

February 5, 2019

Project #: 21399

Bob Galati & Joy Chang
City of Sherwood
22560 SW Pine Street
Sherwood, OR 97140***RE: Middlebrook Residential Subdivision Transportation Impact Analysis – Sherwood, Oregon***

This letter presents the transportation impact analysis prepared for the Middlebrook Residential Subdivision project. This study concludes that the proposed residential uses can be developed in accordance with traffic operations requirements of the City of Sherwood Municipal Code as well as applicable Washington County and Oregon Department of Transportation (ODOT) standards assuming provision of recommended transportation improvements. The study recommends:

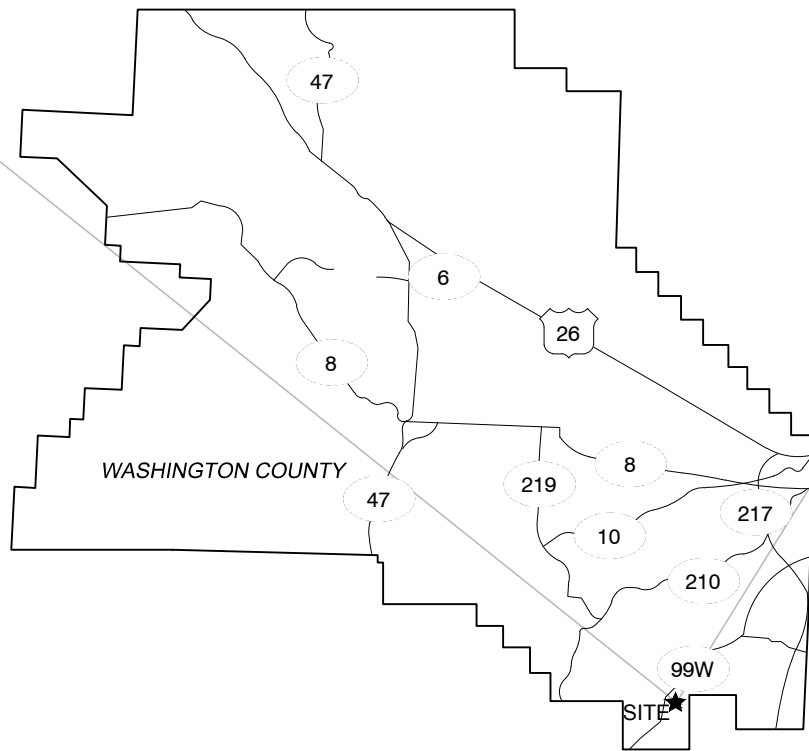
- With site development, provide either a westbound right-turn lane with 200 feet of storage on SW Brookman Road at the Highway 99W/SW Brookman Road-SW Chapman Road intersection or pay a proportionate share contribution (estimated to be \$329,197 per the City's assessment methodology) towards future improvements at the intersection.

Additional details of the study methodology, findings, and recommendations are provided herein.

INTRODUCTION

The Applicant, Brookman Development, LLC, is proposing to develop up to 145 detached single-family homes within a residential subdivision on land located along the north side of SW Brookman Road that was previously annexed into the City of Sherwood. The site is situated north of SW Brookman Road with access proposed at a new public street aligned with SW Oberst Road on SW Brookman Road. The site vicinity is shown in Figure 1 and a conceptual site plan is provided in Figure 2.

Today, the site has two private driveway connections to SW Brookman Road. With redevelopment, both existing private driveway accesses to the site would be vacated and access to the site would be provided by a single new public roadway connection to SW Brookman Road, aligned with the existing intersection at SW Oberst Road. As shown in Figure 2, some of the new public roads through the site will be stubbed for future extension off-site to surrounding properties in conjunction with other future development activities by others. No roadway connections to existing homes off-site to the north are proposed. Construction is expected to begin in 2019 with buildout and occupancy anticipated by 2020.



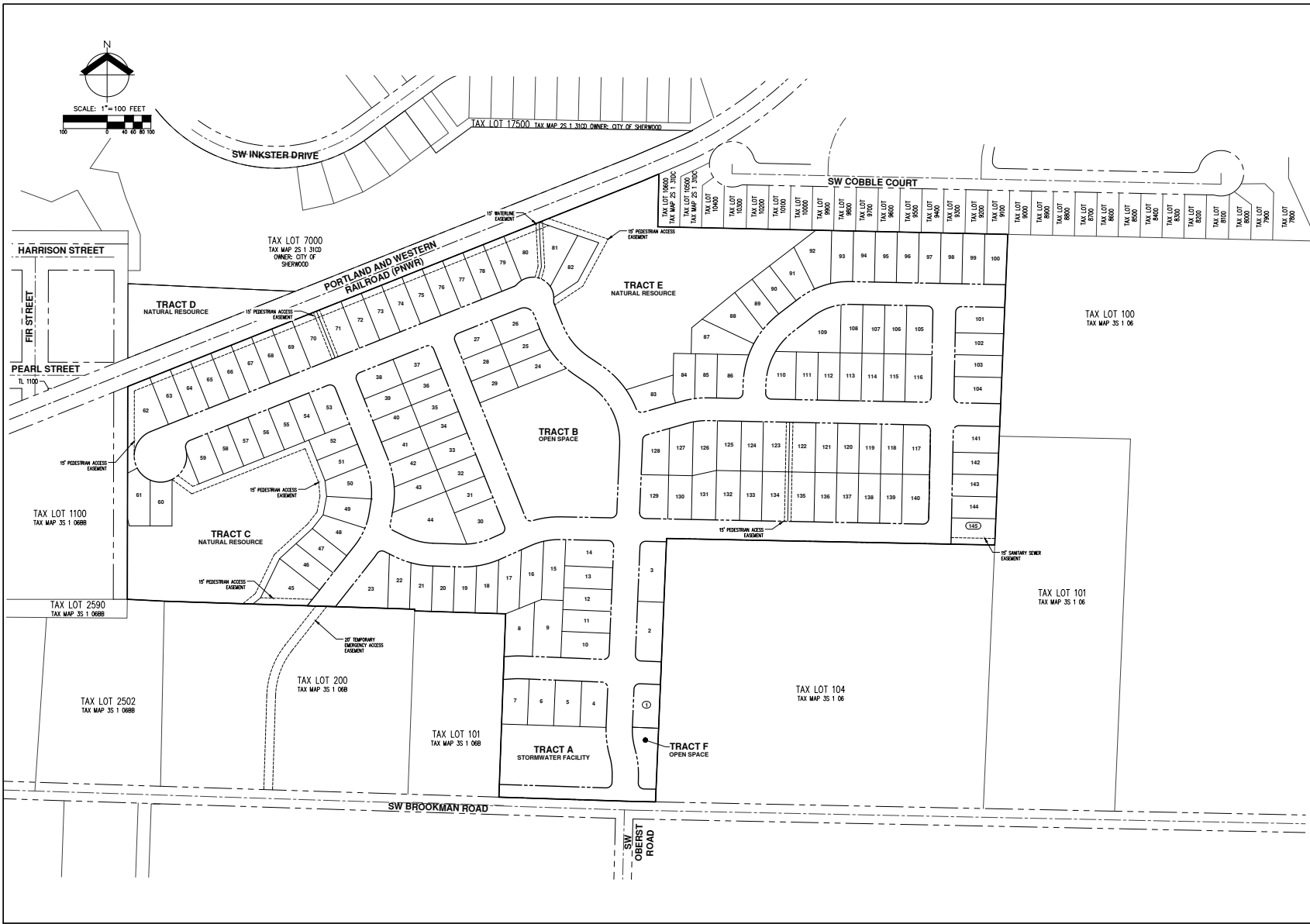
- Study Intersections

Site Vicinity Map
Sherwood, Oregon

Figure
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AKS ENGINEERING & FORESTRY, LLC
 12000 SW HERMAN RD STE 100
 SHERWOOD, OREGON 97140
 P: 503.633.6525
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BROOKMAN SUBDIVISION
 OREGON
 SHERWOOD
 TAX LOTS 100-106

PRELIMINARY SUBDIVISION PLAN

DESIGNED BY: ARS/PAL
 DRAWN BY: ARS
 CHECKED BY: AMH
 SCALE: AS NOTED
 DATE: 3-22-2018

**PRELIMINARY
 NOT FOR
 CONSTRUCTION**

PERSONS
JOB NUMBER 3591
SHEET SUB

Site plan provided by AKS Engineering, April 5, 2018

Conceptual Site Plan
 Sherwood, Oregon

Figure
 2

STUDY METHODOLOGY

The Traffic Impact Analysis (TIA) addresses the requirements of City of Sherwood Municipal Code Section 16.106.080 as well as applicable Washington County and ODOT review requirements. The study methodology, assumptions and scope were determined based on a review of existing travel patterns, the City of Sherwood's Development Code, direction provided by DKS Associates (the City's traffic engineer), as well as discussions with Washington County and ODOT staff. A scoping memo was provided for review and confirmation of the study scope and methodology prior to preparation of this study. A copy of the scoping memo is provided for reference in *Appendix A*, along with comments received from the City and ODOT. Note that the proposed development area and residential unit count has been reduced by approximately 60 percent since the scoping memo was prepared and approved.

Analysis Scenarios

In accordance with review agency requirements, weekday AM and PM peak hour traffic conditions were assessed for the following analysis scenarios:

- Existing conditions
- Year 2020 background conditions (without the proposed development)
- Year 2020 total conditions (with buildout of the proposed development)

Study Intersections

City of Sherwood Development Code Section 16.106.080 requires analysis of all intersections where the analysis shows that fifty (50) or more peak hour vehicle trips can be expected to result from the development. The intersections included in this study were identified based on the City Code requirements as well as review agency feedback during the study scoping process. Some of the study intersections do not experience 50 or more peak hour vehicle trips and are provided for illustrative purposes based on the initial City scoping direction when the project unit count was over twice as large as the number of homes currently proposed.

The study intersections are listed below, including a numerical ID corresponding with report figures:

1. Highway 99W/SW Elwert Road-SW Sunset Boulevard
2. SW Woodhaven Drive/SW Sunset Boulevard
3. SW Timbrel Lane/SW Sunset Boulevard
4. SW Ladd Hill Road-SW Main Street/SW Sunset Boulevard
5. SW Baker Road-SW Murdock Road/SW Sunset Boulevard
6. Highway 99W/SW Brookman Road-SW Chapman Road
7. Old Highway 99 W/SW Brookman Road
8. SW Middleton Road/SW Brookman Road
9. SW Oberst Road-Future Site Access/SW Brookman Road
10. SW Ladd Hill Road/SW Brookman Road

All level-of-service analyses described in this report were performed in accordance with the procedures stated in the *2000 Highway Capacity Manual* (HCM, Reference 1)¹.

Performance Measures & Operating Standards

The volume-to-capacity (V/C) ratio is the principle performance measure documented in this report. V/C operating standards adopted by Washington County, ODOT and the City are summarized below.

Washington County Operating Standards

Washington County has jurisdiction over SW Brookman Road. The County has defined operating standards for signalized and stop controlled intersections assuming a peak hour (60-minute analysis) period as follows:

- **Signalized intersections:** the maximum peak hour intersection V/C ratio shall be no greater than 0.99.
- **Unsignalized intersections:** no movement shall experience a V/C ratio greater than 0.99.

ODOT Operating Standards

ODOT operates and maintains OR 99W (Pacific Highway West). ODOT's operating standard for signalized intersections along Highway OR 99W in the study area is an intersection V/C ratio no greater than 0.99 during the peak 15-minutes as identified in Table 7 of the *Oregon Highway Plan* (Reference 2). For unsignalized intersections, ODOT requires the state highway approaches to operate at a V/C ratio no greater than 0.99 during the peak 15-minutes. Non-state highway approaches are expected to operate at a V/C ratio no greater than identified in Table 6 of the *Oregon Highway Plan* for district/local interest roads (Reference 2). The standard for the Brookman Road and Chapman Road approaches to Highway 99W is a V/C ratio no greater than 0.95.

Sherwood Operating Standards

The City defers to ODOT and Washington County standards for facilities under their jurisdiction. For intersections in the City but on the Metro-designated Arterial and Throughway Network, standards require a V/C ratio less than or equal to 0.99 in both the highest hour and the second hour during the PM peak period. Roadways on the Arterial and Throughway Network include Sunset Boulevard, Murdock Road, Elwert Road, Main Street, and Ladd Hill Road (*City of Sherwood Transportation System Plan*, Reference 3). Table 1 summarizes the minimum operating thresholds by study intersection.

¹ All of the study intersection operational analyses presented in this report were prepared using the Synchro 9 software, which implements the *Highway Capacity Manual* methodology.

