

## Memorandum

**DATE:** June 10, 2010  
**TO:** The Forest Grove TSP Public Advisory Committee  
**FROM:** Carl Springer P.E.  
Mat Dolata

**SUBJECT: Yew Street at Adair Street Alternatives Analysis**

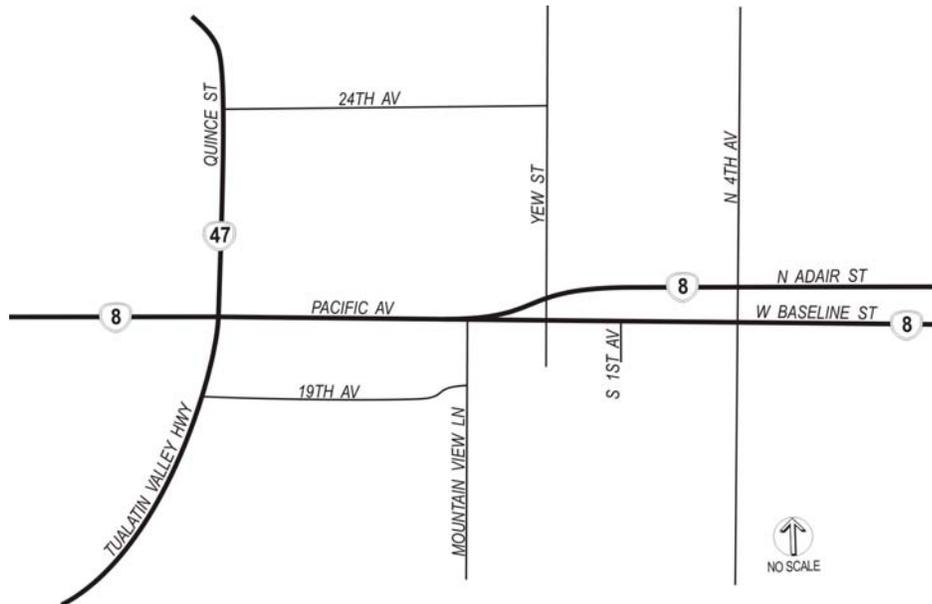
P07136-000-000

The purpose of this memorandum is to provide analysis of alternatives for the identified deficiency at the intersection of Yew Street and Adair Street in Forest Grove. This intersection was the only location outside of the Highway 47 corridor that will fall below minimum operating standards in the future. The memorandum identifies four alternatives that provide direction towards a preferred solution and discusses the relative influence on the nearby intersection of Mountain View Lane and Pacific Avenue. The preferred solution for the Yew Street at Adair Street intersection will be included in the Motor Vehicle Plan section of the Transportation System Plan (TSP).

### Existing and Future Operational Deficiency

The needs and deficiencies for the Forest Grove transportation system were identified in the Future Needs Chapter of the TSP. Utilizing the Metro Travel Demand Forecasting model and assuming construction of financially constrained Regional Transportation Plan (RTP) projects, motor vehicle traffic volumes for 2030 were forecasted and intersection conditions were determined for all study intersections. This is considered the “Base” scenario for the TSP.

The Yew Street / Adair Street intersection is an existing deficiency and, with projected increases in volume, operations are further degraded in the future. Additionally, the Yew Street / Baseline Street intersection is projected to operate at LOS F for minor street approaches in 2030. Preliminary signal warrants for 2030 are met at both intersections. The Mountain View Lane / Pacific Avenue intersection has an existing traffic signal where Adair Street and Baseline Street converge to become Pacific Avenue, at the intersection of Mountain View Lane to the south. Figure 1 illustrates the intersections under analysis and surrounding area.



**Figure 1 – Area of Analysis**

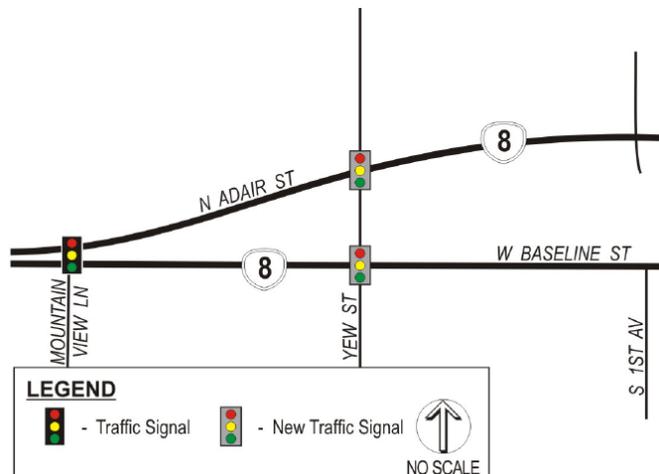
**Alternatives Considered**

Several solutions to address the operational deficiency at Yew Street and Adair Street were suggested including additional turn lanes, new roadways, turn restrictions with alternative routing, and coordinated traffic signals. A variety of configurations with additional turn lanes at existing intersections were evaluated, but no configuration provided the necessary capacity to meet identified performance standards. The City expressed an interest in minimizing turn restrictions to avoid out-of-direction travel and impacts to existing businesses.

Through discussion with the Project Advisory Committee (PAC), ODOT, and City of Forest Grove staff, four alternatives were identified to address the deficiency, as summarized in the following sections.

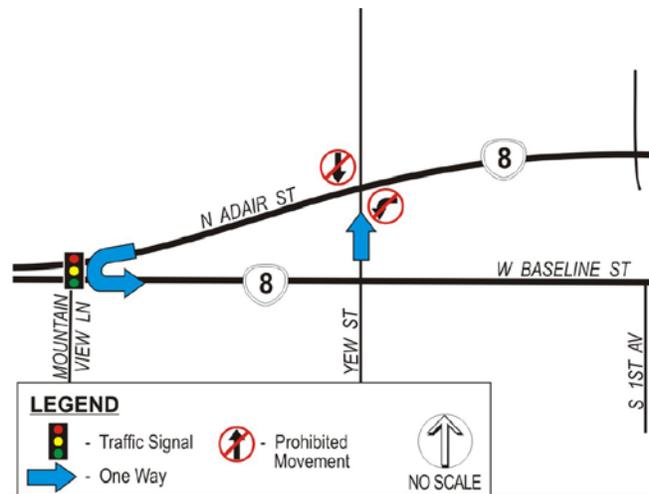
Alternative 1: Traffic Signals

This alternative would include construction of a traffic signal at Yew Street /Adair Street and possibly Yew Street / Baseline Street as well. A traffic signal would be warranted under current conditions due to the high volume of traffic on Adair Street. A second traffic signal at Baseline Street is also preliminarily warranted under future conditions.



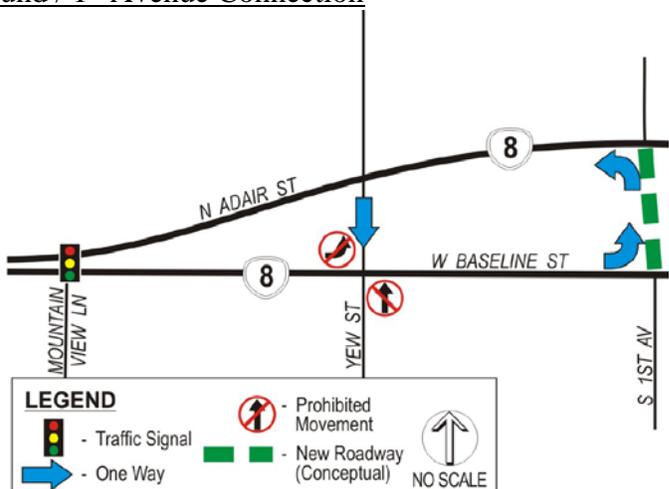
Alternative 2: Yew Street One-way Northbound / U-turn at Mountain View Lane

One-way traffic on Yew Street (between Baseline Street and Adair Street) limits conflicting movements at the Yew Street intersections. Limiting the roadway to northbound traffic prohibits southbound through and westbound left movements at the Yew Street / Adair Street intersection. U-turns west of Yew Street (on the east leg of the Mountain View Lane / Pacific Avenue intersection) would be permitted to provide for these traffic patterns.



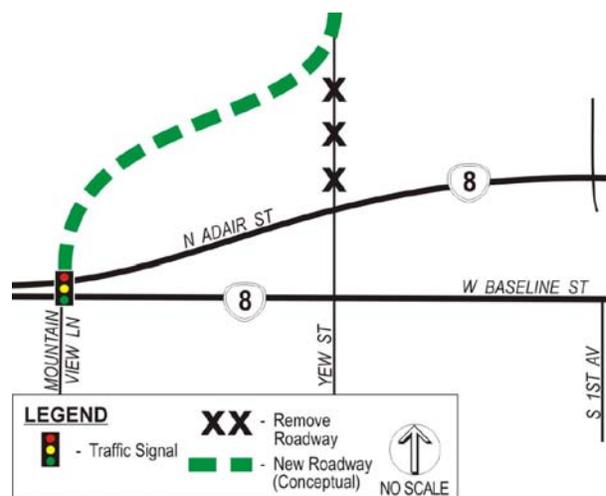
Alternative 3: Yew Street One-way Southbound / 1<sup>st</sup> Avenue Connection

One-way traffic on Yew Street (between Baseline Street and Adair Street) limits conflicting movements at the Yew Street intersections. Limiting the roadway to southbound traffic prohibits northbound through and eastbound left movements at the Yew Street / Baseline Street intersection. In order to provide for these traffic patterns, a new roadway would be constructed between Adair Street and Baseline Street near the 1<sup>st</sup> Avenue alignment. This would function similar to the U-turn proposed at Mountain View Lane / Pacific Avenue in Alternative 3, but would be located east of Yew Street.



Alternative 4: Mountain View Lane Extension

This alternative includes construction of a new roadway to serve as the north leg of the existing intersection at Mountain View Lane / Pacific Avenue. The north leg would be an extension of Mountain View Lane connecting directly to a realigned Yew Street. The existing connection of the north leg of the intersection at Yew Street / Adair Street would be relocated to align with Mountain View Lane. The exact location



and layout of the roadway are to be determined.

## Operations Summary

Table 1 summarizes operational analysis of the three intersections under each of the four proposed alternatives as well as future no-build and existing conditions. The operations summary indicates that Alternatives 1, 3 and 4 would meet operational performance standards.

**Table 1 – Highway 47 Intersection Operations During P.M. Peak Hours**

Scenario	Mt. View Ln. / Pacific Ave.		Yew St. / Adair St.		Yew St. / Baseline St.	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
Existing	B	0.63	<b>A/F</b>	<b>1.00</b>	A/D	0.30
Future Base Scenario	B	0.68	<b>A/F</b>	<b>&gt;1.0</b>	A/F	0.86
Alternative 1 – Signals	B	0.68	B	0.73	A	0.53
Alternative 2 – One-way NB	C	0.85	A/F	0.76	A/E	0.35
Alternative 3 – One-way SB	B	0.68	<b>A/F</b>	<b>&gt;1.0</b>	A/E	0.41
Alternative 4 – Extension	C	0.76	A/C	0.21	A/F	0.34

**Bold text** indicates intersections failing to meet minimum performance standards.

## **Discussion of Alternatives**

Each alternative has benefits and consequences to the transportation system. The following section discusses the issues involved with each alternative.

### Alternative 1: Traffic Signals

While traffic signals provide a good solution for these intersections in isolation, the surrounding environment must be taken into account. The short distance between intersections (approximately 650 feet to Mountain View Lane and just 190 feet to Baseline Street) presents additional issues with signal coordination and queues that could exceed storage and block traffic at adjacent intersections. These proposed signals would have significant construction costs when factoring in coordination with the existing signal at Mountain View Lane and potentially between Baseline Street and Adair Street signals as well.

