratios well above 1.0.

The two strategies that targeted specific physical intersection improvements at SW 53rd Street and SW 26th Street do offer benefits, but after further consideration, both of those projects are better suited for consideration with the Corvallis TSP or similar type of project and not as part of this Optimization Study.

CHAPTER 6: OPERATIONAL CONCEPT

Chapter 6 outlines the concept of operations for proposed operational improvements along 2.2 miles of US 20/OR 34. The following sections present a summary of the project development, an overview of the three strategies, system functions, system needs, the stakeholders roles and responsibilities, system architecture, sequencing considerations, and next steps.

6.1 Project Development Summary

Initially, the project team evaluated 41 potential strategies for the US 20/OR 34 study corridor[15]. The strategies were evaluated based on relative cost, number of modes that benefit, frequency in which the strategy would be used, portion of the corridor that benefits, number of project objectives met, and the type of delay targeted (recurring versus non-recurring). The evaluation categorized each strategy into one of the three groups:

1. Strategies recommended for further evaluation with this project (5 strategies)
2. Strategies recommended for advancement with other efforts such as upcoming Transportation System Plans (TSPs) or repaving projects (12 strategies)
3. Strategies not recommended for further evaluation (24 strategies)

The five strategies recommended for further evaluation were evaluated using a benefit cost analysis[16]. This benefit cost analysis yielded three strategies that provide the best return on investment for the corridor, and together create the recommended operational strategy for the corridor.

For a detailed description of all five strategies that were initially recommended for further evaluation, please refer to Chapter 5.

[15] US 20/OR 34 Optimization Study Technical Memorandum #3 – High Level Strategy Screening. Prepared for ODOT by DKS Associates. September 18, 2014.

[16] US 20/OR 34 Optimization Study Technical Memorandum #4 – Corridor Implementation Plan. Prepared for ODOT by DKS Associates. October 30, 2014.

6.2 Overview of the Three Strategies

The US 20/OR 34 operational concept recommends operations and management strategies to improve safety, commuter mobility, and freight mobility. These strategies, when used together, will create a more efficient and reliable travel experience. These include:

- Adaptive traffic signal system
- Truck signal priority
- Arterial performance measures and real-time equipment monitoring

Figure 6-1 shows the proposed locations along US 20/OR 34 for the three strategies.

Adaptive Traffic Signal System

Estimated Initial Capital Cost: $390,000 to $870,000 (five signals)

An adaptive traffic signal system includes upgrading the traffic signal controllers and detection at the five signalized intersections to adjust the coordinated signal timings based on the real-time traffic information.

A systems engineering process is required[17] prior to implementing an adaptive signal system. Currently, ODOT is seeking to perform a systems engineering analysis at the statewide level for an adaptive signal system. This statewide approach will develop a set of requirements so that adaptive systems across the state will use a common system. If this statewide systems engineering is completed, a project may need supplemental documentation specific to the corridor, but would not need its own systems engineering analysis. A key benefit to the statewide approach is to provide uniformity for adaptive signal systems across the state, instead of having to support a variety of different systems. During this statewide systems engineering process, the specific system requirements will be documented and systems evaluated to select the right system for the corridor. Until those specific requirements and functionality are established, we must make some assumptions to reach a reasonable cost estimate.

General functionality requirements that apply to this corridor include:

- Optimize corridor traffic flow (not a grid system)
- Balance throughput
- Account for pedestrian and bicycle users
- Be compatible with truck signal priority (if selected for implementation)

[17] The systems engineering process is required based on the FHWA Rule 23-940

The adaptive system will use either the existing controllers or new controllers at the five intersections, but it is not possible to know the exact controller type until after the systems engineering effort is complete. It is possible that some of the existing detection could be used, but additional detection is assumed in the cost estimate. Detection equipment and requirements vary depending on the adaptive system chosen.