Table 1. Study Intersection Performance Standard

Intersection		Traffic Control	Responsible Agency	Performance Standard
1	Highway 99W/SW Elwert Road-SW Sunset Boulevard	Signal	ODOT	Intersection V/C \leq 0.99
2	SW Woodhaven Drive/ SW Sunset Boulevard	TWSC	City	Movement V/C \leq 0.99 ¹
3	SW Timbrel Lane/SW Sunset Boulevard	TWSC	City	Movement V/C \leq 0.99 ¹
4	SW Ladd Hill Road-SW Main Street/ SW Sunset Boulevard	AWSC	City	Movement V/C \leq 0.99 ¹
5	SW Baker Road-SW Murdock Road/ SW Sunset Boulevard	AWSC	City	Movement V/C \leq 0.99 ¹
6	Highway 99W/SW Brookman Road-SW Chapman Road	TWSC	ODOT	Movement V/C \leq 0.99 for Highway 99W approaches, movement V/C \leq 0.95 for SW Brookman Road and SW Chapman Road
7	Old Highway 99 W/SW Brookman Road	TWSC	County	Movement V/C \leq 0.99
8	SW Middleton Road/SW Brookman Road	TWSC	County	Movement V/C \leq 0.99
9	SW Oberst Road-Future Site Access/ SW Brookman Road	TWSC	County	Movement V/C \leq 0.99
10	SW Ladd Hill Road/SW Brookman Road	TWSC	County	Movement V/C \leq 0.99 ¹

¹These roadways are located on the Arterial and Throughway Network (Metro Designation, Reference 3)

TWSC = Two-way stop-control, AWSC = All-way stop-control

Turn Lane Warrants

Left-turn lane needs along SW Brookman Road were assessed using turn lane warrants contained in the *ODOT Analysis Procedures Manual (APM, Reference 4)* and Harmelink left-turn warrant thresholds (Reference 5). Washington County policy's is to require a right-turn deceleration lane on roadways with a daily traffic volume greater than 10,000 and with a posted speed of 35 miles per hour (mph) or more in situations where the inbound right-turn movement exceeds 40 vehicles during the AM or PM peak hour.

REPORT FORMAT

This report addresses the following transportation issues:

- Existing land use and transportation system conditions within the site vicinity;
- Planned developments and transportation improvements in the study area;
- Forecast year 2020 background traffic conditions (prior to site development) during the weekday AM and PM peak hours;
- Weekday AM and PM peak hour trip generation and trip distribution estimates for site development;
- Forecast year 2020 total traffic conditions (with site development) during the weekday AM and PM peak hours;
- Turn lane and vehicle queuing needs at key study area intersections;
- Site access compliance with Washington County access management requirements; and
- Conclusions and recommendations.

EXISTING CONDITIONS

The existing conditions analysis identifies site conditions and the current operational and geometric characteristics of roadways within the study area. The purpose of this section is to set the stage for a basis of comparison to future conditions.

Site Conditions and Adjacent Land Uses

Today, the parcels comprising the site include a combination of properties occupied by two single-family homes with private driveway access to SW Brookman Road as well as undeveloped lots.

The site is bordered to the south by SW Brookman Road and single family homes across the roadway, to the west by private properties (generally single family homes) and the Portland & Western Railroad corridor, to the north by existing residential subdivisions, and to the east by additional single family homes.

Transportation Facilities

Table 2 provides a summary of transportation facilities (including pedestrian and bicycle facilities) in the site vicinity while Figure 3 illustrates the existing lane configurations and traffic control devices at the identified study intersections.

Table 2. Existing Transportation Facilities

Roadway	Classification ¹	Jurisdiction	Vehicle Lanes	Posted Speed	Sidewalks Present?	Bike Lanes Present?	On-Street Parking Allowed?
SW Pacific Highway 99W	Principal Arterial	ODOT	4 lanes	45-55 mph ²	No	Yes	No
SW Sunset Boulevard	Arterial	City	2 lanes	35 mph	Yes	Yes	No
SW Woodhaven Drive	Neighborhood ³	City	2 lanes	25 mph	Partial ⁴	No	Yes
SW Timbrel Lane	Collector	City	2 lanes	Unposted	Yes	No	No
SW Main Street	Arterial	City	2 lanes	20 mph	Yes	No	No
SW Ladd Hill Road	Arterial	City	2 lanes	25 mph	Yes	Partial ⁵	No
SW Murdock Road	Arterial	City	2 lanes	35 mph	Partial ⁶	No	No
SW Baker Road	Arterial	City	2 lanes	35 mph	Partial ⁷	No	No
SW Brookman Road	Arterial	County	2 lanes	35 mph	No	No	No
Old Highway 99W	Collector	City	2 lanes	35 mph	No	No	No
SW Middleton Road	Neighborhood ⁸	City	2 lanes	Unposted	No	No	No
SW Oberst Road	Local	City	2 lanes	Unposted	No	No	No

¹ Source: *City of Sherwood Transportation System Plan*, Reference 3.

² The speed limit on SW Pacific Highway 99W changes between SW Sunset Boulevard and SW Brookman Road. The posted speed is 45 miles per hour at the intersection of Sunset Boulevard and 55 miles per hour at the intersection of SW Brookman Road.

³ SW Woodhaven Drive is classified as a neighborhood roadway north of SW Sunset Boulevard. It is designated a local street to the south.

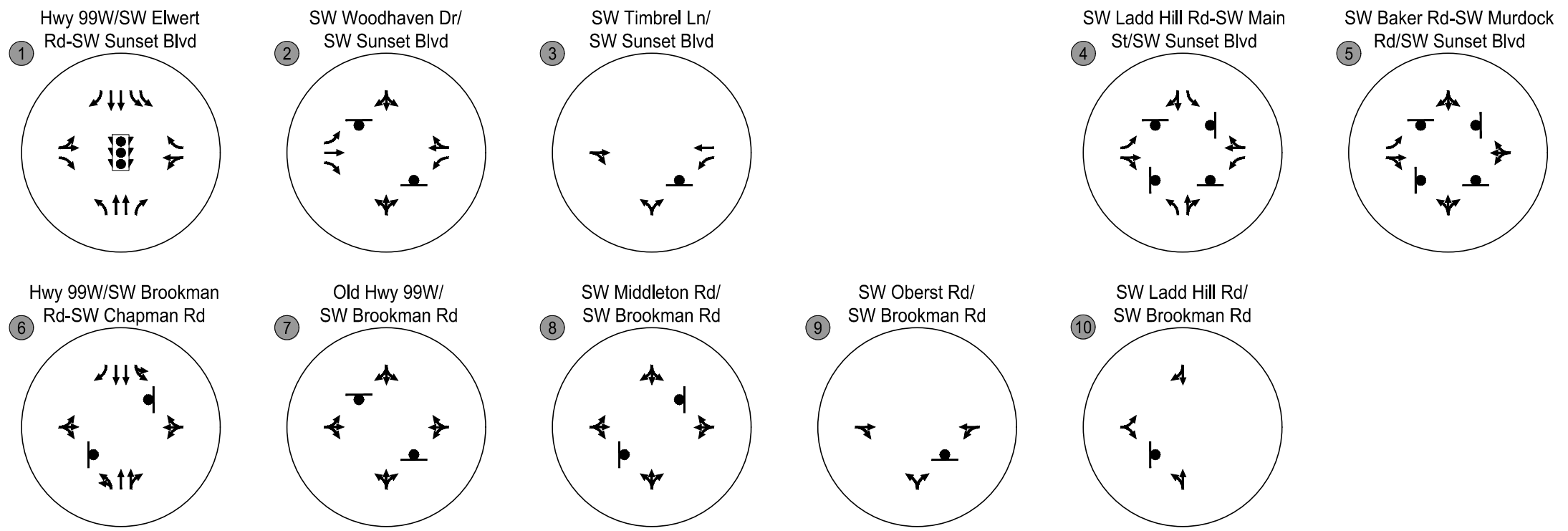
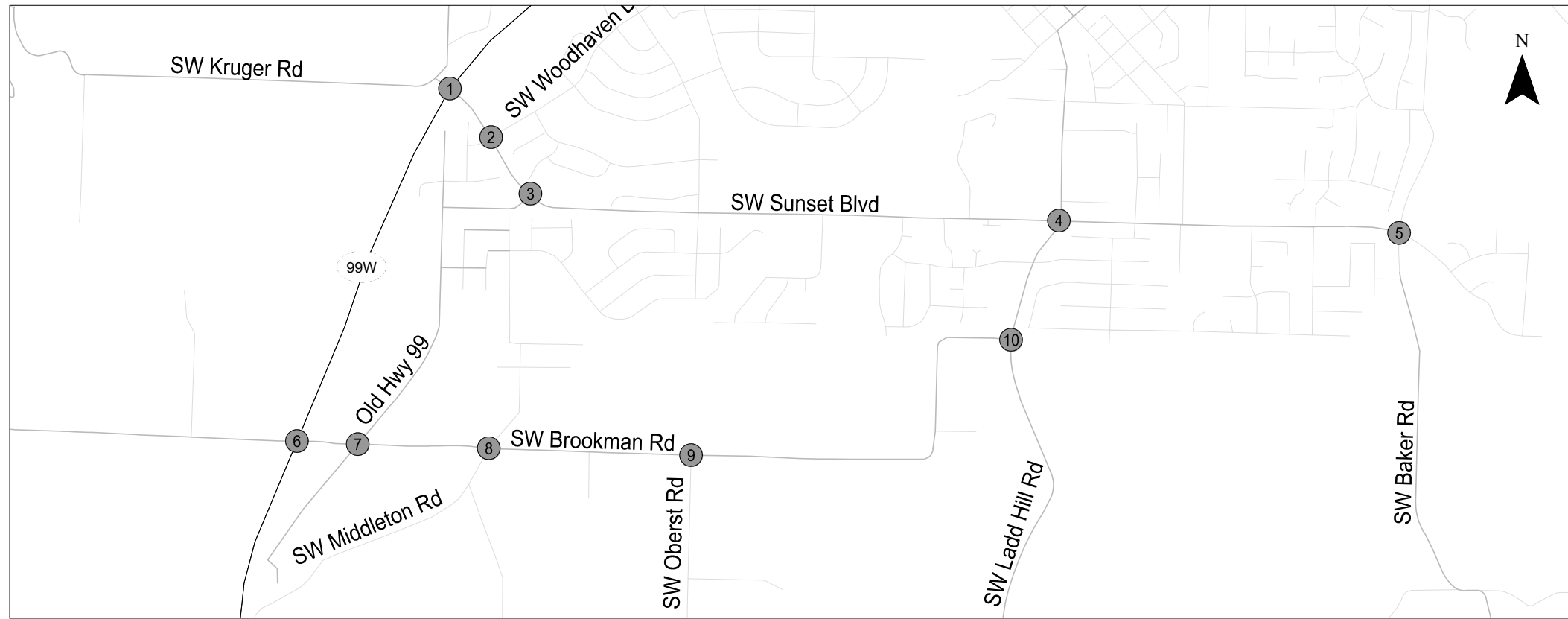
⁴ There is a gap in sidewalk on the north side of SW Woodhaven Drive between SW Sunset Boulevard and SW Fitch Drive.

⁵ There are bike lanes on SW Ladd Hill Road between SW Willow Drive and SW Sunset Boulevard.

⁶ There are sidewalks on the west side of SW Murdock Road.

⁷ There are sidewalks on the west side of SW Baker Road.

⁸ SW Middleton Road is classified as a neighborhood roadway north of SW Brookman Road. It is designated a local street to the south.



 - STOP SIGN
 - TRAFFIC SIGNAL

Existing Lane Configurations and Traffic Control Devices
Sherwood, Oregon

Figure
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Pedestrian and Bicycle Facilities

Table 1 highlights pedestrian and bicycle facilities available in the larger area surrounding the site. There are no sidewalks or bicycle lanes provided along SW Brookman Road serving the site.

Transit Facilities

Transit service in Sherwood is currently provided by TriMet; however, there is no scheduled fixed route service along SW Brookman Road or Highway 99W near the site. The closest fixed route transit service is currently available at the Sherwood Park and Ride located in the downtown area north of SW Sunset Boulevard (Reference 6).

TRAFFIC SAFETY

Crash history was reviewed for the study intersections in an effort to identify potential intersection safety issues. Crash data for the study intersections were obtained from ODOT for the five-year period from January 1, 2012 through December 31, 2016. Table 3 illustrates the crashes reported at the study intersections. *Appendix B* contains the ODOT crash data.

Table 3. Intersection Crash History (January 1, 2012 through December 31, 2016)

	Location	Collision Type						Severity		Total
		Rear-end	Turning	Angle	Backing	Bicyclist	Fixed Object	PDO ¹	Injury	
1	Highway 99W/SW Elwert Road-SW Sunset Boulevard	15	4	0	0	0	0	8	11	19
2	SW Woodhaven Drive/SW Sunset Boulevard	0	1	0	0	1	0	1	1	2
3	SW Timbrel Lane/SW Sunset Boulevard	0	0	0	0	0	0	0	0	0
4	SW Ladd Hill Rd.-SW Main St./SW Sunset Boulevard	2	2	0	0	0	1	2	3	5
5	SW Baker Road-SW Murdock Road/SW Sunset Boulevard	0	0	0	0	0	0	0	0	0
6	Highway 99W/SW Brookman Road-SW Chapman Road	2	5	6	0	0	0	9	4	13
7	Old Highway 99 W/SW Brookman Road	0	0	0	0	0	0	0	0	0
8	SW Middleton Road/SW Brookman Road	0	0	0	0	1	0	0	1	0
9	SW Oberst Road-Future Site Access/SW Brookman Road	0	0	0	0	0	0	0	0	0
10	SW Ladd Hill Road/SW Brookman Road	0	0	0	0	0	0	0	0	0

¹PDO – Property damage only

Critical crash rates were calculated for each of the study intersections following the analysis methodology presented in ODOT’s *SPR 667 Assessment of Statewide Intersection Safety Performance* (Reference 7). SPR 667 provided average crash rates at a variety of intersection configurations in Oregon based on number of approaches and traffic control types. The average crash rate represents the approximate number of crashes that are “expected” at a study intersection. Additionally, this average crash rate was used to calculate the critical crash rate for each study intersection, based on

the *Highway Safety Manual* methodology (Reference 8). The critical crash rate is calculated for each intersection based on the average crash rate for each facility and serves as a threshold for further analysis.