Introducing new traffic signals at the Yew Street intersections violates ODOT's signal spacing criteria. Placing multiple signals in close proximity has ramifications for signal timing efficiency, traffic flow speeds and progression, flexibility for varying time-of-day demand, safety, and total operating and user costs.

### Alternative 2: Yew Street One-way Northbound / U-turn at Mountain View Lane

This alternative necessitates indirect travel for some existing traffic patterns. The two primary traffic movements redirected in this alternative are :

- Southbound on Yew Street headed east on Baseline Street towards Hillsboro (approximately 165 impacted trips during the 2030 PM peak hour)
- Westbound on Adair Street headed south onto the driveway south of Yew Street (approximately 25 impacted trips during the 2030 PM peak hour)

These trips would be rerouted by permitting U-turns at the Mountain View Lane intersection. The spacing required for U-turns by passenger cars is 52 feet between the right edge of the left turn lane to the curb. The existing alignment is approximately 75 feet leaving room for either an additional turn lane or using the existing left-turn lane. Alternative routes are also available via 24<sup>th</sup> Street or the proposed Holladay Street extension.

This alternative would be a low cost solution that requires signing, restriping, and retiming of an existing signal, but no new construction is expected to be necessary and performance standards are met for 2030 conditions.

### Alternative 3: Yew Street One-way Southbound / 1<sup>st</sup> Avenue Connection

This alternative necessitates indirect travel for some existing traffic patterns. The two primary traffic movements redirected in this alternative are :

- Eastbound on Pacific Avenue headed north to Yew Street (approximately 65 impacted trips during the 2030 PM peak hour)

- Northbound on the driveway south of Yew Street headed west on Pacific Avenue (approximately 20 impacted trips during the 2030 PM peak hour)

These trips would be rerouted via a new roadway connection proposed near the 1<sup>st</sup> Avenue alignment between Adair Street and Baseline. This roadway could be as small as one-lane and serve as a U-turn location for eastbound traffic on Baseline Street.

This alternative would be a relatively low-cost alternative and has relatively small impacts to existing traffic. However, some property acquisition would be required and new roadway would be constructed. However, because of the high volume of traffic both westbound and southbound at the Yew Street / Adair Street intersection, the operational deficiency these alternatives attempt to address remains in this scenario, even with an additional turn lane on Yew Street to separate southbound through traffic from southbound right turns.

#### Alternative 4: Mountain View Lane Extension

This alternative would maximize use of the existing traffic signal at Mountain View Lane and consolidates access along Pacific Avenue. However, this requires a new roadway on the north leg of the Mountain View Intersection, connecting to Yew Street. This alternative has the highest costs and, depending on the alignment, requires acquisition of existing residential and/or commercial-industrial properties in an area.

## **Recommendation**

Alternatives 1 (Traffic Signals) and 3 (one-way southbound on Yew Street) result in non-compliance with either ODOT traffic signal spacing guidelines or performance standards. Pursuing these alternatives raises safety concerns and may negatively impact the existing system.

While Alternative 2 (one-way northbound traffic on Yew Street) provides a low-cost solution that meets the operational standards for future year volumes, a significant amount of traffic patterns would be rerouted and existing businesses would be impacted. In addition, delay for minor street approaches at Yew Street remains at LOS E at Baseline Street and LOS F at Adair Street in 2030.

Although Alternative 4 (Mountain View Lane Extension) requires construction of a new realigned roadway as well as redesign of the signal at the intersection, it provides the best long-term operational performance and provides a direct travel option between Yew Street and Mountain View Lane. A realigned Yew Street could be constructed with in cooperation with redevelopment of the area to limit project costs to the City and ODOT.

DKS Associates recommends implementing Alternative 2 (one-way northbound traffic on Yew Street with U-turns at Mountain View Lane) as soon as possible to address the existing deficiency, while pursuing Alternative 4 as a long-term solution at these intersections.

## Memorandum

**DATE:** June 18, 2009  
**TO:** The Forest Grove TSP/Highway 47 AMP Public Advisory Committee  
**FROM:** Carl Springer P.E.  
Mat Dolata

**SUBJECT:** Access Management Alternatives on Highway 47 P07136-000-000

The purpose of this memorandum is to provide analysis of access alternatives for Highway 47 within the City of Forest Grove. The memorandum will discuss background information on key issues for each identified alternative, analysis of how well they will perform, and provide direction towards recommendations for a preferred solution. These alternative scenarios will be included in the Transportation System Plan (TSP) and Highway 47 Access Management Plan (AMP).

### Operational Standards

To facilitate safe and efficient movement of vehicles on its facilities, ODOT identifies access spacing, signal spacing, and mobility standards. The operational standards vary depending on the facility classification, posted speed, and surrounding environment. Table 1 shows the access spacing standards applicable to Highway 47 within Forest Grove.

**Table 1 – Access Management Spacing Standards**

From	To	Segment Length (Feet)	Minimum Spacing Standard (Feet)
Purdin Road	Oak Street	10,200	1,100
Oak Street	Martin Road	1,100	990
Martin Road	Pacific Avenue	2,300	350
Pacific Avenue	Poplar Street	2,000	750
Poplar Street	B Street	9,000	990

Metro identifies maximum desirable access spacing standards of 530 feet for motor vehicles and 330 for pedestrian and bicycles<sup>1</sup>. Generally, 500 feet would be considered the maximum

<sup>1</sup> 2035 Regional Transportation Plan, Final Draft for USDOT Review, Chapter 7, Metro, January 2008.

desirable distance for pedestrian crossings in mixed-use and residential areas. It is notable that the spacing standards for ODOT and Metro are similar along Highway 47 between Martin Road and Pacific Avenue (Highway 8), but outside of this area, the ODOT access spacing standard is significantly longer than Metro recommends.

ODOT Traffic Signal Policy defines desirable spacing of signalized intersections at a minimum distance of one quarter to a half a mile. Signals are rarely added for distances shorter than one half of a mile. Exceptions may be made, but require detailed traffic signal progression analysis and all signals must meet warrants.

The mobility standard for Highway 47 in Forest Grove is a maximum volume-to-capacity ratio of 0.99. Volume-to-Capacity (v/c) ratio is a measure of how congested facilities are during peak hours of operation, and a value of 0.99 means that the facility is essentially operating at capacity, with long delays during those hours. Outside of the City, where speeds are higher and adjoining land uses are more rural, such as at the intersections of B Street and Verboort Road / Purdin Road, the standard allows much less congestion, with minimum volume to capacity ratios of 0.75 and 0.70, respectively.

## **Future Operational Deficiencies**

The needs and deficiencies for the Forest Grove transportation system were identified in the Future Needs Chapter of the TSP. Utilizing the Metro Travel Demand model and assuming construction of financially constrained Regional Transportation Plan (RTP) projects, motor vehicle traffic volumes were forecasted and intersection conditions were computed for all twenty seven study intersections. This is considered the “No-build” or “Base” scenario for the TSP.

The results of the analysis indicate that, with the exception of two intersections (Yew Street at the intersections of Adair Street and Baseline Street), all intersections that fail to meet performance standards within the City of Forest Grove are located on Highway 47. This confirms the need and value of incorporating the more detailed study of Highway 47 into the TSP Update process.

The Base scenario identified for the AMP differs from the TSP in that it does not include the extension of 23<sup>rd</sup>/24<sup>th</sup> Avenue west of Highway 47. For the purposes of the AMP, the TSP “Base” or “No-Build” scenario is identified as Alternative 1. Splitting these scenarios into two alternatives allows for detailed examination of the impacts of the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension.

Table 2 summarizes the intersection operations for Highway 47 intersections under existing and future (2030 AMP Base) conditions. The results show that signalized intersections work within performance standards (including at Pacific Avenue at Highway 47), but five unsignalized intersections that currently operate within standards are projected to fail. Unsignalized intersections are designated as failing when vehicles traveling from side streets experience significant delay in finding gaps in which they can turn safely onto (or travel through) the major street. Average vehicle delay generally remains low as major street vehicles travel without delay. The failing unsignalized intersections include Purdin Road / Verboort Road, Martin Road, 19<sup>th</sup> Avenue, Maple Street / Fern Hill Road, and B Street.

**Table 2 – Highway 47 Intersection Operations**

Intersection	Existing		Future Base		ODOT Standard
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity	Volume / Capacity
<i>Unsignalized Intersections</i>					
Highway 47/Purdin Road	<b>A/D</b>	<b>0.71</b>	<b>A/F</b>	<b>&gt;1.0</b>	0.70
Highway 47/David Hill Road	-	-	A/F	0.82	0.99
Highway 47/Oak Street	A/C	0.14	A/F	0.85	0.99
Highway 47/Martin Road	A/D	0.73	<b>A/F</b>	<b>&gt;1.0</b>	0.99
Highway 47/24th Avenue	A/C	0.19	A/E	0.52	0.99
Highway 47/19th Avenue	A/D	0.42	<b>A/F</b>	<b>&gt;1.0</b>	0.99
Highway 47/Poplar Street	A/C	0.31	A/E	0.55	0.99
Highway 47/Maple Street	<b>A/F</b>	<b>1.00</b>	<b>A/F</b>	<b>&gt;1.0</b>	0.99
Highway 47/Elm Street	A/D	0.45	A/F	0.72	0.99
Highway 47/B Street	A/C	0.37	<b>A/F</b>	<b>0.84</b>	0.75
<i>Signalized Intersections</i>					
Highway 47/Sunset Drive	C	0.36	D	0.52	0.99
Highway 47/Pacific Avenue	D	0.92	E	0.94	0.99

**Bold text** indicates intersections failing to meet minimum performance standards.

The intersection operations analysis above indicates several notable patterns in travel demand:

- New development in the northwest section of the City is driving increased demand at Purdin Road / Verboort Road, even with a new intersection at David Hill Road.
- In the northern section of the City, growth in demand is significant for southbound travel (from metro Portland) making left turns onto Highway 47, especially at Martin Road.
- Growth in demand at Pacific Avenue and Highway 47 does not result in performance below operating standards, but significant delay does exist, as the v/c ratio (0.98) approaches the minimum standard (0.99). A southbound right turn lane would improve performance, as could another alternative route (such as the 23<sup>rd</sup>/ 24<sup>th</sup> Avenue extension.)

## **Pedestrian/Bicycle Deficiencies**

In addition to demand created by motor vehicles, pedestrian and bicycle demand should also be served at several crossing points along Highway 47. The only existing signalized pedestrian crossings are at Pacific Avenue and Sunset Drive. With only two controlled crossings in all of Forest Grove, a significant barrier-effect exists for pedestrian and bicycle traffic attempting to cross the Highway. Signalized intersections provide an opportunity to for safe pedestrian and bicycle crossings.

Worn footpaths indicate the demand for an additional Highway 47 crossing south of Pacific Avenue, particularly where development exists on both sides of the Highway near 19<sup>th</sup> Avenue and Poplar Street. Demand for bicycle and pedestrian travel may also warrant a crossing at the Maple Street / Fern Hill Road intersection. An additional crossing to the north, between Sunset Road and Pacific Avenue is also desirable, especially south of 24<sup>th</sup> Avenue where there are more developed land uses on both sides of the highway. ODOT is already conducting a crosswalk review at 23<sup>rd</sup> Avenue.

## **Alternatives Considered**

Access management (e.g. driveway consolidation or elimination, lane channelization, shared access easements, and local connectivity options) is considered for study area roadways in this analysis, but is not discussed for private accesses. The access alternatives include several variants of new roadways and closures of existing access points on Highway 47 in an effort to maintain or improve access management along the corridor. Access management for private driveways will be addressed independently, on a case-by-case basis, in the full Highway 47 Access Management Report.