Communication requirements also vary considerably depending on whether the intelligence for the adaptive system resides in the field (local) or at a central location (central). For adaptive systems that operate with local intelligence, remote communications back to a central server are only for data transfer and sometimes for configuration, which is not mission critical. In contrast, the communications for central adaptive systems is mission critical. For adaptive systems with central intelligence, the detection and timing information is sent to a central server that processes the data in real-time and then communicates back to the field traffic signal controllers telling it how to adjust.

Communications from the US 20/OR 34 corridor to a central location may need to be upgraded from the current cellular connection to possibly a different type of leased service or a hardwire connection such as fiber optic cable. Leased services such as cellular and digital subscriber line (DSL), both have their limitations and reliability issues. Cellular service is limited by a monthly data cap, DSL is constrained by bandwidth, and both can suffer from service outages. Communications using agency owned fiber optic cable is preferred because it offers the most reliable communications, however, fiber is more costly than leased services.

When evaluating different adaptive signal systems, it is important to know whether it will need to work in conjunction with truck signal priority. Most adaptive signal systems have the capability to program the software for truck signal priority, but working in conjunction with truck signal priority is not typically an “out of the box” application. Installation will likely require some extra consideration to ensure the two strategies work seamlessly together.

Truck Signal Priority

Estimated Initial Capital Cost: $90,000 (five signals)

A truck signal priority system along the corridor will use detection to determine when a truck is approaching a traffic signal, and extend the green time when the truck is in the dilemma zone. Extending the green time for trucks is aimed at improving safety (decreasing rear end collisions or trucks running red lights due to unreasonable deceleration allowance), as well as improving travel through the corridor and decreasing emissions and fuel usage due to trucks idling and accelerating from a stop.

Installing truck signal priority requires additional detection in advance of each of the traffic signals. The detection must classify the vehicle as a truck and measure the speed of the vehicle approaching the intersection. Depending on the available space in each signal cabinet, additional input slots can be installed. Truck signal priority can work in conjunction with adaptive signals, but it is important to document the functional requirements and determine that the adaptive signal system installed can support the truck signal priority functions.

Arterial Performance Measures and Real-Time Equipment Monitoring
Estimated Initial Capital Cost: $360,000

Collecting arterial performance measures involves adding detection at the five signalized intersections as well as one mid-block location on the corridor. Performance measures may include (but are not limited to):

- Traffic volumes
- Traffic speeds
- Travel times
- Vehicle delay
- Vehicle classification *(Note: ODOT does not have an existing system to collect this information. New software development will be necessary if this performance measure is desired)*
- Pedestrian volumes and delay
- Bicycle volumes and delay