Table 4 summarizes the critical crash rate for each intersection and compares those values to the observed crash rate. Per ODOT, if the observed crash rate at the study location exceeds the critical rate, it is a possible indication that the location is exceeding average crash rates.

Table 4. Intersection Crash Rate Assessment

	Location	Total Crashes	Critical Crash Rate by Intersection	Critical Crash Rate by Volume	Observed Crash Rate at Intersection	Observed Crash Rate > Critical Crash Rate?
1	Highway 99W/SW Elwert Road-SW Sunset Boulevard	19	0.62	0.53	0.25	No
2	SW Woodhaven Drive/SW Sunset Boulevard	2	0.40	0.40	0.11	No
3	SW Timbrel Lane/SW Sunset Boulevard	0	0.31	0.42	0.00	No
4	SW Ladd Hill Rd.-SW Main St./SW Sunset Boulevard	5	0.38	0.39	0.23	No
5	SW Baker Road-SW Murdock Road/SW Sunset Boulevard	0	0.38	0.39	0.00	No
6	Highway 99W/SW Brookman Road-SW Chapman Road	13	0.30	0.54	0.20	No
7	Old Highway 99 W/SW Brookman Road	0	0.88	0.75	0.00	No
8	SW Middleton Road/SW Brookman Road	0	0.80	0.67	0.00	No
9	SW Oberst Road-Future Site Access/SW Brookman Road	0	0.92	0.79	0.00	No
10	SW Ladd Hill Road/SW Brookman Road	0	0.49	0.51	0.00	No

As shown in Table 4, the observed crash rate is below the critical crash rate at all of the study intersections.

Field observation of at the SW Oberst Road/SW Brookman Road intersection noted that sight distance is currently limited at the intersection due to the horizontal curvature of the roadway (crest vertical curve on SW Brookman Road west of the intersection). The SW Oberst Road/SW Brookman Road intersection will be reconstructed in conjunction with the proposed site development, improving intersection sight lines and modifying the intersection to add a northern approach. With this site-development related improvement planned, no safety-based mitigations are recommended based on review of the crash data alone.

ODOT SPIS List

ODOT provides an annual list of safety priority index system (SPIS) locations which are based on reported crash data. The intent of the SPIS list is to identify roadway segments exhibiting an unusually high occurrence of crashes. It is used to select locations for investigation. The segment on Highway 99W in the vicinity of SW Elwert Road-SW Sunset Boulevard is listed in the top 5% SPIS sites and the

segment of Highway 99W in the vicinity of SW Brookman Road-SW Chapman Road is listed in the top 10% SPIS sites. The majority of reported crashes at Highway 99W/SW Elwert Road-SW Sunset Boulevard were rear-end crashes. At Highway 99W/SW Brookman Road-SW Chapman Road, the majority of crashes were angle or turning crashes. The City of Sherwood TSP (Reference 3) includes a medium-term project to realign SW Brookman Road to intersect with Highway 99W approximately ¼ mile north of its current location and signalize the intersection. The realignment project is not currently funded.

Washington County SPIS List

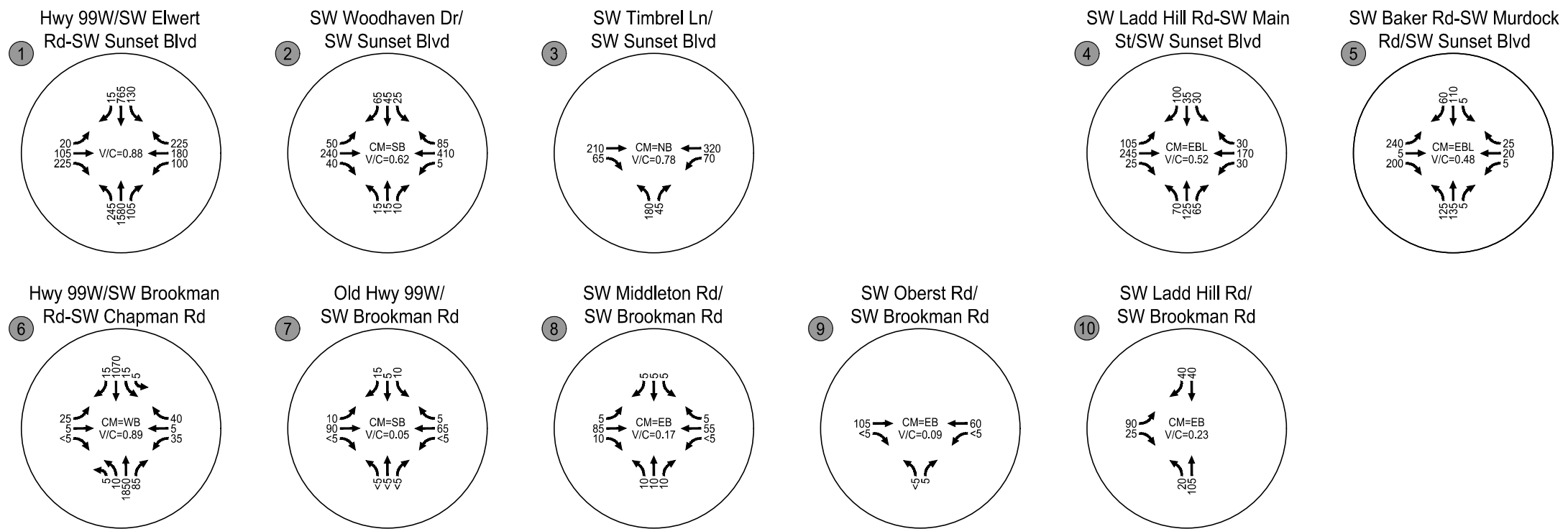
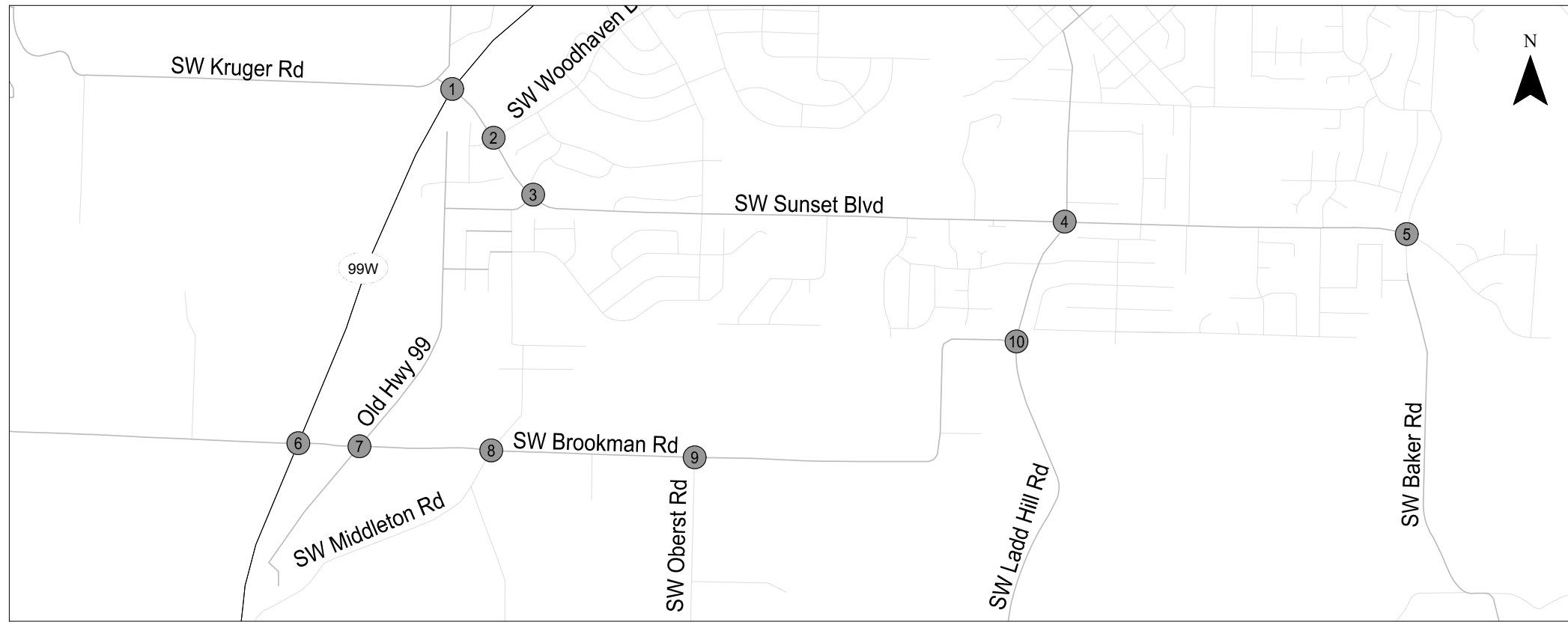
Washington County also maintains a SPIS list to identify existing hazardous intersections for potential safety improvements. Intersections are included in the County SPIS list if they have three or more crashes or if they have one or more severe injury or fatal crashes within three consecutive years. The intersection of Highway 99W/SW Brookman Road-SW Chapman Road appears on the most recent Washington County SPIS list (2013-2015). As noted above, the City of Sherwood TSP includes an unfunded project to realign SW Brookman Road to intersect with Highway 99W approximately ¼ mile north of its current location and signalize the intersection.

TRAFFIC VOLUMES AND PEAK HOUR OPERATIONS

Traffic counts were obtained at the study intersections on a typical mid-week day 2017². These counts were conducted during the morning (7:00 – 9:00 AM) and evening (4:00 - 6:00 PM) hours. *Appendix C* contains the traffic count sheets used in this study.

Figures 4 and 5 present the existing traffic conditions for the weekday AM and PM peak hours, respectively. Each of the study intersections operate in compliance with the respective mobility standards today, though the Highway 99W/SW Elwert Road-SW Sunset Boulevard intersection is approaching capacity during the weekday PM peak hour. *Appendix D* includes the existing conditions level-of-service worksheets.

² Refer to the traffic count summaries in *Appendix C* for specific count dates which occurred in May, September, October and November of 2017.

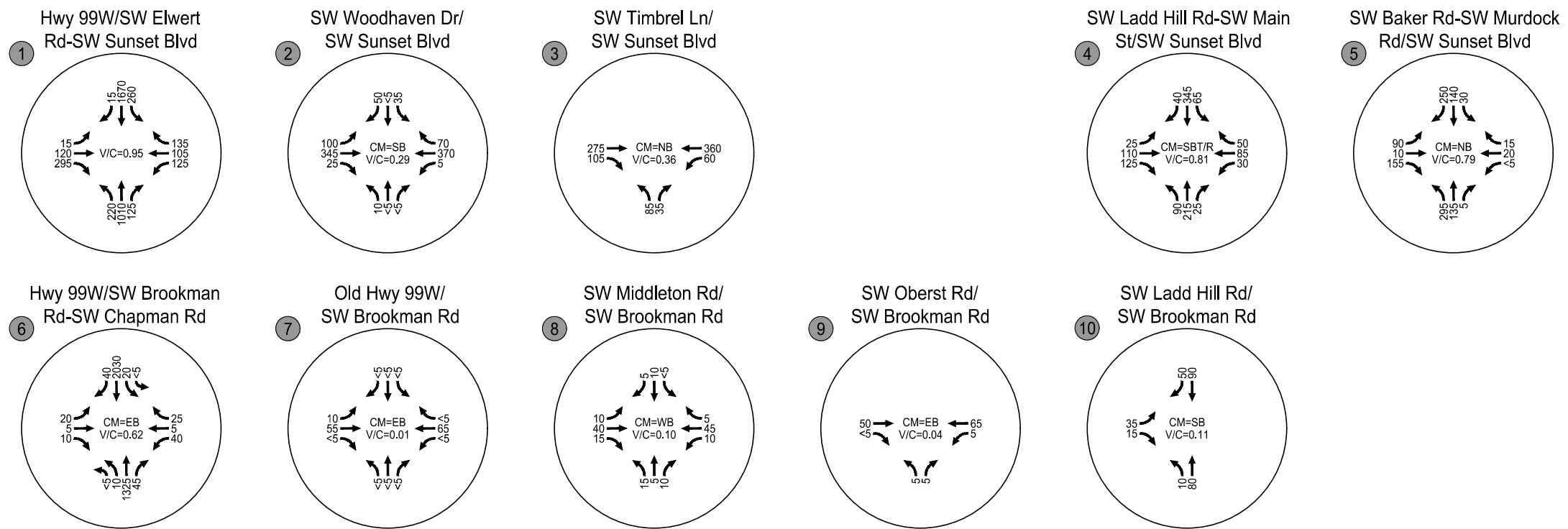
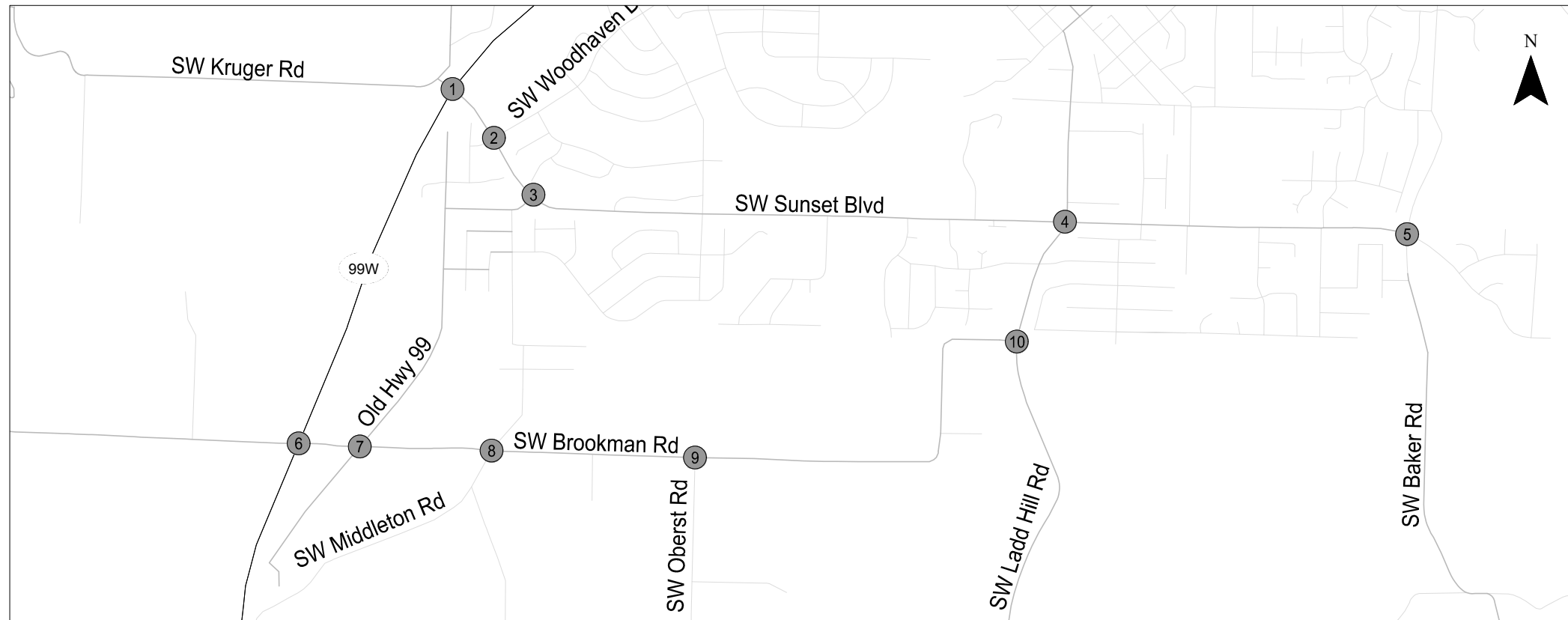