While there are no forecasted needs for additional corridor capacity based on forecasted Highway 47 volumes, the alternatives analysis includes discussion of roadway widening to provide improved operations for vehicles making turns at existing and proposed intersections. Capacity enhancements considered include turn lanes, traffic signals, and signal timing improvements.

Local road network improvements can improve connectivity and reduce demand on Highway 47 by providing parallel routing alternatives. Several local street connections are considered to direct demand to traffic signals and improve overall system operational efficiency.

The need for pedestrian and bicycle crossings on Highway 47 has been identified and will be considered as part of the decision making process for location of new traffic signals. Mid-block crossings were proposed between near 19<sup>th</sup> Avenue and 23<sup>rd</sup> Avenue. However, given the forecasted operational deficiencies at existing highway intersections, a mid-block crossing was removed from consideration after discussion with ODOT, Forest Grove City staff, and the Project Advisory Committee. Any new traffic signal should include crosswalks for pedestrians.

## Strategies To Address Operational Deficiencies

There are three overall strategies to respond to the identified operational deficiencies at these unsignalized intersections: construct a traffic signal or other capacity enhancements (such as new lanes), provide an alternative route of travel to reduce demand, or tolerate the delay. There are positives and negatives to each approach.

- **Signalizing Intersections** - This is the simplest theoretical solution, but decreases mobility for travelers on Highway 47 and conflicts with ODOT signal spacing standards (half a mile between signals).
- **Alternative Travel Routes** - This would provide local circulation options by constructing roadways with new intersections on Highway 47. However, additional intersections could compromise the safety and operations on Highway 47 and also conflict with access spacing standards and objectives.
- **Tolerate Delay** - This strategy is the lowest cost approach and recognizes that delays are limited to minor approaches during peak hour conditions. It is possible that such delays would result in travelers rerouting to other roadways without excessive delay. However, delay on minor street approaches may encourage unsafe driving practices.

Table 3 summarizes the generalized benefits of each approach from the perspective of relative safety, accessibility, mobility and pedestrian and bicycle connectivity.

- *Safety* considerations aim to prevent accidents by staying true to standards that limit conflicts and unsafe operations.
- *Accessibility* is improved by providing more direct options for travel routing.
- Improved *mobility* entails decreasing travel times and limiting delay. Mobility on Highway 47 is compromised when signals are constructed, speeds lowered, and additional access points added.
- Good *bicycle and pedestrian connectivity* limits barriers to direct travel for these modes and makes them more attractive options relative to motor vehicle travel.

**Table 3 – Benefits to Strategies Matrix**

<u>Strategy</u>	Safety	Accessibility	Highway Mobility	Bike/Ped Connectivity
Signalizing Intersections	■			■
Alternative Travel Routes		■		■
Tolerating Delay			■	

A mixed approach that includes alternative travel routes and new signals at a few targeted locations could potentially address the issues identified most effectively, and without compromising the integrity of travel on Highway 47.

## **Proposed Corridor Scenarios**

Six scenarios were created in an attempt to balance serving the various components of travel demand without compromising Highway 47 performance and standards. These alternatives are not the only options available in Forest Grove. Rather, they serve to illustrate a toolbox of design choices that could be made to balance the safety, mobility, accessibility and connectivity needs of the City's transportation system and the Highway.

For each proposed alternative the significant changes in forecasted travel patterns will be described as well as the operations summary, additional mitigations required to meet operational standards, and analysis of relative advantages and disadvantages. Future forecast volumes are based on the Metro travel demand forecast model and post-processed 2030 forecast volumes. Traffic operations are based on *Highway Capacity Manual* methodology.

While operations are analyzed for all study intersections, the Highway 47 intersections with B Street and Verboort Road / Purdin Road are not included in illustrations of the alternatives. This is done to highlight the differences between access alternatives. No alternative access scenarios are considered for these roadways because they are located outside the urban growth boundary. New roadways outside of the urban growth boundary would be unlikely to comply with state policy when other alternatives exist. The projects to consider at these intersections will be intersection-specific (e.g. turn lanes, traffic signals, roundabouts.)

### **Alternative 1**

Alternative 1 is the TSP Base scenario, which includes a local connection via the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension, as identified in the Metro Regional Transportation Plan. Extension of 24<sup>th</sup> Avenue to Highway 47 would require a grant of access from ODOT. A new traffic signal at the intersection of 24<sup>th</sup> Avenue is included, based on need created by the projected traffic demand.

### **Travel Pattern Changes**

As a result of the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension there are changes expected to traffic volumes at the Pacific Avenue intersection, relative to the AMP Base scenario. Southbound left turns and westbound right turns increase, with reductions in east and westbound through traffic. With improved access at the 24<sup>th</sup> Avenue, there is less demand at the Oak Street / Porter Road intersection. There are no significant changes to Highway 47 traffic volumes south of 19<sup>th</sup> Avenue or west of Oak Street.

### **Operations Summary**

Table 4 summarizes the findings of the operations analysis for Alternative 1 and compares operations to the Base scenario. There are no significant changes to the intersections that fail to meet performance standards. Delay is slightly increased at the Pacific Avenue / Highway 47 intersection due to the increase in turn movements, however operations at the Oak Street / Porter Road intersection are improved.



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## Access Management Plan

### Legend

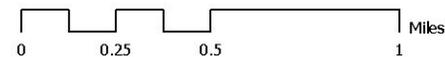
- Water
- City Limits
- Urban Growth Boundary
- Proposed Roadway Project (Conceptual)
- Proposed Roundabout
- Proposed Traffic Signal
- Existing Traffic Signal

CREAL  
CURBAN  
GEOGRAPHICS

DKS Associates  
TRANSPORTATION SOLUTIONS

FIGURE

ALTERNATIVE 1



**Table 4 – Highway 47 Intersection Operations (Alternative 1)**

Intersection	Base		Alternative 1	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
<i>Unsignalized Intersections</i>				
Highway 47/Purdin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/David Hill Road	A/F	0.82	A/F	0.88
Highway 47/Oak Street	A/F	0.85	A/D	0.38
Highway 47/Martin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/24th Avenue	A/E	0.52	<i>B*</i>	0.62
Highway 47/19th Avenue	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Poplar Street	A/E	0.55	A/D	0.50
Highway 47/Maple Street	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Elm Street	A/F	0.72	A/F	0.72
Highway 47/B Street	<b>A/F</b>	<b>0.84</b>	<b>A/F</b>	<b>0.84</b>
<i>Signalized Intersections</i>				
Highway 47/Sunset Drive	D	0.52	C	0.50
Highway 47/Pacific Avenue	E	0.94	E	0.93

*\*Signalized intersection in alternative.*

**Additional Mitigations**

Additional mitigations needed to meet Highway 47 operational standards and address safety concerns in this alternative are likely to include:

- Roundabout at Purdin Road / Verboort Road
- Widening to three lanes at David Hill Road
- Traffic signal at Martin Road
- Westbound right turn lane on 19<sup>th</sup> Avenue
- Traffic signal at Maple Street / Fern Hill Road
- Traffic signal at B Street

**Analysis**

While the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension is projected to remove some traffic from Pacific Avenue, it does not address the operational deficiencies projected at Martin Road, 19<sup>th</sup> Avenue, or Maple Street intersections.

Given the proximity of the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension and the Martin Road intersection (approximately 600 feet away), a signal would not be included at both locations without

violating ODOT's desired signal spacing standards. The proximity of the rail crossing may present difficulties for placement of a signal at this location.

Without a traffic signal at the Martin Road intersection, demand for turns at Martin Road would likely reroute during congested periods and spread between Porter Road and Verboort Road.

As in the Base scenario, Highway 47 should be widened to three lanes near David Hill Road to avoid safety concerns and delay resulting from northbound blockage on the Highway from vehicles attempting to make left turns to David Hill Road.

### **Summary**

Alternative 1 provides a pedestrian crossing across Highway 47 at 24<sup>th</sup> Avenue. It also adheres to the ODOT minimum traffic signal spacing targets and provides an improved local access for industrial areas. Lower demand at the Oak Street/Porter Street intersection reduces delay for turning vehicles at the intersection. However, the five operational deficiencies identified in the Base scenario for vehicles turning onto Highway 47 are not addressed and the Pacific Avenue intersection is not significantly improved.

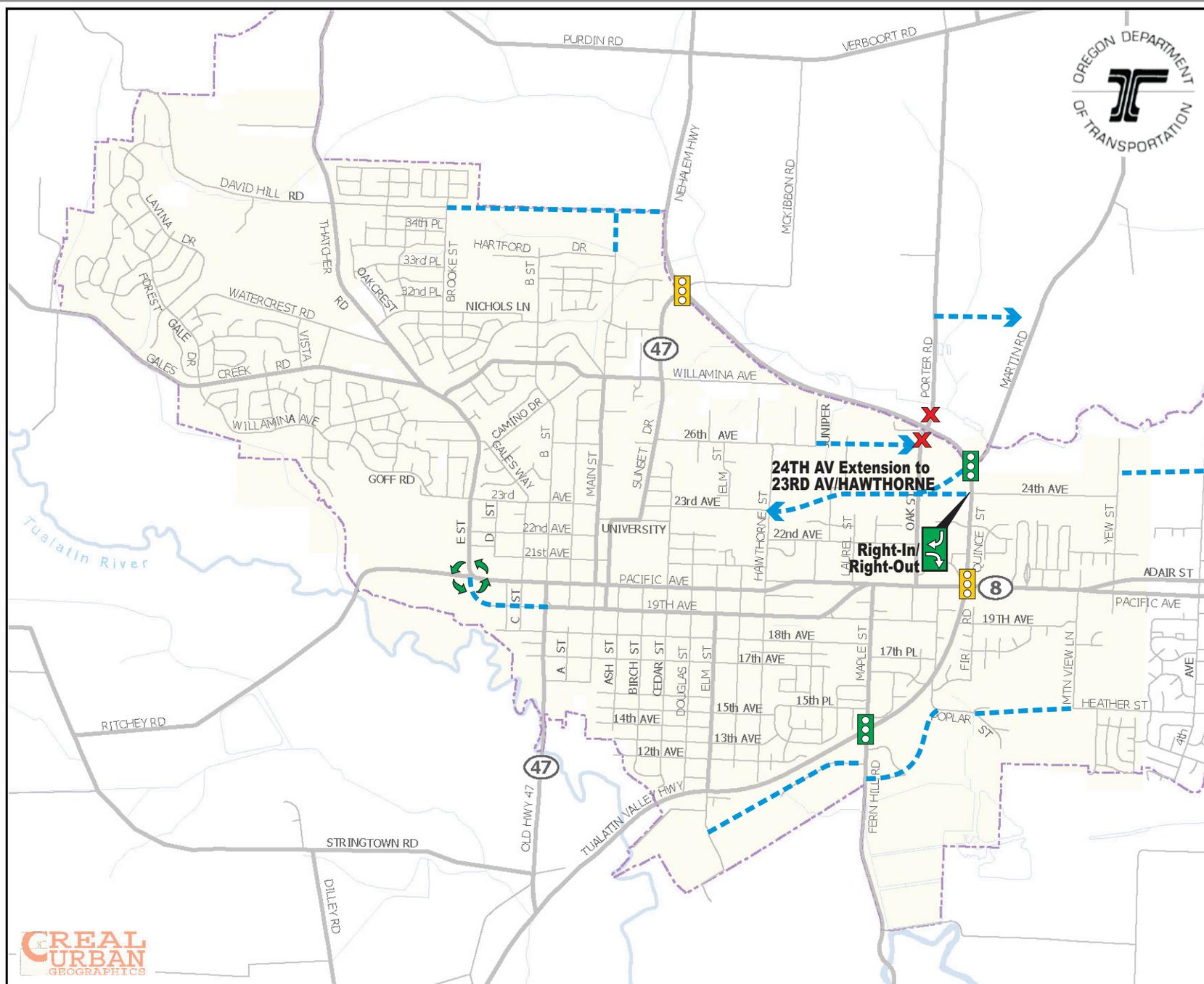
### **Alternative 2**

Alternative 2 modifies the alignment of the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension by connecting it to Martin Road. Access to 24<sup>th</sup> Avenue west of Highway 47 is retained, but would be restricted to right in and right out turns on the west leg. Given the new access point, the Oak Street / Porter Road intersection is closed to maintain the existing access control and direct demand to the traffic signal at Martin Road via a local street connection. Extension of 24<sup>th</sup> Avenue to Martin Road would require a grant of access from ODOT. This could be aided by closing Oak Street and Porter Road.