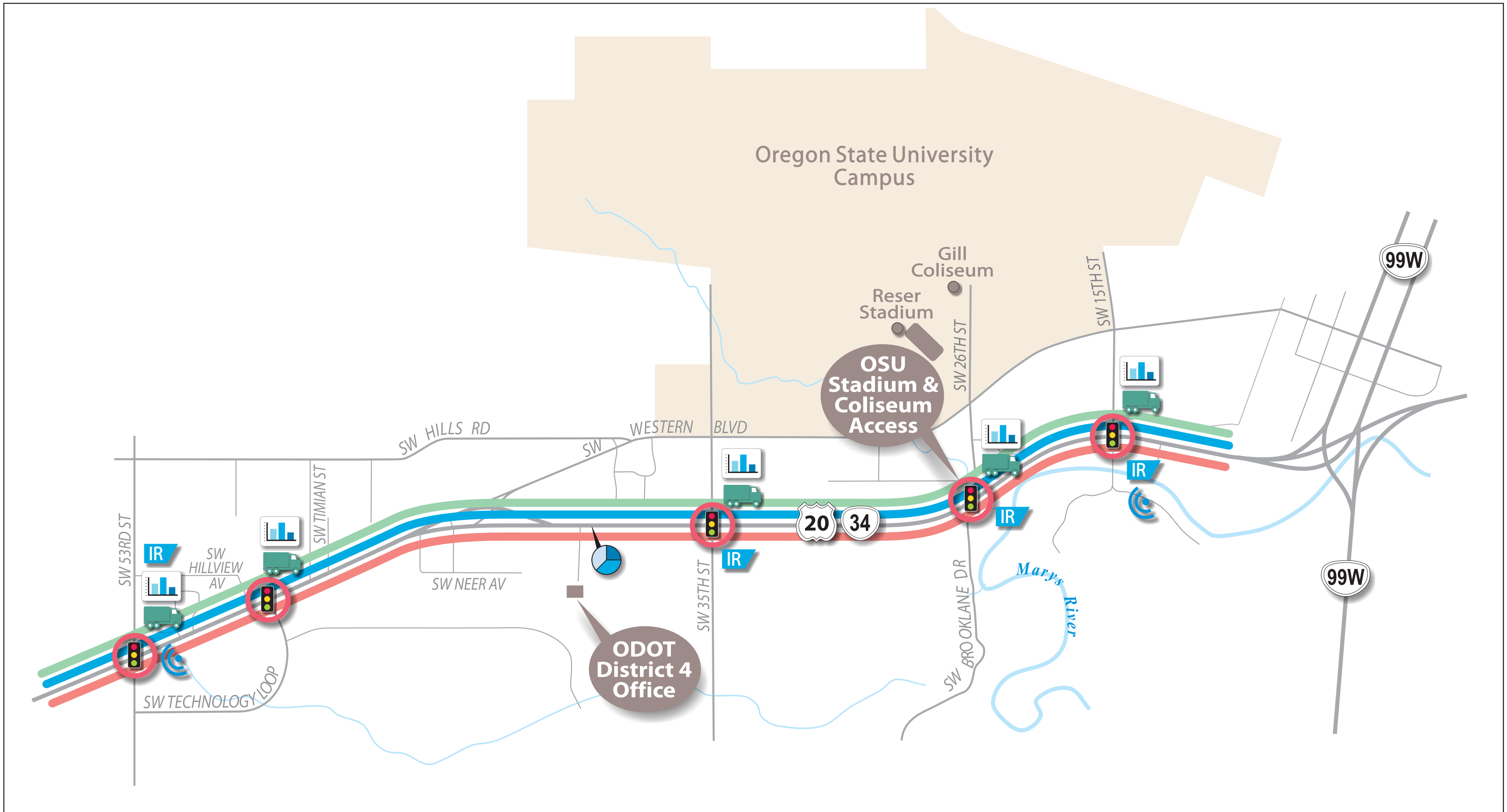
For the pedestrian and bicycle data, ODOT is participating in a Pooled Fund Study to develop an archive for pedestrian and bicycle related data.

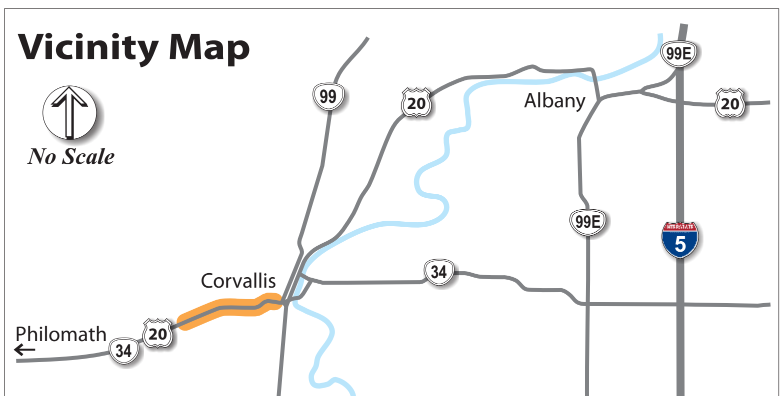
For this strategy it is important to know that the existing traffic signal software and central signal system used at the five study intersections was recently upgraded. Those upgrades include the capability to automatically collect and transfer data to an archive.

When implemented in conjunction with the adaptive signal system or truck signal priority, the detection installed for those projects could also be used to collect performance measures, which could decrease the cost of this project by $50,000 to $100,000.