CM = CRITICAL MOVEMENT (TWSC & AWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL

Existing Intersection Operations
 Weekday AM Peak Hour
 Sherwood, Oregon

Figure
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Existing Intersection Operations
 Weekday PM Peak Hour
 Sherwood, Oregon

Figure
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An assessment of 95th percentile queues under all scenarios is provided in *Appendix E*. Queues were reported from Synchro. As indicated in the summary, all 95th percentile queues can be accommodated within available storage except for the following:

- The eastbound left-turn/through movement and eastbound right-turn movement at the intersection of Highway 99W/SW Elwert Road-SW Sunset Boulevard extend beyond the adjacent intersection at SW Kruger Road/SW Elwert Road during the weekday AM or weekday PM peak hour, respectively.
- The northbound left-turn movement at the intersection of Highway 99W/SW Elwert Road-SW Sunset Boulevard exceeds the available stripped storage by one to two vehicles during the weekday PM peak hour.
- The 95th percentile queue for the southbound through/right-turn movement at the intersection of SW Ladd Hill Rd.-SW Main St./SW Sunset Boulevard extends beyond the adjacent intersection at SW Cornerstone Lane during the weekday PM peak hour.

YEAR 2020 BACKGROUND TRAFFIC CONDITIONS

The background traffic analysis identifies how the study area's transportation system will operate in 2020, the year the proposed development will be built out. This analysis includes traffic growth due to development within the study area but does not include traffic from the proposed subdivision.

Planned Developments and Transportation Improvements

Through the scoping process, the review agencies identified two in-process developments, the Sherwood Hotel located on SW Meinecke Road at Highway 99W and the Sherwood High School relocation to a site northeast of the intersection of SW Elwert Road and SW Kruger Road, east of Highway 99W.

The following improvements at the Highway 99W/SW Elwert Road-SW Sunset Boulevard intersection were included in the year 2020 background and total traffic conditions scenarios per City staff direction:

- Addition of a second northbound left turn lane (required as part of the Sherwood High School Transportation Planning Rule Analysis, as documented in the Sherwood High School Transportation Impact Study, Reference 9)
- Widening the west leg of the intersection to provide a left-turn, through lane, and through/right-turn lane (per conceptual drawings provided by City staff)
- Widening the east leg of the intersection to provide a left-turn, through lane, and through/right-turn lane (per conceptual drawings provided by City staff)

Background Traffic Volumes and Conditions

Year 2020 background traffic volumes were developed by increasing existing study intersection traffic volumes by 1% annually along Highway 99 and 2% annually on all other approaches as per City direction

during the scoping process. Traffic volumes from the in-process hotel development and the high school relocation were then added.

Figures 6 and 7 report the 2020 background traffic volumes and operating conditions at the study intersections during the weekday AM and PM peak hours, respectively. As seen in the figure, the following intersections are projected to exceed operational standards during the weekday AM peak hour:

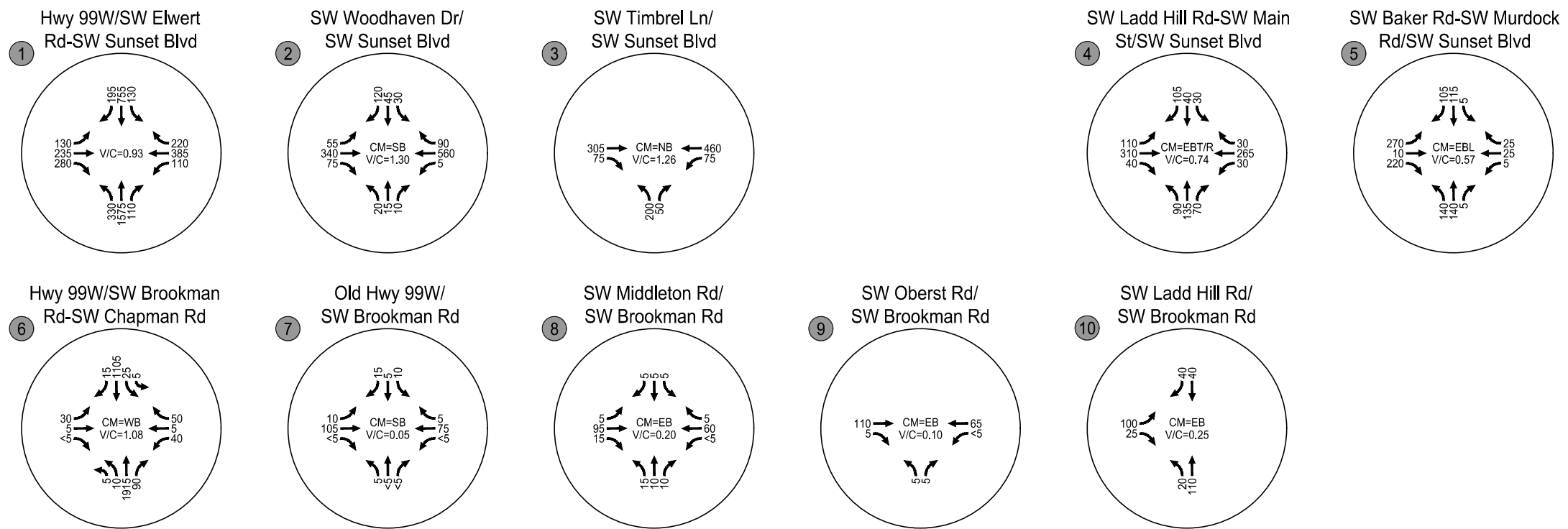
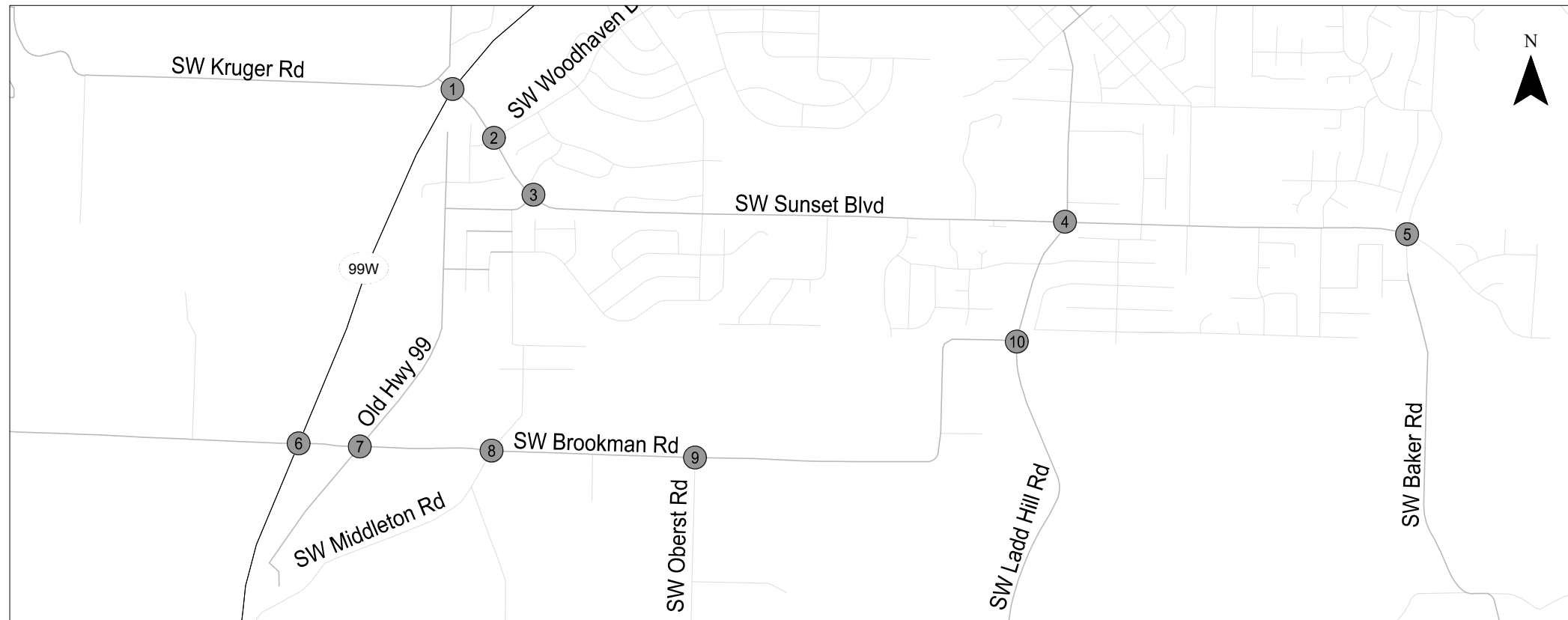
- The southbound approach to the stop-controlled SW Woodhaven Drive/SW Sunset Boulevard intersection is projected to operate with a V/C ratio of 1.30 and at a LOS F, exceeding the City's standard requiring a V/C ratio less than or equal to 0.99.
- The northbound approach to the stop-controlled SW Timbrel Lane/SW Sunset Boulevard intersection is projected to operate with a V/C ratio of 1.26 and at a LOS F, exceeding the City's standard requiring a V/C ratio less than or equal to 0.99.
- The westbound SW Brookman Road approach to the unsignalized Highway 99W/SW Brookman Road-SW Chapman Road intersection is projected to operate with a V/C ratio of 1.08

Potential future mitigations are further discussed under total traffic conditions. *Appendix F* includes the year 2020 background conditions level-of-service worksheets.

An assessment of 95th percentile queues under all scenarios is provided in *Appendix E*. Queues were reported from Synchro. As indicated in the summary, beyond the locations discussed under existing conditions, all 95th percentile queues can be accommodated within available storage except for the following:

- The westbound left-turn movement at the intersection of Highway 99W/SW Elwert Road-SW Sunset Boulevard extends beyond the adjacent intersection at SW Woodhaven Drive during the weekday PM peak hour.
- The southbound left-turn movement at the intersection of Highway 99W/SW Elwert Road-SW Sunset Boulevard exceeds the available stripped storage by one to two vehicles during the weekday AM peak hour.
- The 95th percentile queue for the northbound left-turn/through movement at the intersection of SW Timbrel Lane/SW Sunset Boulevard extends beyond the adjacent intersection at SW Middleton Road during the weekday AM peak hour.

The queue for the northbound left-turn movement at the intersection of Highway 99W/SW Elwert Road-SW Sunset Boulevard is no longer projected to exceed storage with the planned second turn-lane.