A new traffic signal is located at the Maple Street / Fern Hill Road intersection. Local street connections are recommended to Fern Hill Road to provide circulation alternatives south of Highway 47 and maximize the usage of the signalized crossing at Maple Street. This intersection would serve as a bicycle and pedestrian crossing as well.

### **Travel Pattern Changes**

Connecting the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension to Martin Road draws a small amount of traffic away from the northern intersections at Purdin Road / Verboort Road, David Hill Road, and Sunset Drive. Instead of turning left, much of the southbound traffic on Martin Road travels through the proposed extension to 23<sup>rd</sup> Avenue. The traffic signal at Maple Street / Fern Hill Road combined with local connections to Elm Street and Poplar Street reduces the left turning vehicles at these intersections and is effective at re-routing demand to the signalized intersection.



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## Access Management Plan

### Legend

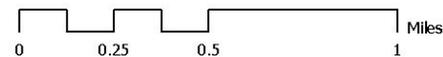
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- Proposed Access Closure

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TRANSPORTATION SOLUTIONS

FIGURE

ALTERNATIVE 2



**Operations Summary**

Table 5 summarizes the findings of the operations analysis for Alternative 2. With Oak Street / Porter Road access closed and a traffic signal at Martin Road, the operational issues north of 24<sup>th</sup> Avenue are limited to Purdin Road / Verboort Road. The additional right turn volumes at 24<sup>th</sup> Avenue create a new operational issue at this intersection. The traffic signal at Maple Street / Fern Hill Road, combined with local connections to Elm Street and Poplar Street, improves operations at all three intersections. Operational issues remain at the Purdin Road / Verboort Road, 19<sup>th</sup> Avenue, and B Street intersections.

**Table 5 – Highway 47 Intersection Operations (Alternative 2)**

Intersection	Base		Alternative 2	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
<i>Unsignalized Intersections</i>				
Highway 47/Purdin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/David Hill Road	A/F	0.82	A/E	0.76
Highway 47/Oak Street	A/F	0.85	-	-
Highway 47/Martin Road	<b>A/F</b>	<b>&gt;1.0</b>	<i>B*</i>	<i>0.66</i>
Highway 47/24th Avenue	A/E	0.52	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/19th Avenue	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Poplar Street	A/E	0.55	A/B	0.19
Highway 47/Maple Street	<b>A/F</b>	<b>&gt;1.0</b>	<i>B</i>	<i>0.69</i>
Highway 47/Elm Street	A/F	0.72	A/E	0.56
Highway 47/B Street	<b>A/F</b>	<b>0.84</b>	<b>A/F</b>	<b>0.84</b>
<i>Signalized Intersections</i>				
Highway 47/Sunset Drive	D	0.52	C	0.50
Highway 47/Pacific Avenue	E	0.94	E	0.93

*\*Signalized intersection in alternative.*

**Additional Mitigations**

Additional mitigations needed to meet Highway 47 operational standards in this alternative are likely to include:

- Roundabout at Purdin Road / Verboort Road
- Widening to three lanes at David Hill Road
- Traffic signal at 24<sup>th</sup> Avenue
- Westbound right turn lane on 19<sup>th</sup> Avenue

- Traffic signal at B Street

### **Analysis**

The proposed 23<sup>rd</sup>/24<sup>th</sup> Avenue extension addresses the operational deficiency at Martin Road and, in conjunction with the Oak Street / Porter Road access closure, directs traffic towards traffic signals. ODOT traffic signal spacing and access spacing standards are maintained. However, the pedestrian crossing at Martin Road is located further from the areas of pedestrian demand.

A new operational deficiency is created from the new access at 24<sup>th</sup> Avenue. Given the proximity of the Martin Road intersection, a signal would not be included at both locations. The proximity of the rail crossing may present difficulties for placement of a signal at this location as well.

A traffic signal at the Maple Street / Fern Hill Road intersection addresses the operational issue identified. Local street access provides alternatives to making turns at unsignalized Highway 47 intersections. Traffic demand may re-direct to the signal at Maple Street / Fern Hill, which would improve the delay experienced for vehicles turning onto Highway 47 from Elm Street and Poplar Street.

### **Summary**

The extension of 23<sup>rd</sup>/24<sup>th</sup> Avenue to connect with Martin Road would provide a traffic signal for the demand from the northwest. Closing highway access to Oak Street / Porter Road directs demand to the new traffic signal and maintains current access spacing. However, a new operational issue is introduced at 24<sup>th</sup> Avenue by providing a new access at the west leg of the intersection. In addition, pedestrian traffic is not well served by a crossing located on the fringe of the urban growth boundary, and the Pacific Avenue intersection operations remain at LOS E.

Constructing a traffic signal at Maple Street / Fern Hill Road with local connections to Elm Street and Poplar Street addresses the operational deficiency at Maple Street / Fern Hill and improves operations at all three intersections while providing improved connectivity away from the Highway.

### **Alternative 3**

In Alternative 3, the 24th Avenue extension is not constructed and the Martin Road access is closed. Traffic is instead oriented towards the proposed traffic signal at the intersection of Oak Street / Porter Road. Access at David Hill Road is restricted to right turns.

The 19<sup>th</sup> Avenue / Pacific Avenue couplet is extended to Highway 47 with a traffic signal at 19<sup>th</sup> Avenue and a northbound free right turn lane constructed on Highway 47 for vehicles travelling east to Pacific Avenue. Another traffic signal is located at Maple Street.

#### **Travel Pattern Changes**

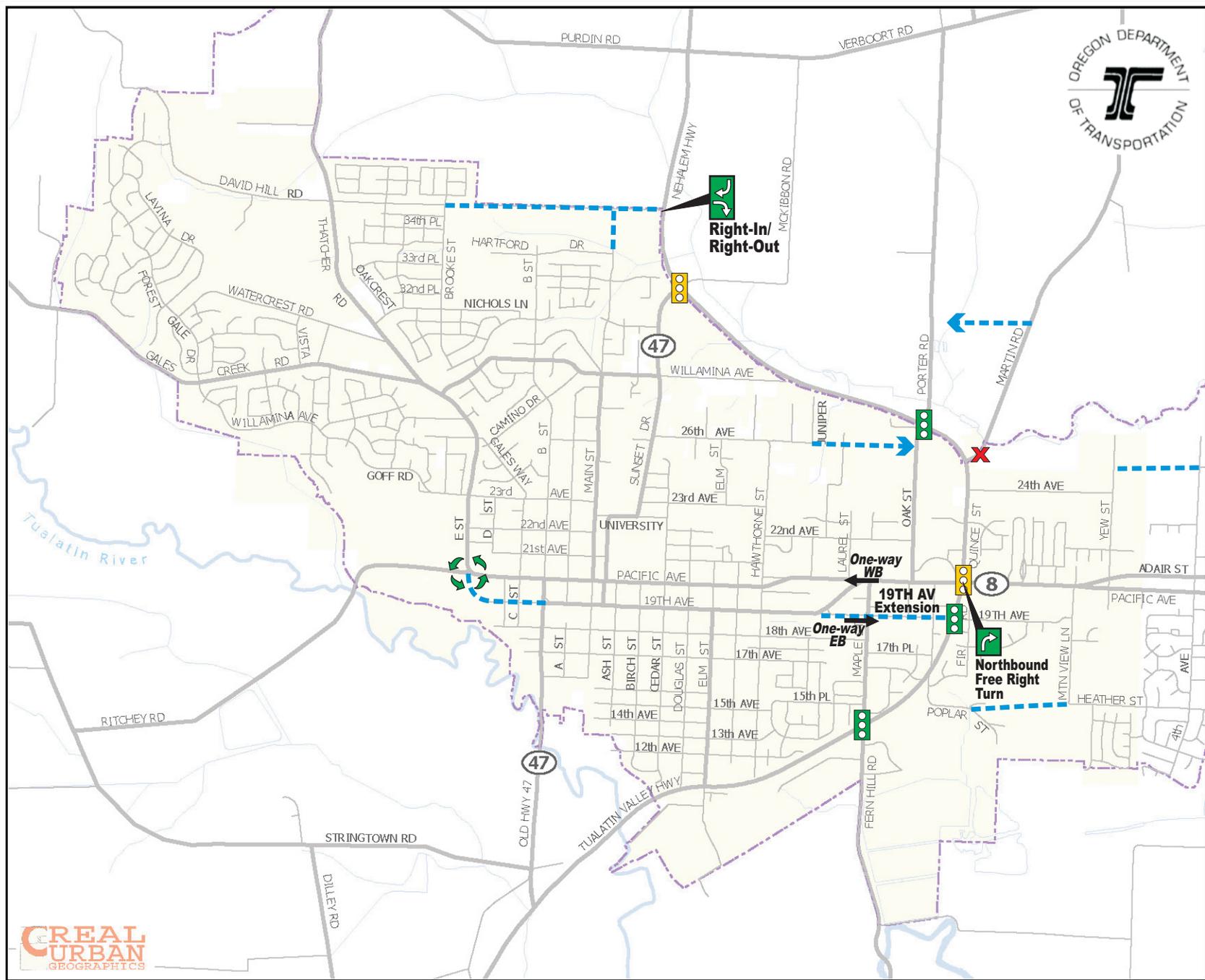
Prohibiting left hand turns at David Hill Road increases left turns at Sunset Drive. As would be expected, closure of Martin Road directs traffic to the traffic signal at Oak Street / Porter Road. The extension of the 19<sup>th</sup> Avenue / Pacific Avenue couplet to Highway 47 splits the Pacific Avenue volume between two intersections. Volume increases on Highway 47 between 19<sup>th</sup> Avenue and Pacific Avenue.

Fewer through trips travel via the segment of Highway 47 near Pacific Avenue, and turning volumes from minor street approaches, such as B Street and Poplar Street are altered.

#### **Operations Summary**

Table 6 summarizes the findings of the operations analysis for Alternative 3. With Martin Road access closed and a traffic signal at Oak Street / Porter Road, the operational issues north of Pacific Avenue are limited to the Purdin Road / Verboort Road intersection.