Similar to the detection requirements for the adaptive signal system and the truck signal priority, detector input slots can be added if the cabinet is full. If an extender is added for one of the strategies, it can be used for the other two strategies and will result in a slightly lower cost for the additional strategies.

Monitoring devices in real-time will allow maintenance staff to operate more efficiently and minimize time between equipment failure and notification.





LEGEND

- Existing Signalized Intersection
- Proposed Adaptive Signals & Extent of Corridor Benefits
- Proposed Freight Signal Priority & Extent of Corridor Benefits
- Recommended Mid-Block Location for Additional Vehicle Detection & Data Collection
- Extent of Data Collection Benefits
- Recommended Intersection Locations for Additional Vehicle Detection & Data Collection
- Recommended Locations for Travel Time Data Collection
- IR - Recommended Locations for Bicycle Detection & Data Collection

Note: We recommend all proposed equipment be connected to a real-time monitoring system.

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Figure **6-1**

US 20/OR 34 Summary of The Three Recommended Strategies

6.3 System Functions

Implementing the proposed strategies supports the goals of improved safety and mobility within the corridor.

- Improved Travel Time Reliability – The components of the system will work together to improve travel time reliability. Adaptive signals will continuously adjust signal timing based on real time traffic demand. Truck signal priority will reduce truck stops, which improves reliability since it takes heavy trucks significantly longer to accelerate to the posted speed limit than a passenger vehicle. This start up speed differential between trucks and passenger vehicles can cause inefficient traffic flow, queuing, and friction. By reducing truck stops, these inefficiencies are reduced.

- Reduced Congestion – The strategies work together to reduce congestion along the corridor by optimizing traffic signal operations, reducing vehicle stops, and ensuring that ODOT staff has immediate knowledge of equipment failures to prioritize maintenance activities.

- Reduced Rear End Crashes – Improved signal timing and truck signal priority work together to reduce stops along the corridor, which reduces rear end crashes.

- Reduced Emissions and Reduced Fuel Consumption – Improving operations along the corridor will result in reduced vehicle emissions and fuel consumption. When vehicles, particularly trucks, accelerate from a complete stop, emissions and fuel consumption increase exponentially compared to the vehicle continuing at a steady speed. By decreasing stops along the corridor emissions and fuel consumption will be reduced.

- Improved knowledge of the corridor – Collection of arterial performance measures will add to the knowledge of how the corridor operates, and can be used to identify key operational issues. The data can be used to prepare before and after studies on completed projects and help prioritize/justify future projects.

- Improved equipment monitoring capabilities – Implementing a real time equipment-monitoring feature will allow faster notification when equipment fails or malfunctions. By decreasing equipment down time, the system will operate more efficiently.

- More efficient maintenance planning – Obtaining real time equipment monitoring knowledge allows maintenance staff to effectively set priorities and schedule maintenance activities with a full knowledge base.

6.4 System Needs

This section provides an overview of the basic system needs of each strategy including: capital improvements, maintenance, and software.

6.4.1 Capital Improvements

Capital improvements involve the construction and installation necessary to accommodate each of the strategies. Table 6-1 lists the field equipment and installation needs.

Table 6-1: Capital Improvements

Item	Comments
Adaptive Signal Software	• Invest in adaptive signal software. There are several options that may be suitable for the corridor.
Traffic Signal Controller	• Depending on the adaptive signal system selected, new traffic signal controllers may be necessary.
Detection (Adaptive Signals)	• Incorporate existing detection as needed to support the adaptive system. • Install additional mainline and side street detection as necessary. • Note that detection requirements vary depending on the adaptive system chosen.
Detection (Truck Signal Priority)	• Install 10 new detection devices (two at each traffic signal, one each for eastbound and westbound traffic) that are capable of distinguishing trucks and speed.
Traffic Signal Equipment	• Option to install additional detector input slots if existing cabinets are too full for added inputs.