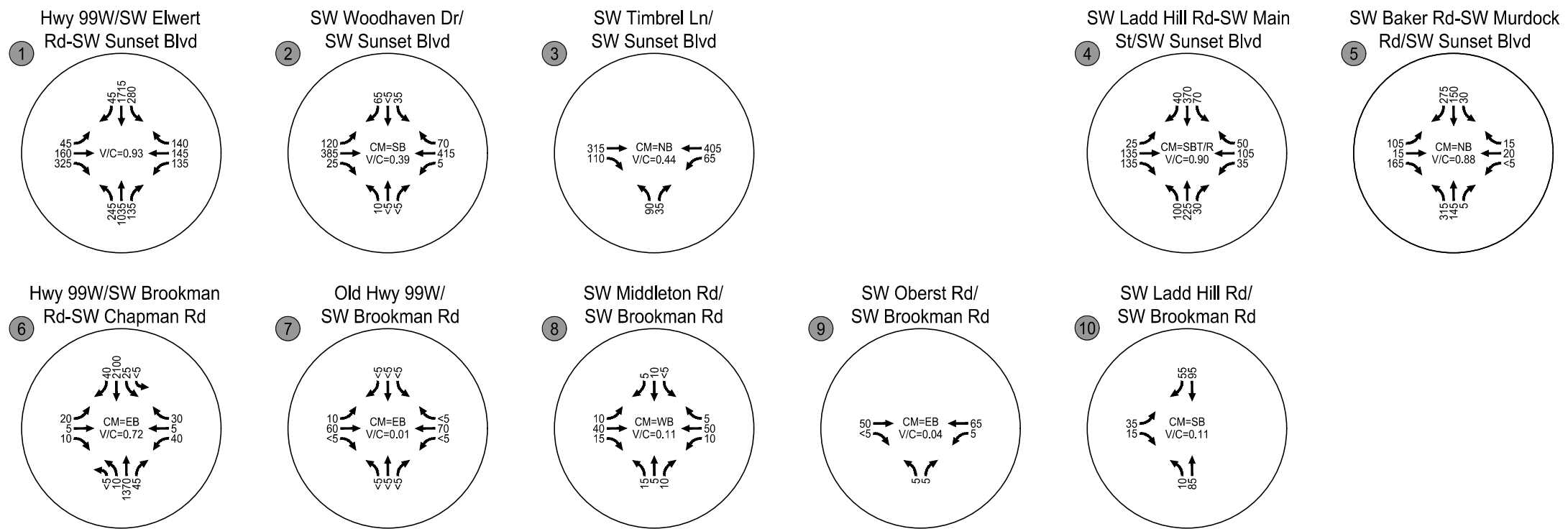
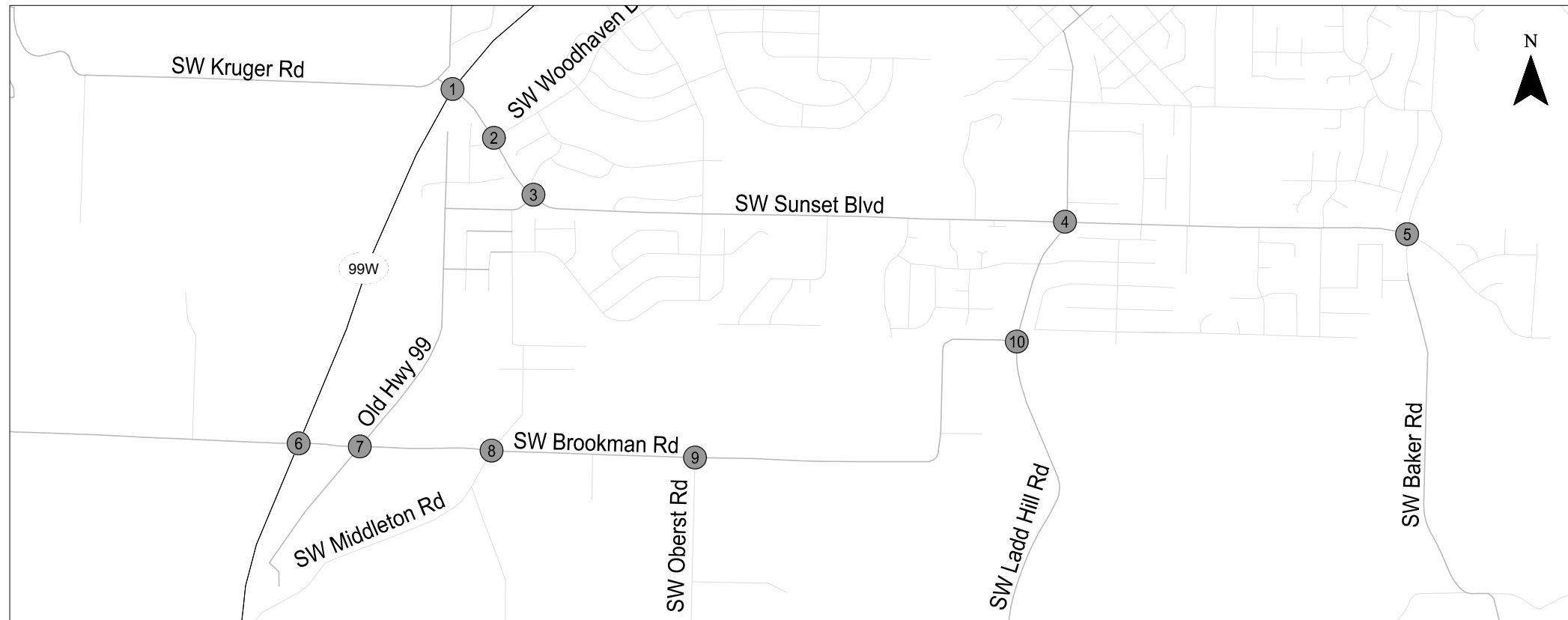


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Year 2020 Background Intersection Operations
 Weekday AM Peak Hour
 Sherwood, Oregon

Figure
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Year 2020 Background Intersection Operations
 Weekday PM Peak Hour
 Sherwood, Oregon

Figure
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PROPOSED DEVELOPMENT PLAN

The development as proposed consists of 145 detached single-family homes. A network of on-site roadways is proposed to provide access to individual homes with one public street connection on SW Brookman Road, aligning with the existing intersection at SW Oberst Road. The lane configurations and traffic control devices assumed for the year 2020 total traffic conditions are shown in Figure 8. The two existing single-family homes on site will be removed and the existing accesses to SW Brookman Road vacated. Site development is expected to be complete by 2020.

Trip Generation Estimate

Trip generation estimates for the proposed development were prepared based on information presented in the *Trip Generation Manual* (Reference 10) and are shown in Table 5.

Table 5. Trip Generation Estimate

Land Use	ITE Code	Size	Daily Trips	Weekday AM Peak Hour			Weekday PM Peak Hour		
				Total	In	Out	Total	In	Out
Single-Family Detached	210	143 units ¹	1,362	110	28	82	145	91	54

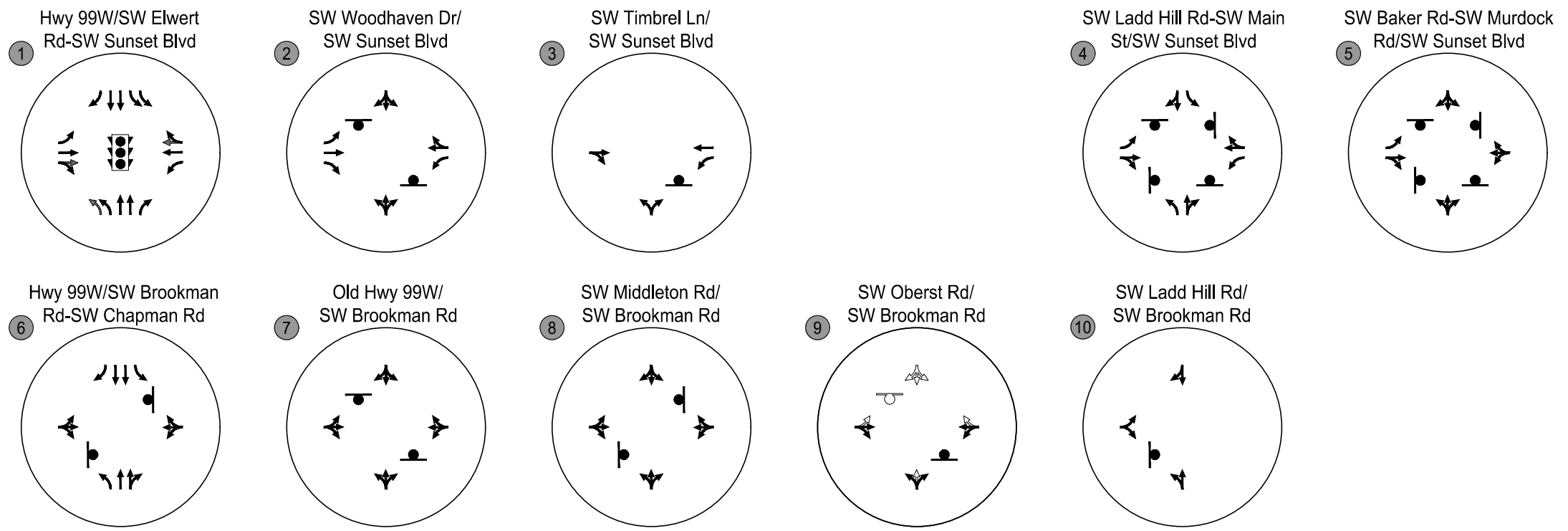
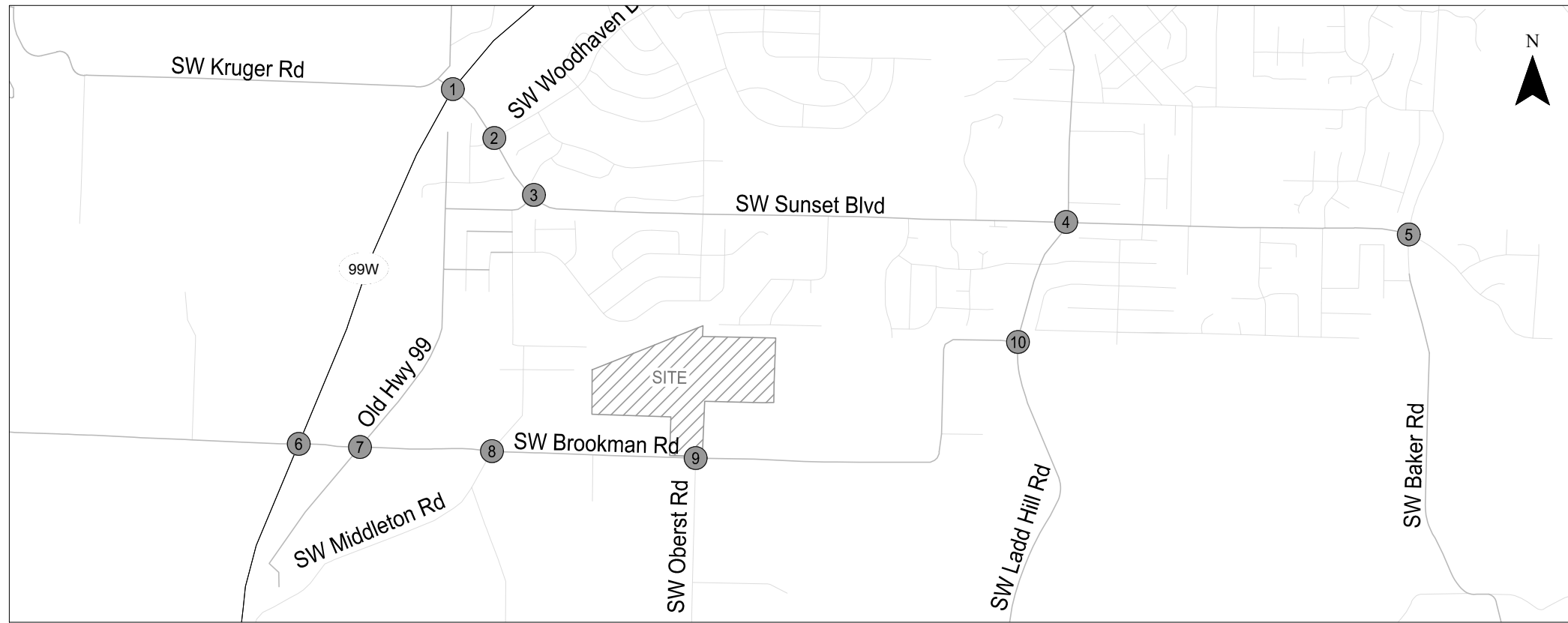
Note: Per direction from ODOT and the City, the average rate was used for the daily trip generation and the fitted curve equation for the weekday AM and PM peak hour trip generation.

¹There are two single-family detached homes on-site currently, so the trip generation is based on 143 units (145 proposed units minus 2 existing units).

As shown in Table 5, the proposed development is estimated to generate an additional 1,362 daily trips, including 110 trips during the weekday AM peak hour and 145 trips during the weekday PM peak.

Trip Distribution & Assignment

The trip distribution pattern for the site was developed considering existing traffic patterns and roadway connectivity. The trip distribution pattern was approved by the review agencies during project scoping and was used to assign the weekday AM and PM peak hour site trips to the study intersections as shown in Figures 9 and 10.