Compared to the Base scenario, vehicles turning from Poplar Street are more inclined to make left turns than right turns, creating an operational issue at Poplar Street. Additional turn movements are also forecasted for B Street as a result of less attractive travel on Highway 47, resulting in increased delay at the intersection. The operational issue identified in the Base scenario remains at the Purdin Road / Verboort Road intersection.



city of  
forest  
grove

## Access Management Plan

### Legend

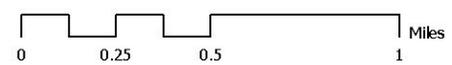
- Water
- City Limits
- Urban Growth Boundary
- Proposed Roadway Project (Conceptual)
- Proposed Roundabout
- Proposed Traffic Signal
- Existing Traffic Signal
- Proposed Access Closure



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TRANSPORTATION SOLUTIONS

FIGURE

ALTERNATIVE 3



**Table 6 – Highway 47 Intersection Operations (Alternative 3)**

Intersection	Base		Alternative 3	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
<i>Unsignalized Intersections</i>				
Highway 47/Purdin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/David Hill Road	A/F	0.82	A/B	0.21
Highway 47/Oak Street	A/F	0.85	C*	0.78
Highway 47/Martin Road	<b>A/F</b>	<b>&gt;1.0</b>	-	-
Highway 47/24th Avenue	A/E	0.52	A/E	0.54
Highway 47/19th Avenue	<b>A/F</b>	<b>&gt;1.0</b>	C	0.76
Highway 47/Poplar Street	A/E	0.55	<b>A/F</b>	<b>0.99</b>
Highway 47/Maple Street	<b>A/F</b>	<b>&gt;1.0</b>	A	0.63
Highway 47/Elm Street	A/F	0.72	A/F	0.69
Highway 47/B Street	<b>A/F</b>	<b>0.84</b>	<b>A/F</b>	<b>&gt;1.0</b>
<i>Signalized Intersections</i>				
Highway 47/Sunset Drive	D	0.52	D	0.60
Highway 47/Pacific Avenue	E	0.94	C	0.77

*\*Signalized intersection in alternative.*

**Additional Mitigations**

Additional mitigations needed to meet Highway 47 operational standards and address safety concerns in this alternative are likely to include:

- Roundabout at Purdin Road / Verboort Road
- Dual eastbound left turn lanes and a westbound right turn lane on 19<sup>th</sup> Avenue approaching Highway 47
- Westbound right turn lane on Poplar Street
- Traffic signal at B Street

**Analysis**

The proposed left turn restrictions at David Hill Road would limit the delays experienced at this intersection and would not require widening Highway 47 to three lanes along this segment. Left turn volume would shift to the Sunset Drive intersection in this scenario,

increasing delay at the intersection, though remaining within operational standards. The potential effects of re-routing local traffic from David Hill Road to Sunset Drive include additional traffic and delays along Sunset Drive and the connecting streets in the downtown area.

The proposed signal at Oak Street / Porter Road combined with the closure of access at Martin Road would improve access management on Highway 47 while providing adequate spacing between signals. However, the scenario would not provide a bicycle and pedestrian crossings across Highway 47 at a location that serves demand in the vicinity of Quince Street (Highway 47 between Pacific Avenue and 24<sup>th</sup> Avenue).

The extension of the 19th Avenue / Pacific Avenue couplet, with a channelized and free-flowing northbound right turn on Highway 47 allows for more efficient traffic signal phasing. With fewer phases required for one-way traffic, both the proposed signal at 19<sup>th</sup> Avenue and the Pacific Avenue intersection are forecasted to operate at LOS C. However, additional traffic volume combined with additional traffic signals may make travel along this segment of Highway 47 less attractive for through trips. As a result, increases in some turn volumes from minor street approaches at 19<sup>th</sup> Avenue and B Street would degrade operations at these intersections or require additional mitigation.

A traffic signal at the Maple Street / Fern Hill Road intersection addresses the operational deficiency identified there. Without the local street connectivity to Elm Street and Poplar Street, as identified in Alternative 2, the traffic signal does not provide significant benefit to those intersections.

### **Summary**

The extension of the one-way Pacific Avenue and 19th Avenue couplet improves operations at the Highway 47 intersections by splitting demand between two signals. However, the additional volume on the Highway and additional delay created by having two signals may make through travel along Highway 47 less attractive. Resulting changes to turn demand at Poplar Street and B Street increases delay on those approaches and may require additional mitigation. This scenario would require further study to identify detailed operational interactions and coordination priority between Pacific Avenue and Highway 47. The two intersections are in close proximity and would violate both signal spacing and access spacing standards for Highway 47. This proposal would also require right-of-way acquisition and make pedestrian crossings more difficult.

A traffic signal at the Oak Street / Porter Road intersection would not provide an effective pedestrian crossing, but would serve the vehicular traffic demand from the northwest. When combined with closing highway access to Martin Road, traffic is directed to the proposed traffic signal and existing access spacing is improved.

## **Alternative 4**

Alternative 4 examines the impacts of removing the existing traffic signal at Sunset Drive and installing a new signal at David Hill Road. A new Highway 47 access between Sunset Drive and Oak Street would be constructed along the Hawthorne Street alignment. The 23<sup>rd</sup>/24<sup>th</sup> Avenue extension is also included.

Extending 19<sup>th</sup> Avenue to Highway 47 as a two-way street differs from Alternative 3, which extended the one-way street couplet configuration. ODOT has conditionally approved a grant of access at 19<sup>th</sup> Avenue for right turns.

A local access road is constructed that connects Fern Hill Road to Elm Street, where a new signal would be located instead of at the intersection of Maple Street / Fern Hill Road and Highway 47.

### **Travel Pattern Changes**

The improved connectivity provided by new access points to Highway 47 at Hawthorne Street and 24<sup>th</sup> Avenue draw volume away from other intersections. The extensions of 23<sup>rd</sup>/24<sup>th</sup> Avenue and 19<sup>th</sup> Avenue remove some traffic volume from Pacific Avenue.

The traffic signal at Elm Street combined with the local connection between Elm Street and Fern Hill Road shifts some left turn volume at Highway 47 from Maple Street / Fern Hill Road to Elm Street.

### **Operations Summary**

Table 7 summarizes the findings of the operations analysis for Alternative 4. The proposed changes to David Hill Road, Sunset Drive, and the new access at Hawthorne Street all result in operational performance at the Highway 47 intersections that fall within standards, as the demand for turn movements is split between these intersections as well as Oak Street and 24<sup>th</sup> Avenue. The Martin Road intersection continues to fail to meet minimum performance standards.

The 19<sup>th</sup> Avenue intersection, which already fails to meet performance standards as a three-leg intersection, is further degraded with the extension to Highway 47. The Poplar Street intersection sees improved operational performance as some vehicles turn right instead of left, in order to take advantage of the improved local access via 19<sup>th</sup> Avenue.

The Maple Street / Fern Hill Road intersection with Highway 47 continues to have operational issues despite the local access to Elm Street and the proposed traffic signal at Elm Street and Highway 47.

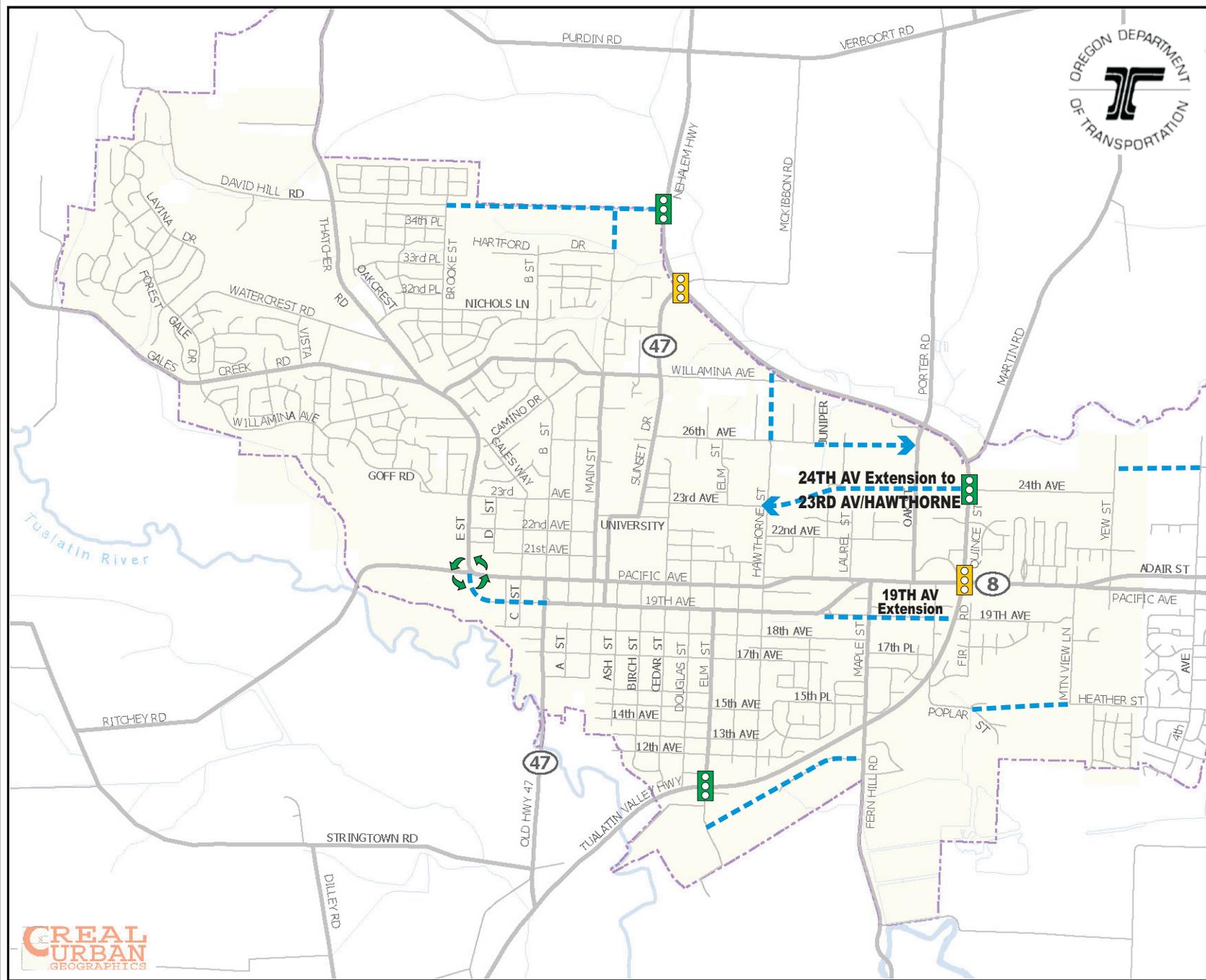


city of forest grove

# Access Management Plan

## Legend

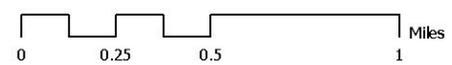
- Water
- City Limits
- Urban Growth Boundary
- Proposed Roadway Project (Conceptual)
- Proposed Roundabout
- Proposed Traffic Signal
- Existing Traffic Signal
- Proposed Access Closure



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TRANSPORTATION SOLUTIONS

FIGURE

# ALTERNATIVE 4



**Table 7 – Highway 47 Intersection Operations (Alternative 4)**

Intersection	Base		Alternative 4	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
<i>Unsignalized Intersections</i>				
Highway 47/Purdin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/David Hill Road	A/F	0.82	A*	0.57
Highway 47/Hawthorne Street	-	-	A/C	0.68
Highway 47/Oak Street	A/F	0.85	A/F	0.76
Highway 47/Martin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/24th Avenue	A/E	0.52	B*	0.63
Highway 47/19th Avenue	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Poplar Street	A/E	0.55	A/C	0.29
Highway 47/Maple Street	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Elm Street	A/F	0.72	A*	0.63
Highway 47/B Street	<b>A/F</b>	<b>0.84</b>	<b>A/F</b>	<b>0.81</b>
<i>Signalized Intersections</i>				
Highway 47/Sunset Drive	D	0.52	A/D**	0.48
Highway 47/Pacific Avenue	E	0.94	E	0.96

*\*Signalized intersection in alternative.*

*\*\*Stop-controlled intersection in alternative.*

**Additional Mitigations**

Additional mitigations needed to meet Highway 47 operational standards in this alternative are likely to include:

- Roundabout at Purdin Road / Verboort Road
- Widening to three lanes at David Hill Road
- Traffic signal at Martin Road
- Widening to three lanes at Hawthorne Street
- Traffic signal at 19<sup>th</sup> Avenue
- Traffic signal at Maple Street / Fern Hill Road
- Traffic signal at B Street

## **Analysis**

The proposed signal at David Hill Road, together with roadway extensions to Highway 47 for Hawthorne Street and 23<sup>rd</sup>/24<sup>th</sup> Avenue, draw enough demand away from Sunset Road that the intersection continues to meet performance standards with stop signs on Sunset Drive. However, the demand for left turns from Highway 47 to David Hill Road and Hawthorne Street would necessitate expanding this segment of Highway 47 to three lanes to avoid significant blockage to through traffic on the Highway and preserve safe operations. While local access to the Highway is improved via the Hawthorne Street and 23<sup>rd</sup>/24<sup>th</sup> Avenue extensions, the need to provide a signalized intersection for traffic between Forest Grove and the northwest is not addressed in this scenario. The Martin Road intersection continues to fail to meet operational performance standards

Although the improved connectivity at 24<sup>th</sup> Avenue and 19<sup>th</sup> Avenue reduces the overall volume at the Pacific Avenue intersection in the east and west directions, the north and south volumes increase, resulting in slightly increased delay at the intersection.