Item	Comments
Communications	• Existing point to point interconnect communication and leased cellular service back to the ODOT Region 2 Office may meet requirements for the truck signal priority project if implemented alone. • If the adaptive signal system and arterial performance measure strategies are both implemented, communication upgrades may be necessary, especially the connection from the center to the field. ODOT ITS will need to work with the ODOT networking department and the ODOT Department of Administrative Services to determine the preferred communication network infrastructure.
Power	• Provide power to all devices from nearest traffic signal service.

6.4.2 Maintenance and Operations

Maintenance and operations involve ongoing needs to support the functions of each strategy. Table 6-2 lists the maintenance and operation needs associated with each of the three strategies.

Table 6-2: Maintenance and Operations Needs

Strategy	Maintenance and Operations Needs
Adaptive Signal System	• ODOT Region 2 Traffic needs to monitor and adjust adaptive signal timing parameters. • ODOT district maintenance needs to maintain detection equipment and address equipment failures. • Option to upgrade the communications network (depending on system requirements).
Truck Signal Priority	• ODOT Region 2 Traffic needs to operate truck signal priority system and monitor activity. • ODOT Region 2 maintenance needs to maintain truck signal priority detection system.
Arterial Performance Measures/Real-Time Equipment Monitoring	• ODOT Region 2 ITS Support Coordinator needs to monitor equipment status and maintain detection equipment.

	• ODOT ITS will manage the automated data transfer process from signal controller to an archive database. Traffic signal software is already configured and capable of data transfer automatically. • Option to upgrade the communications network.

6.4.3 Software Requirements and System Interfaces

Each component of the US 20/OR 34 Optimization Strategy requires specific software and system interfaces. The existing traffic signal software and systems are designed to accommodate the truck signal priority and arterial performance strategies (some slight modifications might be necessary). Using the existing traffic signal software means they can be installed without needing to procure new central systems, and can be installed at a significant cost savings.

For the adaptive signal system, new software is necessary. The other two strategies can operate with either the existing signal software as discussed above, or with new adaptive signal software.

The following list describes the central systems that will be used to operate the US 20/OR 34 optimization strategies:

- Adaptive Signal System – NEW software required at each traffic signal. Depending on the selected adaptive system, ODOT may already own the central system, which could reduce costs.
- Truck signal priority – Voyage (existing) or selected adaptive system software (NEW)
- Arterial Performance Measures/Real-Time Equipment Monitoring – Voyage (existing) or selected adaptive system software (NEW)

6.5 Project Stakeholders

6.5.1 Roles and responsibilities

Table 6-3 lists the roles and responsibilities of each stakeholder involved with the proposed strategies.

Table 6-3: Roles and Responsibilities related to the US 20/OR 34 Optimization Strategies

Stakeholder	Roles and Responsibilities	Status
ODOT Region 2 Traffic Operation Center (TOC)	Operate Region 2 traffic operations and dispatch	Existing
	Respond to real-time equipment alerts	**Future**
ODOT ITS	Oversee ITS project implementation	Existing
	Oversee systems engineering for adaptive signal system	**Future**
	Design ITS projects	Existing
	Configure ITS equipment (detection/adaptive signal system)	Existing
	Maintain the ITS equipment (detection/adaptive signal system)	Existing
	Determine how the arterial performance measure data is routed and archived.	**Future**
ODOT Region 2 Management Team	Continue to identify and support additional corridor projects in conjunction with the Corvallis TSP Update, and pursue funding as available	Existing
ODOT Region 2 Traffic	Monitor and adjust the adaptive signal system	**Future**
	Monitor and adjust the truck signal priority system	**Future**
	Design traffic signal system improvements	Existing
	Apply the arterial performance measures as appropriate and make available to others	**Future**
ODOT Region 2 Maintenance	Maintain traffic signals and detection. Respond to maintenance requests for equipment failures	Existing

6.6 System Architecture

Figure 6-2 shows the high-level system architecture for the three recommended strategies. This diagram illustrates that ODOT already has some of the necessary field equipment for each strategy. A new processing system is necessary for the adaptive signal system, and the other two strategies can operate with either the existing traffic signal software, or with the adaptive signal software if that strategy is implemented. The diagram identifies additional field equipment for each strategy, as well as field equipment that can be shared between strategies. For the adaptive signal system, detection and communication are dependent on the selected system.