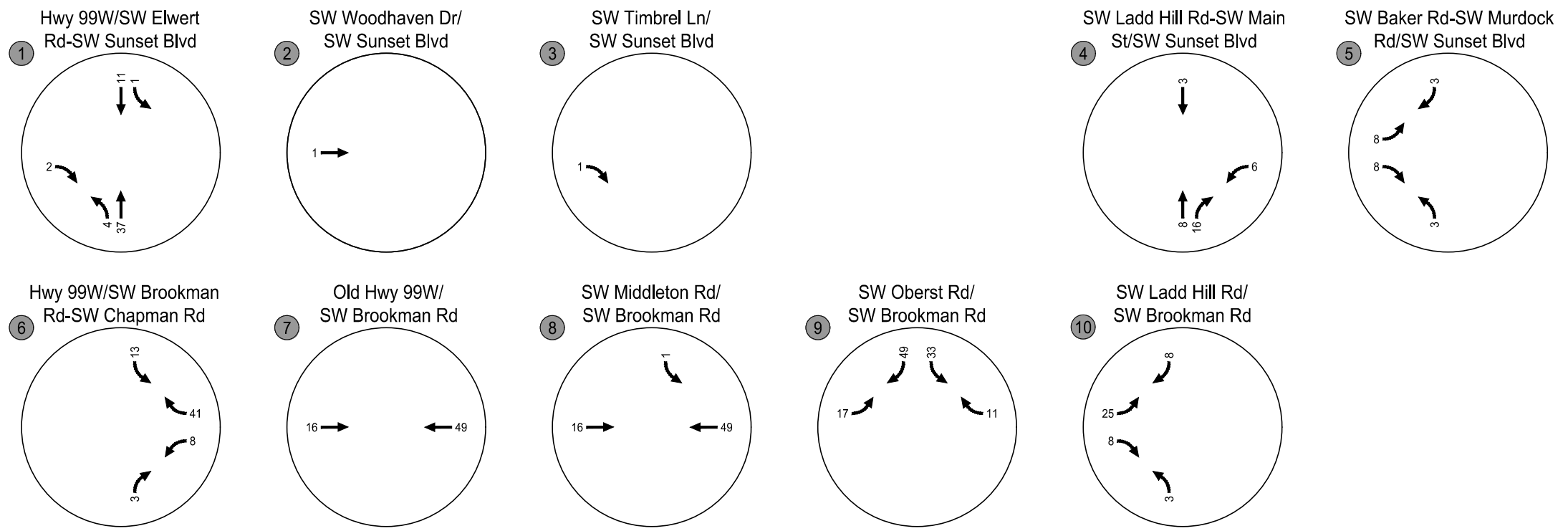
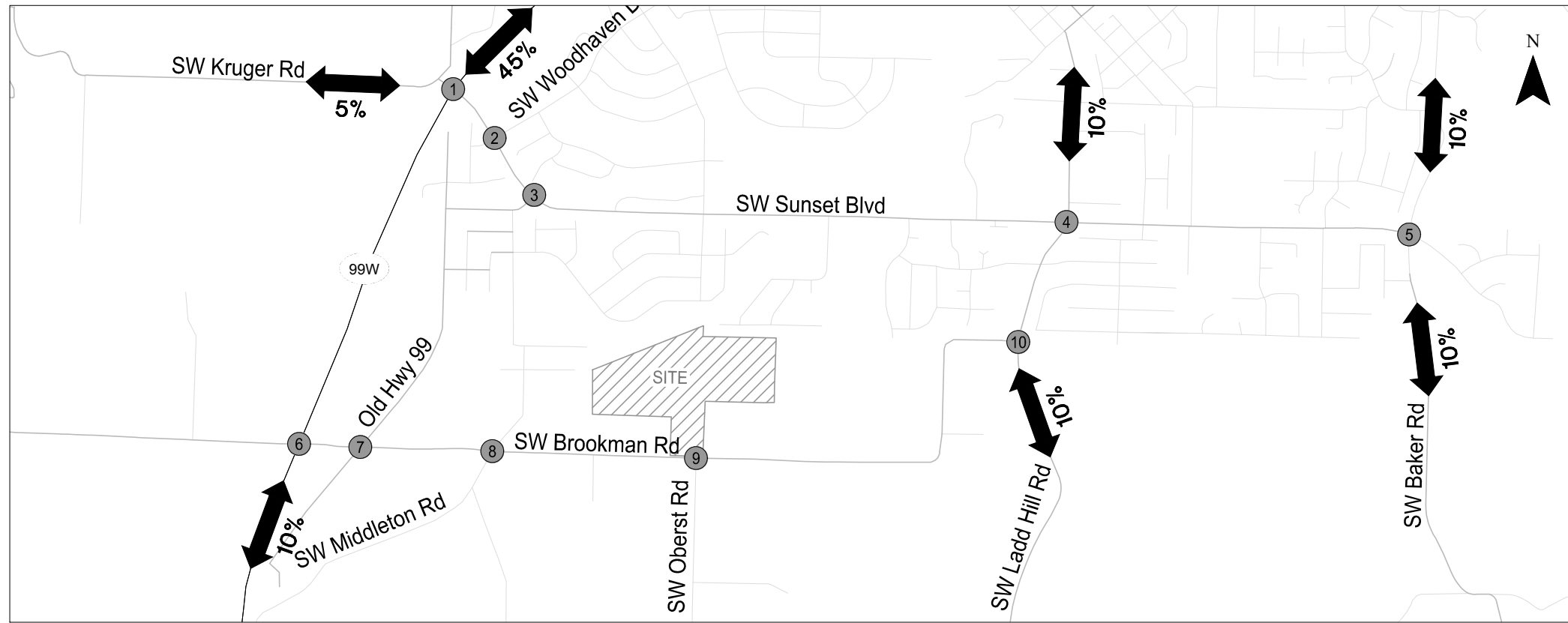


- STOP SIGN
- TRAFFIC SIGNAL
- PLANNED IMPROVEMENT
- MOVEMENT ADDED WITH DEVELOPMENT

Year 2020 Total Traffic Assumed Lane Configurations and Traffic Control Devices
Sherwood, Oregon

Figure
8

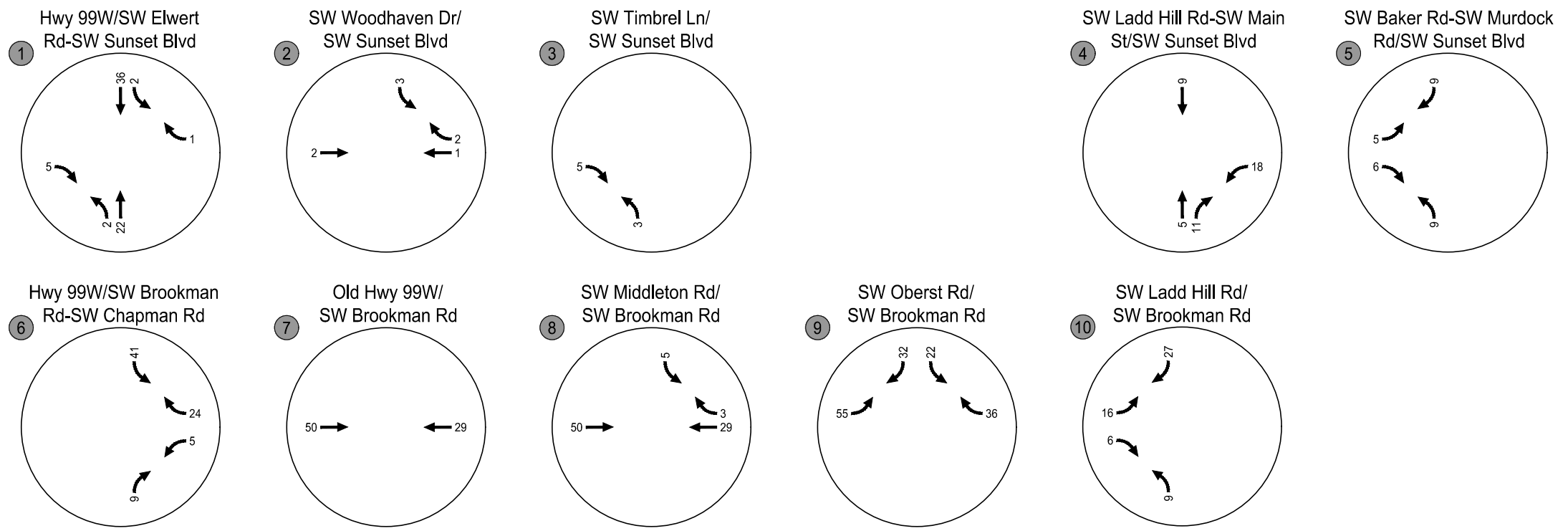
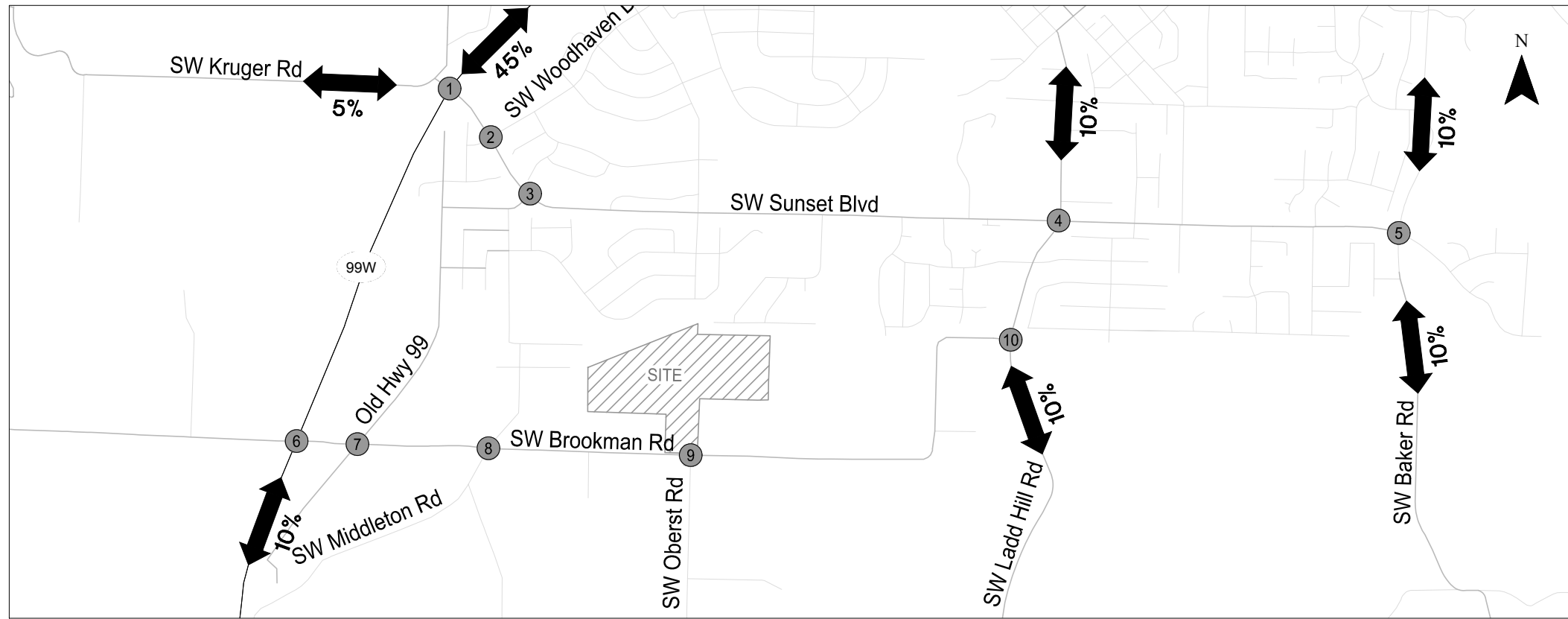
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Assumed Trip Distribution and Assignment
 Weekday AM Peak Hour
 Sherwood, Oregon

Figure
 9

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Assumed Trip Distribution and Assignment
 Weekday PM Peak Hour
 Sherwood, Oregon

Figure
 10

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YEAR 2020 TOTAL TRAFFIC CONDITIONS

The 2020 total traffic conditions analysis forecasts how the study area's transportation system will operate with the inclusion of traffic from the proposed development and identifies traffic mitigation measures required to support the site. Future traffic conditions were estimated by adding site-generated traffic to the 2020 background traffic volumes for the weekday AM and PM peak hours to arrive at the 2020 total traffic volumes.

Figures 11 and 12 report the 2020 total traffic volumes and operating conditions for the weekday AM and PM peak hours with site development. As seen in the figures, as under background conditions, the following intersections are projected to not satisfy operational standards during the weekday AM peak hour:

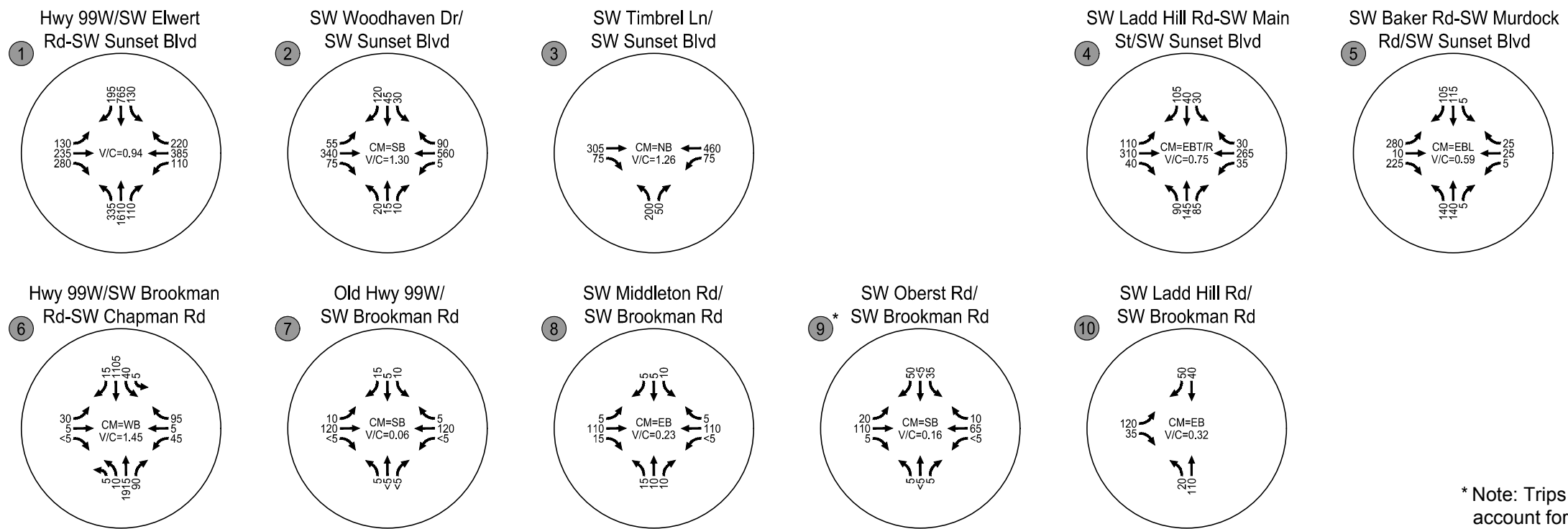
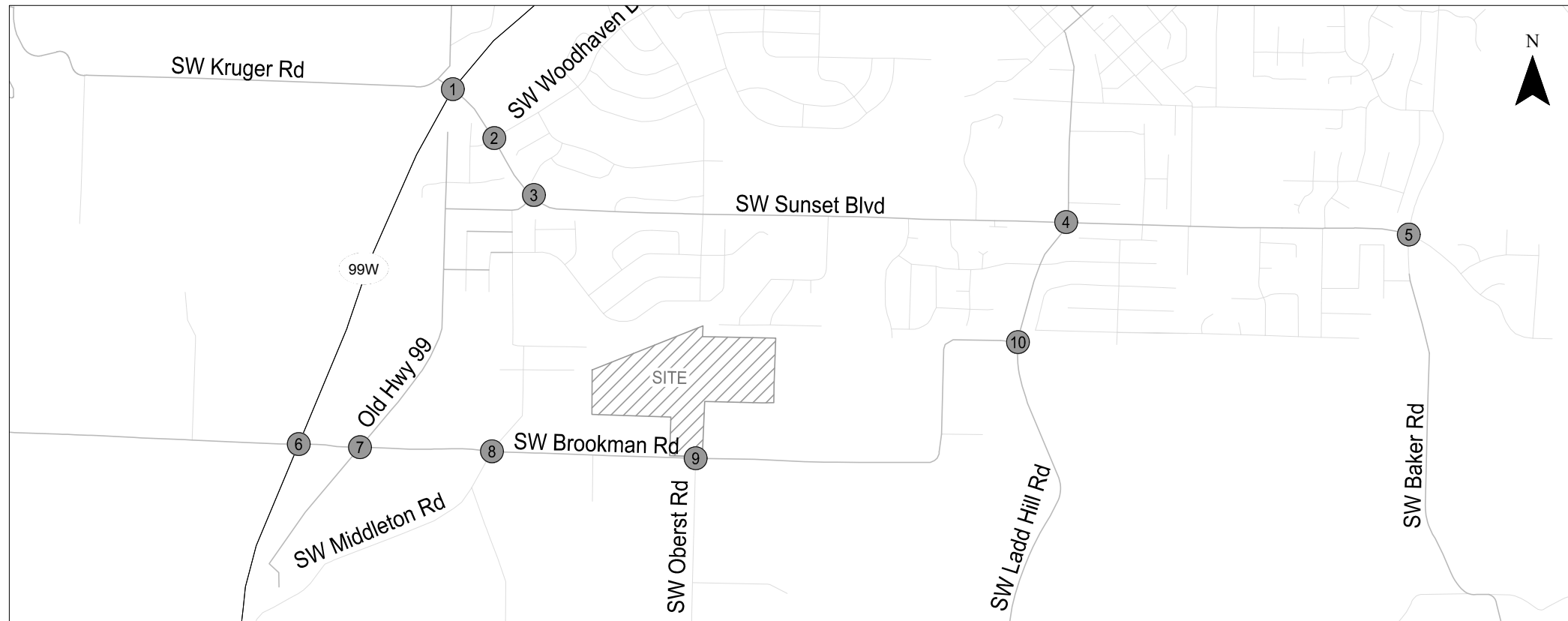
- The southbound approach to the stop-controlled SW Woodhaven Drive/SW Sunset Boulevard intersection is projected to operate with a V/C ratio of 1.30 and at a LOS F (no change from background conditions and the proposed development adds no trips to the southbound approach).
- The northbound approach to the stop-controlled SW Timbrel Lane/SW Sunset Boulevard intersection is projected to operate with a V/C ratio of 1.26 and at a LOS F (no change from background conditions and the proposed development adds no trips to the northbound approach).
- The westbound SW Brookman Road approach to the unsignalized Highway 99W/SW Brookman Road-SW Chapman Road intersection is projected to operate with a V/C ratio of 1.45.

Operations at these three intersections are discussed further below. *Appendix G* includes the year 2020 total traffic conditions level-of-service worksheets.

An assessment of 95th percentile queues under all scenarios is provided in *Appendix E*. Queues were reported from Synchro. As indicated in the summary, beyond the locations discussed under existing and background conditions, all 95th percentile queues can be accommodated within available storage. The only queuing mitigation needs identified in conjunction with site development are at the unsignalized Highway 99W/SW Brookman Road-SW Chapman Road intersection.

SW Woodhaven Drive/SW Sunset Boulevard

The southbound approach to the stop-controlled intersection of SW Woodhaven Drive/SW Sunset Boulevard is projected to operate at a LOS F and V/C ratio of 1.30 under both background and total traffic conditions during the weekday AM peak hour. The site is anticipated to add one eastbound through-trip to the intersection and therefore have a negligible impact on the intersection. Given that the intersection does not meet standards under background conditions, no site trips are added to the critical stop controlled approach, and the site's impact on the critical approach V/C ratio is negligible, no mitigations are recommended.



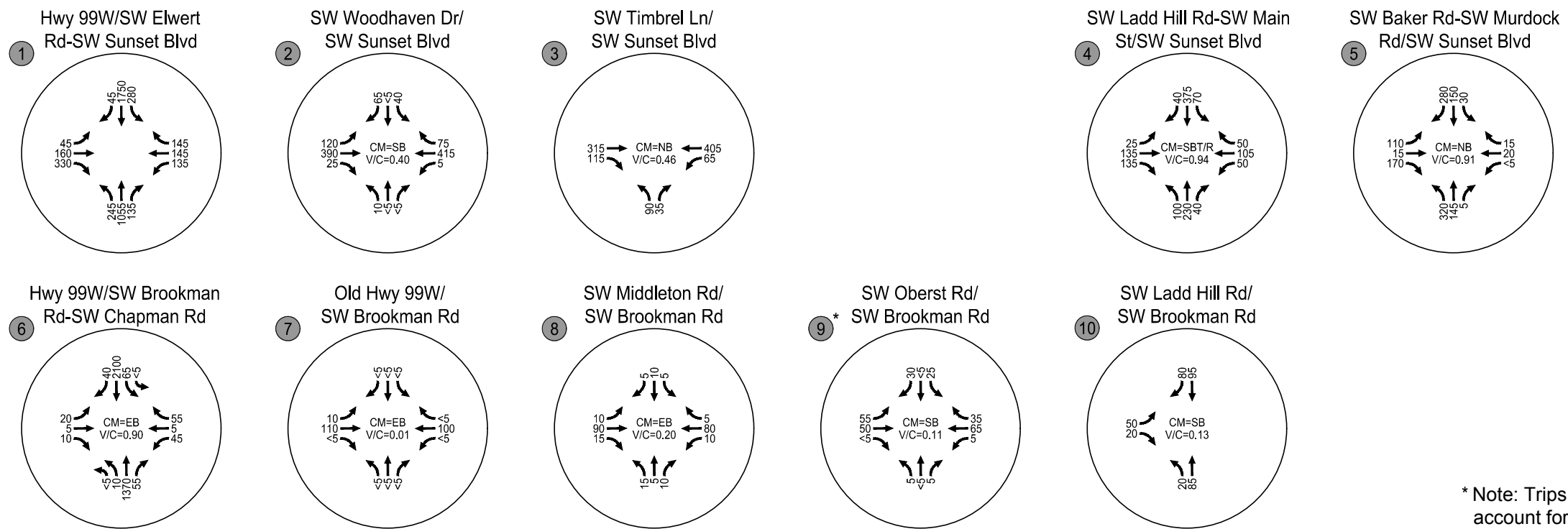
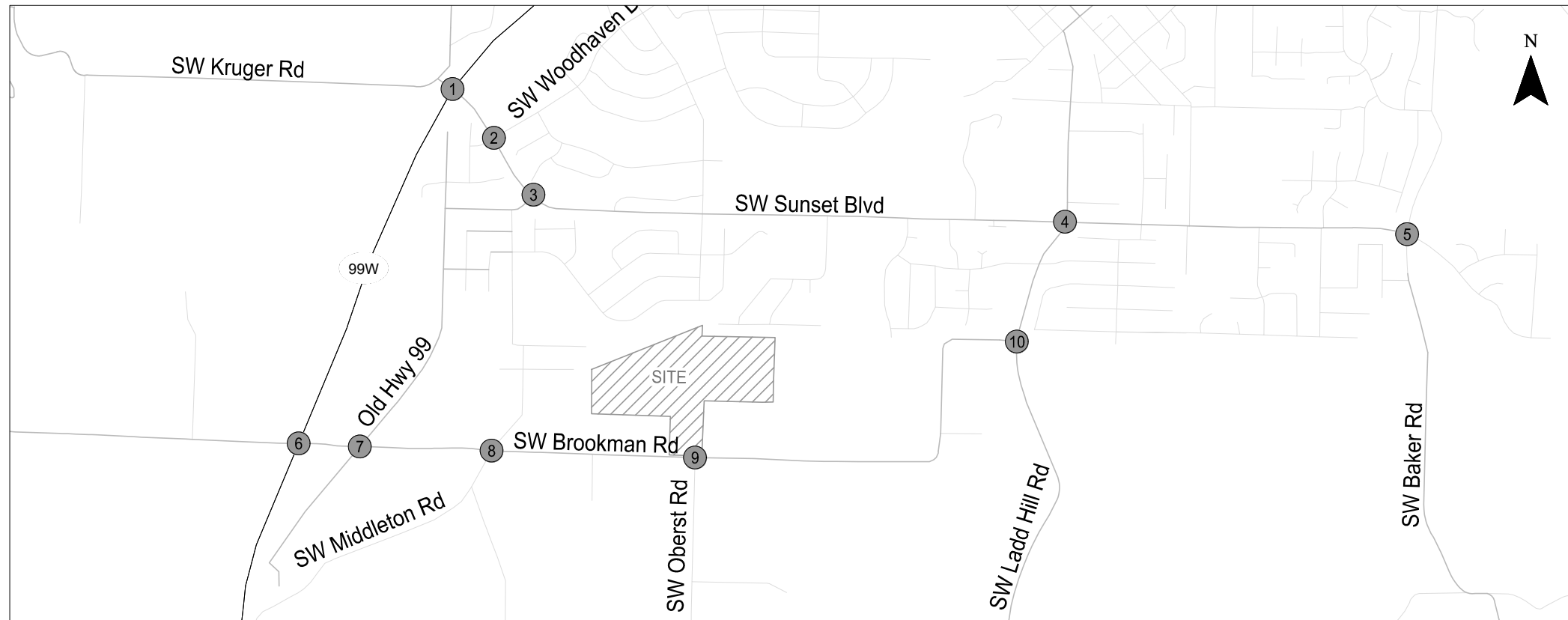
* Note: Trips were added to intersection 9 to account for rerouted trips associated with the existing two homes on site.

CM = CRITICAL MOVEMENT (TWSC & AWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL

Year 2020 Total Traffic Intersection Operations
 Weekday AM Peak Hour
 Sherwood, Oregon

Figure
 11

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* Note: Trips were added to intersection 9 to account for rerouted trips associated with the existing two homes on site.

CM = CRITICAL MOVEMENT (TWSC & AWSC)
 V/C = CRITICAL VOLUME-TO-CAPACITY RATIO
 TWSC = TWO-WAY STOP CONTROL
 AWSC = ALL-WAY STOP CONTROL

Year 2020 Total Traffic Intersection Operations
 Weekday PM Peak Hour
 Sherwood, Oregon

Figure
 12

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SW Timbrel Lane/SW Sunset Boulevard

The northbound approach to the stop-controlled intersection of SW Timbrel Lane/SW Sunset Boulevard intersection is projected to operate at a LOS F and V/C ratio of 1.26 under both background and total traffic conditions during the weekday AM peak hour. The site is anticipated to add one eastbound right-turn trip to the intersection and therefore have a negligible impact on the intersection. Given that the intersection does not meet standards under background conditions, no site trips are added to the critical stop-controlled approach, and the site’s impact on the critical approach V/C ratio is negligible, no mitigations are recommended.

Highway 99W/SW Brookman Road-SW Chapman Road

The SW Brookman Road westbound approach to the Highway 99W/SW Brookman Road-SW Chapman Road intersection is projected to operate with a V/C ratio of 1.45 under total traffic conditions during the weekday AM peak hour, compared to a V/C ratio of 1.08 under background conditions. ODOT’s standards require a V/C ratio equal to or less than 0.95 for the Brookman Road and SW Chapman Road approaches to the intersection.

Site-impact mitigation is recommended through either provision of an exclusive right-turn lane on the SW Brookman Road approach in conjunction with site development or payment of a proportionate share contribution to planned future intersection improvements. Both options are discussed below.