Extending 19<sup>th</sup> Avenue as a two-way street to Highway 47 results in a four-leg intersection that fails to meet performance standards based on the projected travel demand. The intersection has operational issues as a three leg intersection as well. While these may be adequately addressed with an additional turn lane on 19<sup>th</sup> Avenue, a traffic signal would be required if the intersection includes a fourth leg.

A traffic signal at the Elm Street intersection, rather than the Maple Street / Fern Hill Road intersection, fails to address the operational deficiency identified in the Base scenario. Maple Street / Fern Hill Road has higher forecasted volumes in 2030 and, even with a local connection to Elm Street, would face significant delay for vehicles turning onto Highway 47.

## **Summary**

Alternative 4 provides additional circulation options and improved local access to Highway 47 via extensions at Hawthorne Street, 24<sup>th</sup> Avenue and 19<sup>th</sup> Avenue. Although local access is improved, the alternative does not address the deficiencies identified in the Base scenario and increases delay at the Pacific Avenue intersection.

Alternative placements of traffic signals at David Hill Road and Elm Street do not provide significant operational benefits and may not meet future signal warrants based on forecasted travel demand. The intersections of B Street and Purdin Road / Verboort Road fail to meet operational performance standards, as identified in other alternatives.

## **Alternative 5**

Alternative 5 is based on the preferred solution identified in the 1996 Environmental Impact Study for the Highway 47 Bypass. The study proposed a five-lane roadway near the current Highway 47 alignment (between Pacific Avenue and 24<sup>th</sup> Avenue) with a separated local frontage road east of the roadway. The roadway would require land acquisition to the west of Highway 47.

The alternative also identifies no new connection to Highway 47 at David Hill road and includes construction of a traffic signal at the Maple Street / Fern Hill Road intersection.

### **Travel Pattern Changes**

As a result of no new access to Highway 47 being provided at David Hill Road, through traffic volumes increase at the Purdin Road / Verboort Road intersection relative to the Base scenario. The Sunset Drive intersection is projected to have higher turn volumes.

Widening of Highway 47 between 24<sup>th</sup> Avenue and Pacific Avenue would make the route more attractive to through travel, resulting in higher overall traffic volumes at intersections south of Sunset Drive. Right turn volumes from B Street onto the Highway are forecasted to decrease, but left turns increase slightly as a result of a more attractive route of travel along Highway 47 north of the intersection.

### **Operations Summary**

Table 8 summarizes the findings of the operations analysis for Alternative 5. The Maple Street / Fern Hill Road intersection meets minimum performance standards with a traffic signal constructed. The other four intersections that fail to meet performance standards in the Base scenario remain as operational issues in this alternative. Operational performance is slightly degraded at B Street and Sunset Avenue as the result of additional left turns compared to the Base scenario. Operations at the Pacific Avenue intersection improve to LOS D with the additional lanes constructed by the proposed widening.



**Table 8 – Highway 47 Intersection Operations (Alternative 5)**

Intersection	Base		Alternative 5	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
<i>Unsignalized Intersections</i>				
Highway 47/Purdin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/David Hill Road	A/F	0.82	-	-
Highway 47/Oak Street	A/F	0.85	A/E	0.72
Highway 47/Martin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/24th Avenue	A/E	0.52	A/F	0.61
Highway 47/19th Avenue	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Poplar Street	A/E	0.55	A/E	0.55
Highway 47/Maple Street	A/F	>1.0	<i>B*</i>	<i>0.71</i>
Highway 47/Elm Street	A/F	0.72	A/F	0.74
Highway 47/B Street	<b>A/F</b>	<b>0.84</b>	<b>A/F</b>	<b>&gt;1.0</b>
<i>Signalized Intersections</i>				
Highway 47/Sunset Drive	D	0.52	D	0.57
Highway 47/Pacific Avenue	E	0.94	D	0.80

*\*Signalized intersection in alternative.*

**Additional Mitigations**

Additional mitigations needed to meet Highway 47 operational standards in this alternative are likely to include:

- Roundabout at Purdin Road / Verboort Road
- Traffic signal at Martin Road
- Westbound right turn lane on 19<sup>th</sup> Avenue
- Traffic signal at B Street

**Analysis**

Widening of Highway 47 between Pacific Avenue and 24<sup>th</sup> Avenue would allow for higher speeds of travel and decreased delay and queuing at the Pacific Avenue intersection. As a result, travel along this segment becomes more attractive. Current access and signal spacing is maintained and no construction or widening is necessary beyond the identified segment between 19<sup>th</sup> Avenue and 24<sup>th</sup> Avenue.

Delays on B Street are slightly degraded as a result of forecasted increases in left turns onto the highway. The Sunset Drive intersection is also forecasted to experience more delay as a result of additional left turn demand that could be served by David Hill Road.

Serving demand between Forest Grove and the northwest is not addressed in this scenario. The Martin Road intersection continues to fail to meet operational performance standards. There are also no pedestrian or bicycle crossings identified north of Pacific Avenue.

With no access to Highway 47 from David Hill, the demand on the current roadway network and the Sunset Drive intersection is increased. However, the intersection continues to meet performance standards and remains forecasted to perform at LOS D.

### **Summary**

Alternative 5 improves mobility for travel along Highway 47 by allowing for higher speed travel and reducing congestion at the Pacific Avenue intersection. Traveler delay at the Pacific Avenue intersection would be significantly improved. However, the costs of property acquisition and reconstructing Highway 47 and the Pacific Avenue intersection would be substantial, and most of the operational deficiencies identified in the Base scenario are not addressed. Also, no new pedestrian/bike crossings are provided beyond the Maple Street / Fern Hill Road intersection.

Not providing access to Highway 47 via David Hill Road would not create any operational deficiencies but would reduce accessibility and increase out of direction travel for some travelers.

## **Alternative 6**

Alternative 6 includes the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension as well as an extension of Yew Street north to Martin Road. Martin Road is closed at Highway 47 to focus traffic demand to the Yew Street and 23<sup>rd</sup>/24<sup>th</sup> Avenue extensions

David Hill Road is restricted to right turns to limit conflicts and delay at the intersection, while still providing local access to Highway 47. An additional southbound right turn lane would be constructed at the Pacific Avenue intersection.

As in Alternative 2, the Maple Street / Fern Hill Road intersection includes a new traffic signal and local connections to Elm Street and Poplar Street.

### **Travel Pattern Changes**

Prohibiting left turns at the David Hill Road intersection increases left turns at the Purdin Road / Verboort Road and Sunset Drive intersections.

Some movements at the intersection of Oak Street / Porter Road are increased as a result of the 23<sup>rd</sup>/24<sup>th</sup> Avenue extension and closed access at Martin Road, but overall volume decreases at the intersection.

Volume at the Pacific Avenue intersection decreases slightly as the result of the 23<sup>rd</sup>/24<sup>th</sup> Avenue intersection. Volumes at Elm Street and Poplar street decrease by providing greater connectivity to Fern Hill Road and the proposed traffic signal at Highway 47 and Maple Street / Fern Hill Road.

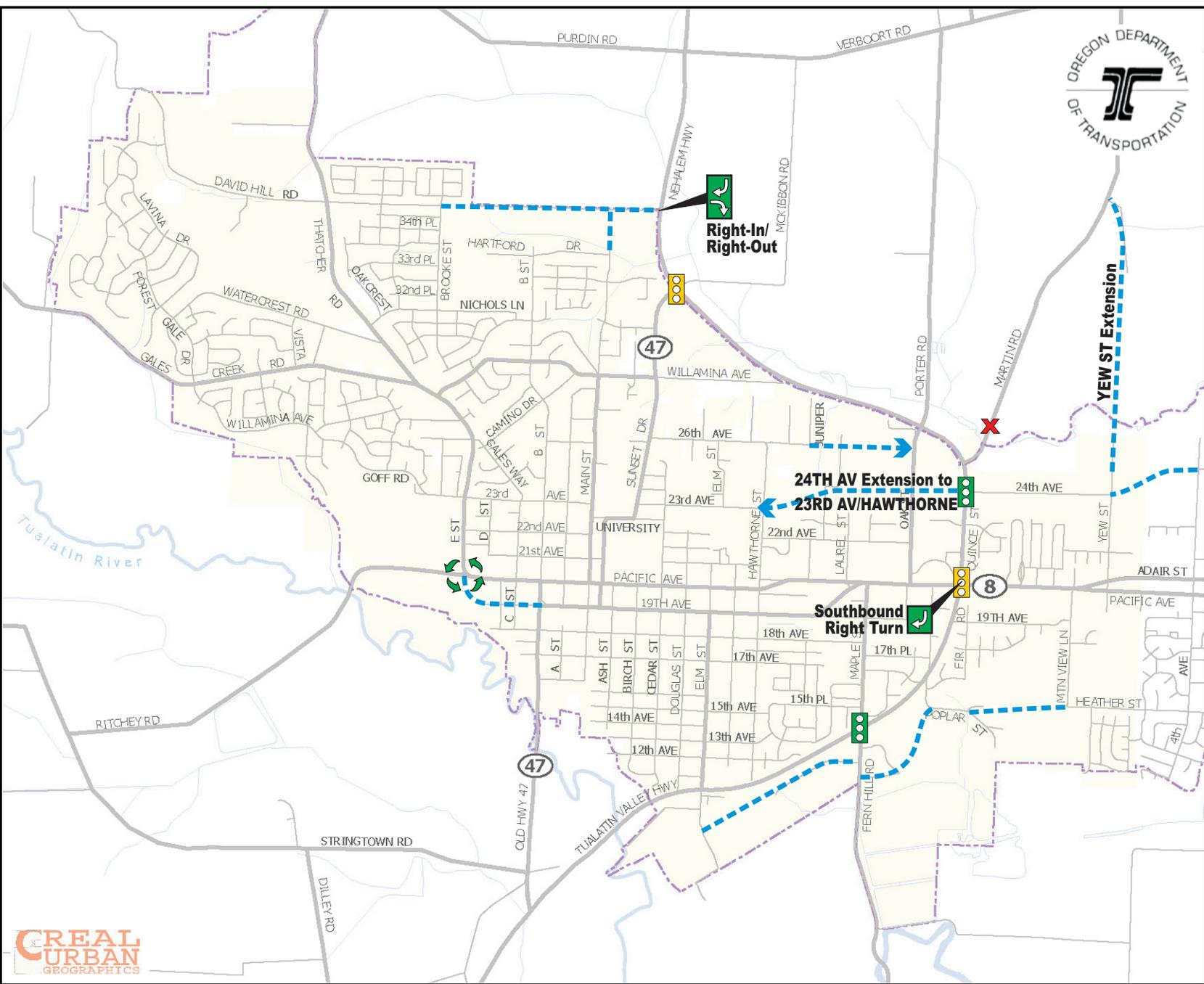
### **Operations Summary**

Table 9 summarizes the findings of the operations analysis for Alternative 6. The Maple Street / Fern Hill Road intersection meets minimum performance standards with a traffic signal constructed, as does 24<sup>th</sup> Avenue with the proposed 23<sup>rd</sup>/24<sup>th</sup> Avenue extension. Closure of Martin Road does not result in any new operational issues in this alternative. Operations at the Pacific Avenue intersection improve to LOS D with the additional southbound right turn lane and changes in traffic patterns resulting from the proposed roadway extensions. The Purdin Road / Verboort Road, 19<sup>th</sup> Avenue and B Street intersections continue to fail to meet minimum performance standards.