At this point, we show all of the information flowing from the traffic signal controllers to the ODOT Region 2 headquarters, and then on to other ODOT Traffic Operation Centers (TOCs), ODOT Maintenance, and possibly to the traveler information portal as well. Depending on the selected systems, this information flow may vary. At this point the information flow diagram is meant to represent general concepts and communication connections.

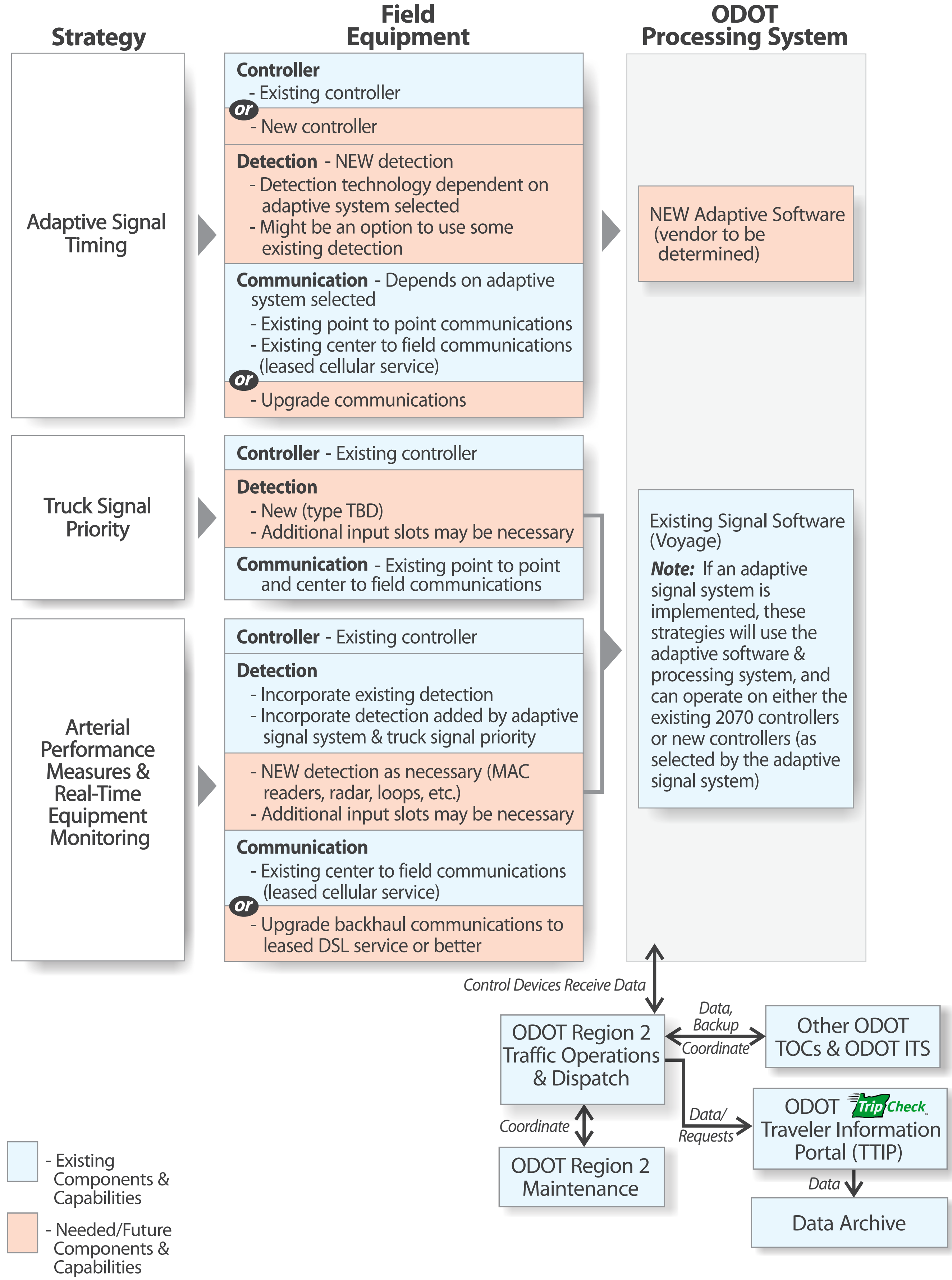

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Figure **6-2**

Architecture Diagram
US20/OR34 Optimization Strategies

6.7 Implementation Considerations

This section provides information about each of the three strategies that should be used to inform project development and select a strategy consistent with available resources. The projects can be implemented in any order, as long as systems engineering is used to ensure that the strategies will work together if implemented at different times. Table 6-4 identifies things to consider when determining which strategy to implement at a given time.

Table 6-4: Implementation Considerations

Strategy / Consideration	Adaptive Signal Timing	Truck Signal Priority	Arterial Performance Measures/Real-Time Equipment Monitoring
Estimated Cost of Full Build Out	$460,000	$90,000	$360,000 (some data can be collected with existing system, cost includes additional detection and system upgrades)
Systems Engineering Analysis Required?	Yes *Note: ODOT is in the processes of procuring a statewide systems engineering analysis for adaptive signal systems. If completed, this systems engineering analysis will apply to all future adaptive signal systems on ODOT facilities, setting uniform standards and requirements, and establishing one or two standard adaptive systems for the state. Some additional corridor specific documentation may be required for an individual project.*	Yes – if federal funding is involved. Otherwise it is recommended.	Yes – if federal funding is involved. Otherwise it is recommended.

Consideration \ Strategy		Adaptive Signal Timing	Truck Signal Priority	Arterial Performance Measures/Real-Time Equipment Monitoring
Able to implement in stages?		No. The complete system must be implemented together.	Yes. Each signalized intersection could be implemented independently.	Yes. Existing detection can be used to collect some performance measures now. As detection is added and upgraded this strategy will continue to develop.