Option #1. Westbound Right-Turn Lane on SW Brookman Road

One option identified to mitigate the site’s impact at Highway 99W/SW Brookman Road-SW Chapman Road is provision of a westbound right-turn lane with 200 feet of storage. The right-turn lane mitigation will enable right-turning vehicles to bypass queued left-turning or through vehicles and will reduce projected queueing on the westbound approach to the intersection, as shown in Table 6. *Appendix H* includes the year 2020 total traffic conditions level-of-service worksheets for the mitigated scenario.

Table 6. Projected Operations at Highway 99W/SW Brookman Road-SW Chapman Road

Scenario	Weekday AM Peak Hour			Weekday PM Peak Hour		
	Critical Movement	V/C Ratio	95 th %ile Queue	Critical Movement	V/C Ratio	95 th %ile Queue
Year 2020 Background Conditions	WB	1.08	175 feet	EB	0.72	100 feet
Year 2020 Total Traffic Conditions	WB	1.45	275 feet	EB	0.90	100 feet
Year 2020 Total Traffic Conditions - Mitigated	WB	0.97	200 feet	EB	0.90	100 feet

Shading indicates ODOT standard not met

Given the recommended right-turn lane mitigates the site impact to V/C ratio (background traffic weekday AM peak hour westbound approach V/C of 1.08 reduced to 0.97 under mitigated total traffic), no additional capacity improvements are recommended at the Highway 99W/SW Brookman Road-SW Chapman Road intersection in conjunction with site development recognizing that the existing

intersection is likely to be relocated and signalized in the future as per the City TSP. The timing and location of the future realignment and signalization is not currently programmed.

Option #2. Proportionate Share Contribution

The City’s TSP includes a project to realign Brookman Road and install a traffic signal Highway 99W/SW Brookman Road-SW Chapman Road. The Sherwood High School Transportation Impact Study (Reference 9) recommended a proportionate share contribution to the intersection to mitigate the site’s impact, which was conditioned with the development. The same approach could be followed to mitigate the Middlebrook Subdivision’s impact. Table 7 illustrates the application of the proportionate share methodology established by the Sherwood High School study. As seen in the table, the methodology results in a proportionate share cost of \$329,197 for the Middlebrook subdivision.

Table 7. Proportionate Share Methodology at Highway 99W/SW Brookman Road-SW Chapman Road

Peak Hour	Scenario When Mitigation is Triggered	Existing TEV (X)	2020 Background (Y)	2020 Project Trips (PT)	Growth (Z=Y-X)	Proportionate Share (%)*	Mitigation Cost Estimate (\$)	Proportionate Share Cost (\$) **
AM	No Build	3,157	3,288	61	131	31.77%	\$1,936,000	\$329,197
PM	Existing	3,576	3,701	80	125	2.24%		

* if 2020 mitigation is triggered in: Existing Proportionate Share % = PT / X
No Build/Build Proportionate Share % = PT / (PT+Z)

** if intersection fails in AM and PM, use average of AM and PM proportionate share (%) to estimate share cost (\$)

Note: Methodology applied directly from Sherwood High School Transportation Impact Study (Reference 9) with volumes from Middlebrook Traffic Study

Site Access-SW Oberst Road/SW Brookman Road Intersection Turn Lane Considerations

The public street providing SW Brookman Road access to the new residential subdivision will be aligned with SW Oberst Road in conjunction with site development. Site development and frontage improvements will include reconstruction of the existing SW Oberst Road/SW Brookman Road intersection. Intersection sight distance is being assessed by AKS under a separate cover.

The need for an eastbound left-turn lane on SW Brookman Road into the site access was assessed using ODOT APM volume-based criterion for left-turn lanes as well as Harmelink left-turn warrants. Considering the two volume-based warrants, the intersection does not warrant provision of a separate left-turn lane with site development. In the future, SW Brookman Road is expected to be widened to a three- or five-lane arterial at which point a left-turn lane will be provided. The proposed development will provide half-street right-of-way dedication to Washington County consistent with a future five-lane arterial.

The projected total traffic volumes at the Site Access-SW Oberst Road/SW Brookman Road intersection also do not warrant an eastbound right-turn deceleration lane at the site access per Washington County criteria.

The turn lane warrant analysis worksheets are provided in *Appendix I*.

Site Access-SW Oberst Road/SW Brookman Road Intersection Vehicle Queuing Analysis

Vehicle queuing conditions were assessed at the proposed site access on SW Brookwood Road. Synchro 9 and the *2000 Highway Capacity Manual* (Reference 1) procedures were used to project 95th percentile queues, shown in Table 8. *Appendix E* contains the queue analysis worksheets generated by the Synchro software.

Table 8. Projected 95th Percentile Vehicle Queues for 2020 Total Traffic Conditions

Intersection		Movement	Assumed Storage Length	Weekday AM Peak Queue	Weekday PM Peak Queue	Storage Adequate? (Yes/No)
9	SW Oberst Road-Future Site Access/ SW Brookman Road	Southbound	250 ¹ feet	25 feet	<25 feet	Yes
		Eastbound	100 ² feet	<25 feet	<25 feet	Yes
		Westbound	100 ² feet	<25 feet	<25 feet	Yes

Queues rounded up to the nearest 25 feet

¹Approximate distance to first internal intersection

²Approximate distance to adjacent access/intersection

The queuing results indicate there will be adequate storage at the site access upon site development.

SW BROOKMAN ROAD ACCESS MANAGEMENT

Washington County *Community Development Code* (Reference 11) Section 501 provides standards for access spacing along arterial roads. Per the code, when allowed, accesses to arterial facilities such as SW Brookman Road should be spaced at least six hundred feet apart.

Figure 13 is an influence area map that shows existing site driveways, the proposed site access as well as other existing accesses in the vicinity within 600 feet of the site frontage. The existing site driveways serving single family homes will each be closed as noted.

The proposed new connection to SW Brookman Road is aligned with SW Oberst Road and will necessitate regrading of SW Brookman and the existing intersection of SW Oberst Road. As proposed, the public street location aligned with SW Oberst Road satisfies Washington County’s minimum 600-foot spacing standard along SW Brookman Road and thus complies with the *Community Development Code* spacing requirements.

Referring to Figure 2, the proposed site plan provides for future connectivity to the east and west along SW Brookman Road, allowing for future public roadway connections to SW Brookman Road to meet or exceed the County’s 600-foot minimum spacing standard east and west of the proposed Site Access-SW Oberst Road.



- 1 Existing Access - Private
- 2 Existing Access - Private
- 3 Existing Access - Private
- 4 Existing Access - Private
- 5 Existing Access - Private
- 6 Existing Access - Private
- 7 Existing Access - Private
- 8 Existing Access - Private
- 9 Existing Access - Private
- 10 Existing Access - Private
- 11 Existing Access - Private
- 12 Existing Access - Private (To Be Closed)
- 13 Existing Access - Private (To Be Closed)
- 14 Existing Access - Private (To Be Closed)
- 15 SW Oberst Road-Future Site Access/SW Brookman Road
- 16 Existing Access - Private (To Be Closed)
- 17 Existing Access - Private
- 18 Existing Access - Private
- 19 Existing Access - Private

Influence Area Map
Sherwood, Oregon

Figure
13

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Local Street Exception

Washington County will need to process an exception to allow the proposed local street connection to SW Brookman Road per CDC Section 501-8.5 which requires that direct access to arterials be from collector and other streets. Per the CDC 501-8.5, exceptions for local streets may be allowed through a Type II process when collector access is found to be unavailable and impracticable by the Director.

Support for granting the proposed local street connection is provided by multiple adopted documents guiding local area transportation needs. First, the City of Sherwood's adopted *Brookman Addition Concept Plan* (Reference 12) identifies only local street connections to SW Brookman Road in the area of the site. Further, the City's *Transportation System Plan* as well as the recently adopted minor amendments to the Transportation System Plan (Ordinance 2018-03) each show local street connections to SW Brookman Road along the site frontage as well as to the east and west. No planned north-south collector or arterial through the proposed site area is identified in any of the City's guiding documents. Considering the adopted planning documents, the Washington County Director should make a determination that collector access is both unavailable and impracticable and that local access can be allowed as proposed in accordance with CDC 501-8.5. As noted above, the proposed local access will satisfy County access spacing standards for SW Brookman Road.

COMPLIANCE WITH REQUIREMENTS IN THE SHERWOOD MUNICIPAL CODE

Section 16.106.080 of the Sherwood Municipal Code outlines the purpose, applicability, requirements, and approval criteria for a traffic impact analysis. The approval criteria provided in 16.106.080F are listed below with specific application to the proposed development.

1. The analysis complies with the requirements of 16.106.080.C

Per 16.106.080.C:

- *A pre-application conference was held involving the City, Washington County and ODOT (on July 13, 2017)*
- *This TIA has been prepared by an Oregon Registered Professional Engineer*
- *The latest edition of the Trip Generation Manual (9th Edition) was used when the traffic study was scoped (Note that a more recent 10th Edition is now available, however the latest available data has a negligible impact to the rates utilized in this study; for example, the 9th Edition daily trip rate used in this study was 9.52 trips per home whereas the 10th Edition documents a daily rate of 9.44 trips per home; similarly, the average AM peak hour and PM peak hour rates in the 9th Edition were each reduced by 0.01 trips per home in the 10th Edition). Per direction from ODOT and the City, the average rate was used for the daily trip generation and the fitted curve equation for the weekday AM and PM peak hour trip generation.*
- *Intersection-level analysis was conducted at ten study intersections identified in coordination with City staff. The study locations include all public intersections*

anticipated to have fifty or more peak hour vehicle trips generated by the development. Subsequent to the traffic study scoping, the size of the site and proposed unit count was reduced; however, the original study intersections identified by City staff were analyzed even if they no longer were impacted by 50 or more peak hour trips.

- *The Transportation Planning Rule is not applicable to a land division application, per OAR 660-012-0060*

2. The analysis demonstrates that adequate transportation facilities exist to serve the proposed development or identifies mitigation measures that resolve identified traffic safety problems in a manner that is satisfactory to the City Engineer and, when County or State highway facilities are affected, to Washington County and ODOT

This study addresses the adequacy of the transportation facilities and recommends mitigation at the intersection of Highway 99W/SW Brookman Road-SW Chapman Road, through construction of a westbound right-turn lane or payment of a proportionate share contribution.

3. For affected non-highway facilities, the TIA demonstrates that mobility and other applicable performance standards established in the adopted City TSP have been met

The City's mobility performance standards have been applied, as documented in this study.

4. Proposed public improvements are designed and will be constructed to the street standards specified in Section 16.106.010 and the Engineering Design Manual, and to the access standards in Section 16.106.040.

The appropriate street and access standards will be applied to the development. The development plans will be subject to review by the City.

5. Proposed public improvements and mitigation measures will provide safe connections across adjacent right-of-way (e.g., protected crossings) when pedestrian or bicycle facilities are present or planned on the far side of the right-of-way.

The project will provide a sidewalk and bike lane along the site frontage on Brookman Road. Off-site bicycle and pedestrian facilities are expected to be constructed in conjunction with future off-site development by others consistent with County and City frontage improvement requirements.

FINDINGS AND RECOMMENDATIONS

Based on the results of the transportation impact analysis, the proposed site can be developed while maintaining acceptable operations at the study intersections. The analysis developed the following findings and recommendations.

Findings

- All study intersection operations currently satisfy City, County, and ODOT standards.
- The proposed residential development is estimated to generate approximately 1,362 daily trips, including 110 trips during the weekday AM peak hour and 145 weekday PM peak trips after accounting for the two existing detached single-family homes on the site.
- Under background and total traffic conditions, three of the study intersections were found to not operate in accordance with the standards during the weekday AM peak hour.
 - During the weekday AM peak hour, the westbound approach to the Highway 99W/SW Brookman Road-SW Chapman Road intersection is projected to operate with a V/C ratio of 1.08 under background conditions and with a V/C ratio of 1.45 under total traffic conditions.
 - Provision of a westbound right-turn lane with 200 feet of queue storage would mitigate the proposed development's impact to the intersection.
 - Future relocation and signalization of the intersection is identified as a long-term need in the City's Transportation System Plan but is not currently programmed or funded. A proportionate share methodology for contributions to the future improvement was established as part of the Sherwood High School Transportation Impact Study (Reference 9) and conditioned with the development.
 - During the weekday AM peak hour, the southbound approach to the stop-controlled intersection of SW Woodhaven Drive/SW Sunset Boulevard is projected to operate at a LOS F and V/C ratio of 1.30 under both background and total traffic conditions.
 - The site is anticipated to add one eastbound through trip to the intersection and therefore have a negligible impact on the intersection.
 - During the weekday AM peak hour, the northbound approach to the stop-controlled intersection of SW Timbrel Lane/SW Sunset Boulevard intersection is projected to operate at a LOS F and V/C ratio of 1.26 under both background and total traffic conditions.
 - The site is anticipated to add one eastbound right-turn trip to the intersection and therefore have a negligible impact on the intersection.
- The proposed site access on SW Brookman Road aligns with SW Oberst Road and complies with the Washington County *Community Development Code* minimum access spacing requirements.

Recommendations

Recommended transportation improvements to be implemented with site development include:


- Provide either a westbound right-turn lane with 200 feet of storage on SW Brookman Road at the Highway 99W/SW Brookman Road-SW Chapman Road intersection with site development

or pay a proportionate share contribution of \$329,197 to future improvements at the intersection.

We trust that this letter adequately documents the transportation impacts associated with the proposed development. Please contact us if you have any questions or comments regarding the contents of this letter or the analyses performed.

Sincerely,
KITTELSON & ASSOCIATES, INC.


Chris Brehmer, PE
Senior Principal Engineer


Kelly Laustsen, PE
Senior Engineer



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