**Access  
Management  
Plan**

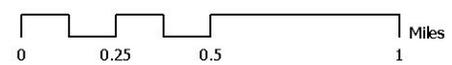
**Legend**

-  Water
-  City Limits
-  Urban Growth Boundary
-  Proposed Roadway Project (Conceptual)
-  Proposed Roundabout
-  Proposed Traffic Signal
-  Existing Traffic Signal
-  Proposed Access Closure



**FIGURE**

**ALTERNATIVE 6**



**Table 9 – Highway 47 Intersection Operations (Alternative 6)**

Intersection	Base		Alternative 6	
	Level of Service	Volume / Capacity	Level of Service	Volume / Capacity
<i>Unsignalized Intersections</i>				
Highway 47/Purdin Road	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/David Hill Road	A/F	0.82	A/B	0.20
Highway 47/Oak Street	A/F	0.85	A/D	0.31
Highway 47/Martin Road	A/F	>1.0	-	-
Highway 47/24th Avenue	A/E	0.52	<i>B*</i>	<i>0.58</i>
Highway 47/19th Avenue	<b>A/F</b>	<b>&gt;1.0</b>	<b>A/F</b>	<b>&gt;1.0</b>
Highway 47/Poplar Street	A/E	0.55	A/C	0.20
Highway 47/Maple Street	A/F	>1.0	<i>B*</i>	<i>0.74</i>
Highway 47/Elm Street	A/F	0.72	A/D	0.50
Highway 47/B Street	<b>A/F</b>	<b>0.84</b>	<b>A/F</b>	<b>0.83</b>
<i>Signalized Intersections</i>				
Highway 47/Sunset Drive	D	0.52	E	0.65
Highway 47/Pacific Avenue	E	0.94	D	0.88

*\*Signalized intersection in alternative.*

### **Additional Mitigations**

Additional mitigations needed to meet Highway 47 operational standards in this alternative are likely to include:

- Roundabout at Purdin Road / Verboort Road
- Westbound right turn lane on 19<sup>th</sup> Avenue
- Traffic signal at B Street

### **Analysis**

Restricting David Hill Road to right turns to and from Highway 47 would mitigate the need to widen the Highway along this segment from its current two lane section to a third lane. With left turns allowed, the third lane is necessary to prevent northbound left turns from blocking the Highway. Local access would be provided for right turn movements, but left turns would reroute to Purdin Road or Sunset Drive.

By closing Martin Road and tying the proposed Yew Street extension into the proposed 24<sup>th</sup> Avenue extension and traffic signal at Highway 47, two major needs are addressed simultaneously. An effective pedestrian crossing is created and a traffic signal crossing at Highway 47 between Forest Grove and the northwest is provided. Some local traffic that would otherwise travel via Highway 8 and Highway 47 would use the parallel routes on Yew Street and 24<sup>th</sup> Avenue. However, the feasibility of the proposed Yew Street extension is unclear given the location of the project in the vicinity of environmentally sensitive wetlands north of 24<sup>th</sup> Avenue and outside of the Urban Growth Boundary.

The southbound right turn lane at the Pacific Avenue intersection improves the critical movement at the intersection and addresses some of the operational concerns and queuing at the intersection, although delays during the PM peak period remain significant (LOS D).

Constructing a traffic signal at Maple Street / Fern Hill Road with local connections to Elm Street and Poplar Street addresses the operational deficiency at Maple Street/Fern Hill and improves operations at all three intersections while providing improved connectivity away from the Highway.

### **Summary**

Alternative 6 addresses most of the operational issues identified for Highway 47 and observes ODOT traffic signal spacing standards and access management objectives. Traffic is directed to the proposed signals at 24<sup>th</sup> Avenue and Maple Street / Fern Hill Road by providing new connections that are parallel to existing ODOT highways and encouraging a “grid” of roadways. Pedestrian and bicycle crossing are added to the north and south of Pacific Avenue near current and planned development.

The feasibility of the Yew Street extension and connection with the planned extensions of 24<sup>th</sup> Avenue and Halladay Street in Cornelius would require further study.

## Summary of Findings By Alternative

Table 10 lists key objectives and issues identified for future conditions. Each alternative is included to illustrate objectives addressed by each alternative and which deficiencies remain.

**Table 3 – Objectives and Issues Addressed By Alternative**

Objective / Issue	Alternative						
	Base	1	2	3	4	5	6
<i>Safety - Operational Issues</i>							
Mobility Standard - Highway 47/Purdin Road							
Significant Delay - Highway 47/David Hill Road			□	■	■	■	■
Significant Delay - Highway 47/Sunset Drive	■	■	■	■	□	■	□
Significant Delay - Highway 47/Oak Street		■	■	■		□	■
Mobility Standard - Highway 47/Martin Road			■	■			■
Mobility Standard - Highway 47/24th Avenue	□	■		□	■	□	■
Significant Delay - Highway 47/Pacific Avenue				■		■	□
Mobility Standard - Highway 47/19th Avenue				■			
Mobility Standard - Highway 47/Poplar Street	■	■	■		■	■	■
Mobility Standard - Highway 47/Maple Street			■	■		■	■
Significant Delay - Highway 47/Elm Street			□		■		□
Mobility Standard - Highway 47/B Street							
<i>Safety - Maintain Current Access Spacing</i>							
near Hawthorne Street	■	■	■	■		■	■
near Oak Street / Martin Road / 24th Avenue	■		□	■		■	■
near Pacific Avenue / 19th Avenue	■	■	■			■	■
<i>Safety / Highway Mobility - Additional Costs</i>							
No Hwy 47 widening necessary near David Hill Road				■		■	■
No Hwy 47 widening necessary near Elm Street	■	■	■	■		■	■
<i>Highway Mobility - Signal Spacing</i>							
Maintain signal spacing near Martin Road/24th Avenue	■					■	
Maintain signal spacing near 19th Avenue	■	■	■		■	■	■
Maintain signal spacing near Maple Street/Oak Street	■	■					
<i>Pedestrian/Bicycle Connectivity</i>							
Pedestrian Crossing North of Pacific Avenue		■		□	■		■
Pedestrian Crossing South of Pacific Avenue			□	■	□	□	□
<i>Accessibility / Local Circulation</i>							
at David Hill Road	■	■	■	□	■		□
at Hawthorne Street					■		
at/near 24th Avenue		■	■		■		■
at 19th Avenue				■	□		
between Fern Hill Road, Elm Street, and Poplar Street			■		□		■

- Addressed in alternative
- Partially addressed in alternative

## **Summary of Findings By Intersection**

The following section discusses each intersection under forecasted 2030 operating conditions. The findings from the alternatives analysis are summarized.

### **Purdin Road / Verboort Road**

The intersection fails to meet minimum performance standards in each identified alternative as well as under existing conditions. Because the intersection is located outside the Urban Growth Boundary, the operational standard is lower (v/c 0.70) than within the City (v/c 0.99). A traffic signal or roundabout should be constructed at this intersection to address the current deficiency, which will continue to degrade with forecasted increases in volume. ODOT recommends construction of a roundabout<sup>2</sup>. This is a desirable location for a roundabout given the character of the surrounding area and safety concerns resulting from high-speed travel. Several nearby roundabouts should make familiarity with roundabout operations a non-issue. Were a roundabout to be constructed, the intersection would operate at LOS B with forecasted 2030 volumes. A traffic signal would also address the operational issue at the intersection.

### **David Hill Road**

This intersection is projected to meet minimum performance standards as a stop-controlled intersection, but would experience significant delay on the minor street approaches (LOS F). Highway 47 should be widened to three lanes for safety and mobility concerns to avoid the potential for northbound left turns to block through traffic on Highway 47. The intersection would operate well with a traffic signal constructed, but is located near the Sunset Drive signal (and proposed signal or roundabout at Purdin Road / Verboort Road). If the intersection is closed or restricted to right hand turns, the some traffic would shift to the Purdin Road / Verboort Road and Sunset Drive intersections without creating a new operational deficiency on Highway 47.

### **Sunset Drive**

This intersection is projected to meet minimum performance standards as a signalized intersection in all scenarios. Therefore, no mitigations are identified. The level of service improves when Highway 47 access is provided at nearby intersections such as David Hill Road or Hawthorne Street. If enough access to Highway 47 is provided via other routes, the intersection could function within performance standards with a traffic signal being replaced by stop signs on Sunset Drive approaches.

### **Hawthorne Street**

The proposed Highway 47 access along the Hawthorne Street alignment would improve circulation and local access to the Highway and reduce turn demand and delay at other intersections. However, it does not address any of the identified operational deficiencies and compromises access management along Highway 47. The Highway would need to be widened to three lanes along this section to avoid westbound left turns (to Hawthorne Street) blocking through traffic on Highway 47.

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<sup>2</sup> Draft comments received from ODOT 3/20/2009.

### **Oak Street / Porter Road**

The traffic demand at Oak Street / Porter Road is heavily influenced by the potential construction of the 23rd/24th Street extension. With construction of the extension, turn volumes are relatively minor and the intersection may be a candidate for closure to maintain access management along the Highway. Without the 23rd/24th Street extension, demand increases and the approach experiences significant delay (LOS F in the Base scenario and Alternative 4.)

In Alternative 3, the Martin Road access is closed and demand is directed to a signal at this intersection. This performs well from an operational perspective, but does not address demand for a pedestrian and bicycle crossing in the developed areas along Quince Street.

### **Martin Road**

Martin Road provides the primary connection between Forest Grove and the northwest (including access to Beaverton and Portland via US 26). Due to this demand, future conditions show significant growth for westbound left turns. This intersection fails to meet performance standards unless a traffic signal is constructed or alternative access from the northwest to the Highway is created. If a signal is not constructed at Martin Road, an alternative signal location should be considered in conjunction with improved connections to direct demand away from the intersection.

### **24<sup>th</sup> Avenue**

The intersection operates with no additional mitigation if no new access is constructed (Base and alternatives 3 and 5). If a western approach is added, a signal would need to be constructed to meet future minimum performance standards. The proposed traffic signal is likely to require interconnection with the nearby railroad crossing.