Communication Requirements		Varies based on selected system. Some systems can work with existing while others require upgrades.	None. Option to send data to central controller to monitor equipment and use, for which existing communications are adequate.	Point to center. Existing cellular communications can be used, but data quantity has a monthly limit. Upgrades would enable faster downloading and larger data bundles.
New Capital Requirements		New signal software, and likely new detection.	New detection required.	None required to begin collecting some performance measures. Additional detection will enhance data collection capabilities.
Staffing Effort	**Upfront**	Significant: • Staff training • Working out software glitches	Moderate • Staff training • Ensuring detection is properly functioning	Significant • Staff training • Automate data download and upload process
	Ongoing	Moderate • Regular monitoring • Periodic review and updating parameters	Minimal • Once running, the system needs periodic maintenance	Minimal to Moderate • Responding to equipment alerts • Use data as appropriate for projects or decision making
Additional Considerations		There is a statewide effort underway to establish	Although existing software can be used, to ensure that	Option to include automatic alerts for monitoring

Strategy / Consideration	Adaptive Signal Timing	Truck Signal Priority	Arterial Performance Measures/Real-Time Equipment Monitoring
	uniform protocol and functionality requirements for adaptive signal systems in Oregon. If truck signal priority is implemented before the adaptive signal system, a requirement for the adaptive system could be compatibility with the selected truck signal priority system.	this strategy works well with the adaptive signal system, a systems engineering approach is recommended prior to installing a truck signal priority system.	equipment and to identify congestion. Existing traffic signal controller and central signal server software has been updated to support automated data collection and transfer from field devices to an archive.

6.7.1 Infrastructure Overlap

At each of the five traffic signals along the study corridor, the three strategies will overlap. For efficiency, the detection used for the adaptive signal system and truck signal priority should also be used to collect/log performance measure data. The five traffic signals along the corridor already have power and communication connections, so new equipment will tie into those existing utilities.

With all new equipment installations and upgrades, ODOT should consider including a real-time equipment monitoring component.

6.8 Next Steps

This section discusses the next steps for implementing each of the strategies, and specifically references some unknowns at this stage that require further investigation as part of a high level design. The high level design for each strategy would identify equipment locations, availability of power and communications, and any potential conflicts.

Adaptive Signal System

For an adaptive signal system, a systems engineering analysis must be completed. Through this process, all of the system requirements and functions will be established. Once these requirements are established, an adaptive system will be selected that meets the requirements.

Another consideration for this strategy is whether to extend the adaptive system to a sixth signalized intersection at the east end of the study area: OR 34/Van Buren Avenue and Harrison Boulevard, and possibly even OR 34/Peoria Road. Analysis is necessary to determine whether extending to this intersection at the east end of the project would benefit the corridor.

Once an adaptive system is selected, that will determine the type of detection and required detection locations, as well as necessary communication that can be incorporated into a high level design. At this point, the project cost assumes an upgrade to leased DSL communication services; however, the center-to-field communications infrastructure upgrade ultimately depends on the selected adaptive system.

Truck Signal Priority

Similar to the adaptive signal system, we recommend a systems engineering approach to determine the best type of detection and system to use for this strategy. Although the truck signal priority system is not as complex as the adaptive signal system, there are still many considerations that need to be vetted and explored.

Most importantly, ODOT needs to determine whether this strategy will be implemented in conjunction with an adaptive signal system. If they will be implemented together, it is critical that the two strategies be designed with that in mind. These determinations will establish which detection options best meet the project needs.

Arterial Performance Measures/Real-Time Equipment Monitoring

For this strategy, the next step is to determine the exact performance measures that will be collected, and whether to collect the performance measures at all five signalized intersections or only select intersections. Collection of some performance measures could begin almost immediately using existing detection and traffic signal software. The existing traffic signal software and central signal server software were recently upgraded and have the capability to automatically collect and transfer data from field devices to an archive.

As additional performance measures are identified that cannot be captured with existing detection, appropriate technology should be selected and high-level design developed to install the new detection. It may also be beneficial to consider extending data collection to the east at the OR 34/Van Buren Avenue and Harrison Boulevard intersection.

The data management approach should also be explored as high-level design moves forward. Portal, the transportation database managed by Portland State University, is one option for where the data could be archived, but there is currently no agreement between ODOT and Portal for statewide data storage. The ODOT ITS unit is currently exploring some options for data archiving.

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CHAPTER 7: CONCLUSIONS

The US 20/OR 34 project seeks to identify mitigations that can be implemented in the short term to improve operations and safety throughout the study corridor. After developing project goals and objectives and reviewing forty-one initial strategies, three are recommended for implementation in the corridor.

7.1 Adaptive Signal Timing

The adaptive signal timing option will install specialty signal software that monitors, responds to, and adjusts the signal timing based on traffic data and user-defined objectives. Prior to installation, ODOT will need to conduct a systems engineering analysis to meet FHWA requirements and identify software requirements, communication needs, detection configuration, and scope of study area (i.e. whether to extend further east). This should be coordinated with the ODOT statewide adaptive system engineering effort.

7.2 Truck Signal Priority

The truck signal priority option will install specialty detection at traffic signals that will extend the green time of a signal movement when trucks are detected on the approach. Prior to installation, ODOT will need to consider detection and communications overlap with other strategies. Identify signal timing impacts (i.e. amount of green extension, etc.).

7.3 Arterial Performance Measurement and Real-Time Equipment Monitoring

The arterial performances measurement and real-time equipment monitoring will install detection at the five signalized intersections within the study area and one mid-block location to collect arterial performances measures, including: traffic volumes, travel speeds, travel times, vehicle classification, vehicle occupancy, pedestrian and bicycle volumes, and delay for vehicles, pedestrians, and bicyclists. Prior to installation, ODOT will need to select performances measures for data collection, finalize implementation locations, and identify data management/archiving needs.

Together, these strategies should provide a better functioning corridor for future uses.