### **Pacific Avenue**

The intersection operates with significant delay in all alternatives but remains within minimum performance standards. The southbound queuing issue remains unless additional capacity is added at the intersection (southbound right turn lane in Alternative 6 or full widening to five lanes in Alternative 5). Extension of the 19th Avenue / Pacific Avenue one-way couplet (Alternative 3) would improve operations at the intersection by shifting westbound demand to 19th Avenue and a channelized free right turn northbound from Highway 47. Providing parallel routes via extensions at 19th Avenue or 24<sup>th</sup> Avenue reduces overall demand at the intersection but does not significantly impact level of service, as the benefits from a drop in eastbound and westbound traffic is generally offset by an increase in northbound and southbound turn movements.

### **19<sup>th</sup> Avenue**

As with several of the other minor street approaches, the intersection is highly sensitive to the expected number of left turns. In most alternatives, a westbound right turn lane on 19<sup>th</sup> Avenue is needed to separate left turning vehicles. If access to Highway 47 were to be provided via an extension of 19th Avenue to the west of Highway 47, the intersection would require a traffic signal to meet operational performance standards. While providing improved

local access, an extension of 19th Avenue would violate ODOT traffic signal spacing standards and also compromise access spacing without addressing identified operational deficiencies.

### **Poplar Street**

Due to the forecasted volume on Highway 47 and a lack of separate turn lanes, the Poplar Street approach is highly sensitive to the number of left turns attempted at the intersection. The intersection is forecasted to meet operational performance standards without constructing a new turn lane in all alternatives with the exception of Alternative 3, where the additional volume and signal delay expected north of the intersection on Highway 47 result in an increase of left turns from Poplar Street.

### **Maple Street / Fern Hill Road**

Without a traffic signal, this intersection fails to meet minimum performance standards in each identified alternative as well as under existing conditions. Operations will continue to degrade with forecasted increases in volume. The location meets preliminary traffic signal warrants with existing volumes. A traffic signal should be constructed at this intersection to address the current deficiency. The proposed traffic signal would require interconnection with the nearby railroad crossing.

A signal at Elm Street, with local connection to Fern Hill Road (Alternative 4), does not address the operational issue at the Maple Street / Fern Hill Road intersection with Highway 47.

### **Elm Street**

This intersection is projected to meet minimum performance standards as a stop-controlled intersection in all identified alternatives, but would experience significant delay on the Elm Street approaches (LOS F). Local street connectivity to Fern Hill Road and the proposed signal at Highway 47 would provide alternative access and reduce delay for vehicles turning at the intersection.

### **B Street**

In all future scenarios, forecasted volumes at this intersection indicate a failure to meet operational performance standards for vehicles making turns onto Highway 47. Because the intersection is located outside the Urban Growth Boundary, the operational standard is lower (v/c 0.75) than intersections within the city (v/c 0.99). The intersection meets operating standards under current conditions, but should be monitored in the future. Southbound right turning vehicles may simply reroute to Old Highway 47 if queuing occurs at the B Street approach. A traffic signal at the intersection would address operational issues.

## MEMORANDUM

**DATE:** March 15, 2010

**TO:** Carl Springer, P.E., DKS Associates  
**FROM:** Peter Coffey, P.E., DKS Associates

**SUBJECT:** Forest Grove – Highway 47 Access and Traffic Signal Control Alternatives

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This memorandum provides an evaluation of various proposed access and traffic signal control alternatives for Highway 47 in Forest Grove. Today Highway 47 is generally one lane in each direction with left turn lanes at key intersections and traffic signals located at NW Sunset Drive and Pacific Avenue (OR 8). Two proposed access and traffic signal control options for Highway 47 that are under consideration are:

Option 1- With Traffic Signals on Highway 47 at:

- David Hill
- NW Sunset Drive
- Hawthorne
- Martin
- 24<sup>th</sup> Avenue
- Pacific Avenue
- 19<sup>th</sup> Avenue
- Maple Street
- B Street

Option 2- With Traffic Signals on Highway 47 at:

- Verboort Road
- NW Sunset Drive
- 24<sup>th</sup> Avenue
- Pacific Avenue
- 19<sup>th</sup> Avenue
- Maple Street
- B Street

Coordinating traffic signals can improve traffic flow and minimize delays if the green indications at the downstream traffic signal is arranged to coincide with the arrival of the platoon of vehicles coming from the upstream traffic signal. On a one-way street this can often be simple to do as the downstream traffic signal is programmed to turn green when the platoon from the upstream intersection arrives. On two-way streets it can often be difficult to have the signal indications for

both directions turn green at the appropriate time. Several terms are used when discussing traffic signal coordination including:

- Signal Phase – a predetermined set of traffic signal movements that operate concurrently (such as the eastbound and westbound through movements)
- Cycle Length – the total time taken to serve all phases at a traffic signal
- Offset – the relative difference in time between the beginning (or end) of the green period on the coordinated approach for each intersection. For a group of traffic signals that are coordinated together, a background cycle is established and the offset for each intersection is related to the background cycle.
- Split – the green plus yellow plus all-red time that is programmed for each signal phase

Traffic signals that operate as part of a coordinated signal system must run on a common cycle length (or in special cases, one half of the cycle length). The common cycle length allows all the traffic signals to stay “in-step” with one another.

The cycle length that is used must be long enough to accommodate all signal phases at each traffic signal. Each signal phase must be long enough to accommodate associated pedestrian movements. For signal phases that do not have pedestrian movements associated with them, their minimum time is typically ten seconds of green time plus clearance time (yellow plus all-red). Table 1 provides a listing of each traffic signal associated with Option 2 and the minimum cycle length for each traffic signal.

The longest minimum cycle for all traffic signals to be included in the signal timing group must be used. As shown in Table 2, the longest minimum cycle length under Option 2 is 76 seconds at Sunset Drive. Typically the cycle length would be rounded up to 80 seconds. Any cycle length less than this amount would not be able to accommodate pedestrian movements. For example a proposed 52 second cycle length would not be long enough to accommodate all signal phases at the Highway 47/Sunset Drive intersection. As shown in Table 1, the group of signals identified along Highway 47 would need an approximately 80 second cycle length to operate in the coordinated mode.

Left turn signal phasing for each approach at each intersection can either be protected or permissive. Protected left turn phasing allows for a protected left turn movement (with a green arrow) where vehicles do not need to yield to on-coming traffic. Permissive left turn phasing is where left turning vehicles yield to on-coming traffic and pedestrians. Protected/permissive left turn phasing uses both protected and permissive periods in the cycle length. ODOT has a criterion that provides guidelines for the type of left turn phasing to be used. Table 1 shows the assumptions for the traffic signals on Highway 47 which included protected left turn phasing in the north/south direction and permissive left turn phasing in the east/west direction at all study area intersections.

Coordinating traffic signals does not mean that there will be no delays for traffic, but that the amount of delay per vehicle will be minimized. This is primarily because:

- All traffic signals in a group have different traffic flows, and often have different signal phasing, so the amount of green time available to the coordinated approaches varies along a coordinated route. Therefore, some vehicles in a platoon can be stopped somewhere along a route.
- It is necessary to start the green period on the coordinate route sufficiently in advance of the arrival of the platoon to allow any standing queues of traffic stopped at the downstream traffic signals to clear.
- Signal coordination can't improve the capacity of an intersection above what it would have under independent operation, unless vehicle queues extend from one traffic signal through another traffic signal.
- Outside periods of heavy traffic flow in one direction and lighter flow in the opposite direction, traffic along roadways such as Highway 47 is typically balanced, so two-directional coordination is highly desired. It is rare that intersection green times, spacing and travel times align to allow for complete two-way coordination. Normally a compromise coordination plan is required, which minimizes (not eliminates) stops and delays in both directions. Vehicle speed, cycle length and distance between intersection play a role in the efficiency of the signal coordination. Table 2 shows a listing of the distance between intersections that can provide for efficient two-way vehicle progression, based on the cycle length and speed of a roadway.
- The mix of traffic is also a consideration when determining offsets as large trucks take longer to accelerate than passenger cars. Therefore offsets for passenger vehicles will not necessarily be as effective to large trucks.
- Coordination along an arterial roadway most often results in increased delays for side-street traffic, because longer cycle lengths typically are used when compared to "free" or uncoordinated traffic signal operation. During peak hours the overall delays to all traffic is most often lower as the results of signal coordination (depending upon traffic volume and many other factors). As traffic flow along a roadway reduces, the justification for imposing additional delays on traffic on the side streets reduces.

The most significant concern with the proposed traffic signals with Option 2 is the close spacing (approximately 725 feet) between Pacific Avenue and 19<sup>th</sup> Street. Adequate storage of left turn movements must be provided between the two intersections, which may widen this portion of Highway 47 to four, five or more lanes. If protected left turn phasing is utilized along the north/south approaches, then lead/lag left turn phasing can be used to minimize vehicle delays and enhance the signal progression.

***Findings***

In summary, the following are the key findings regarding signal coordination along Highway 47 with either Option 1 or Option 2:

- A 52 second cycle length will not be long enough to provide for pedestrian movements at intersections. With protected left turn phasing in the north/south direction along Highway 47, as shown in Table 1 a minimum cycle length of 76 to 80 seconds will be needed.
- Adequate storage of left turn movements must be provided between the two intersections which may widen this portion of Highway 47 to four, five or more lanes.
- It is rare that intersection green times, spacing and travel times align to allow for complete two-way coordination. Normally a compromise coordination plan is required, which minimizes (not eliminates) stops and delays in both directions. Vehicle speed, cycle length and distance between intersection play a role in the efficiency of the signal coordination. Table 2 shows a listing of the distance between intersections that can provide for efficient two-way vehicle progression, based on the cycle length and speed of a roadway.

Please contact me if you have any questions.

**Table 1: Option 2 Traffic Signal Locations**

Signal Location	Distance Between Signals (feet)	Existing Posted Speed (mph)	Estimated Signal Phasing	E/W Ped. Xing Distance (feet)	E/W Green Time For Peds (seconds)	N/S Ped. Xing Distance (feet)	N/S Green Time For Peds (seconds)	Estimated Minimum Cycle Length	Rounded Cycle Length	Desired Signal Spacing
Verboort			Protected LT's N/S; Permissive E/W	72	22	60	19	63	80	2930 / 5860
	4710	50								
Sunset			Protected LT's N/S; Permissive E/W	84	25	100	29	76	80	2820 / 5640
	7150	48								
24th			Protected LT's N/S; Permissive E/W	80	24	52	17	63	80	1465
	1780	25								
Pacific			Protected LT NB; Permissive E/W	92	27	80	24	73	80	1465
	725	25								
19th			Protected LT SB; Permissive E/W	92	27	80	24	73	80	2930 / 5860
	2780	50								
Maple			Protected LT's N/S; Permissive E/W	70	21.5	70	21.5	65	80	3230 / 6460
	7390	55								
B Street			Protected LT's N/S; Permissive E/W	70	21.5	70	21.5	65	80	

**Notes:**

Estimated minimum cycle length is calculated by the following: green time for E/W + green time for N/S + 10 sec green for LT phase plus 12 sec for Yellow + All Red  
Desired signal spacing is based on Table 1 for appropriate speed and cycle length

**Table 2: Traffic Signal Spacing That Provides for Two-Way Progression**

Cycle Length (seconds)	Progression Speed (Miles Per Hour)								
	20	25	30	35	40	45	48	50	55
50	733	917	1100	1283	1467	1650	1760	1833	2017
60	880	1100	1320	1540	1760	1980	2112	2200	2420
70	1027	1283	1540	1797	2053	2310	2464	2567	2823
80	1173	1467	1760	2053	2347	2640	2816	2933	3227
90	1320	1650	1980	2310	2640	2970	3168	3300	3630
100	1467	1833	2200	2567	2933	3300	3520	3667	4033
110	1613	2017	2420	2823	3227	3630	3872	4033	4437
120	1760	2200	2640	3080	3520	3960	4224	4400	4840

Note: multiples of the above numbers are also adequate