



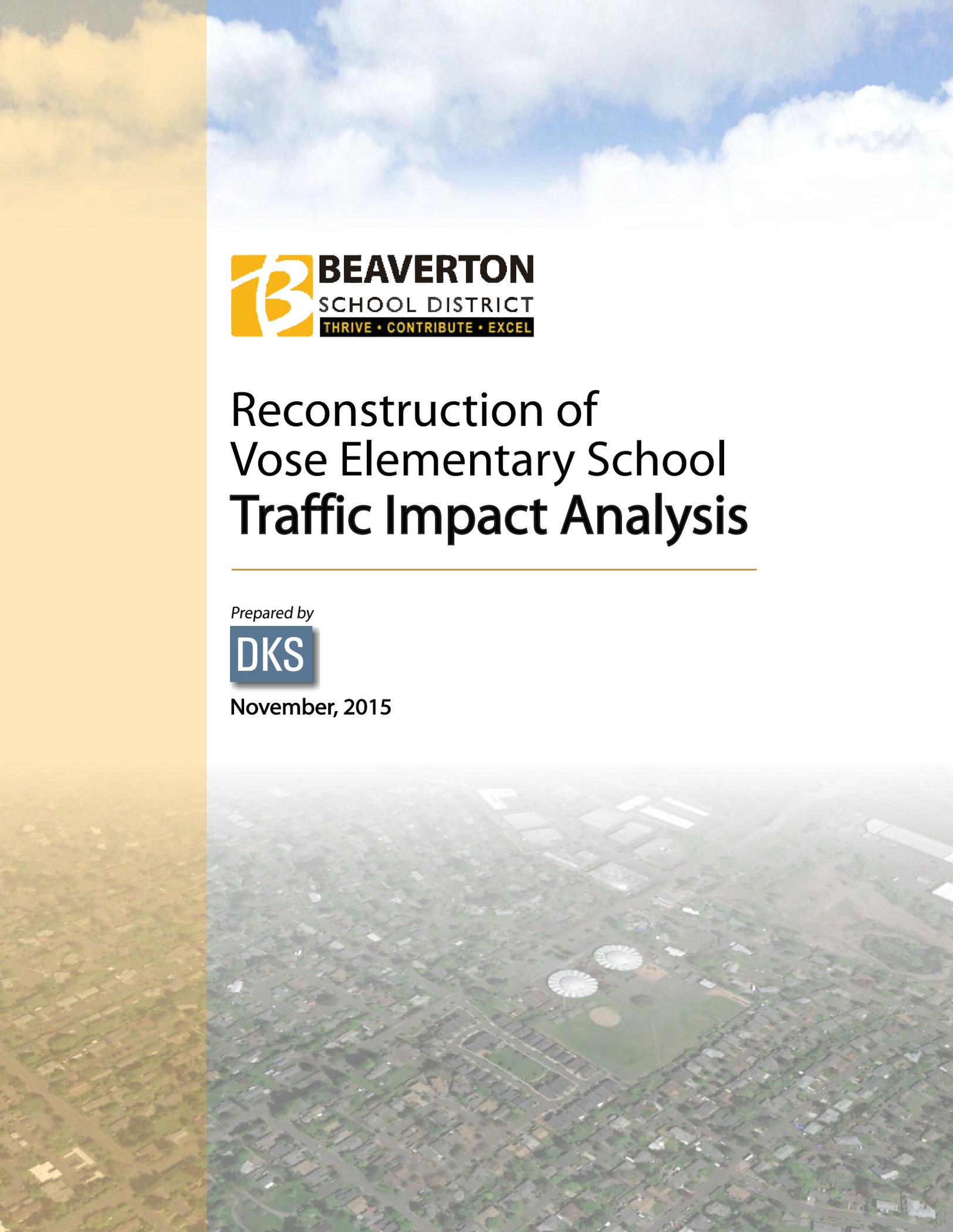
# Reconstruction of Vose Elementary School Traffic Impact Analysis

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*Prepared by*

**DKS**

November, 2015



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## EXECUTIVE SUMMARY

This study documents the transportation impacts for the proposed Beaverton School District reconstruction of Vose Elementary School located on the south side of the SW Denney Road at the SW King Road intersection in Beaverton, Oregon. This report documents the evaluation of existing transportation conditions, trip generation and distribution, future year 2035 transportation conditions, and transportation impacts within the study area as a result of the reconstructed elementary school. The purpose of this report is to determine the impacts on the surrounding transportation system as a result of the proposed project and identify mitigation measures that would be needed to offset these impacts.

The transportation impact analysis follows transportation impact study guidelines outlined by the City of Beaverton<sup>1</sup> and the scope of services prepared in coordination with City of Beaverton staff.

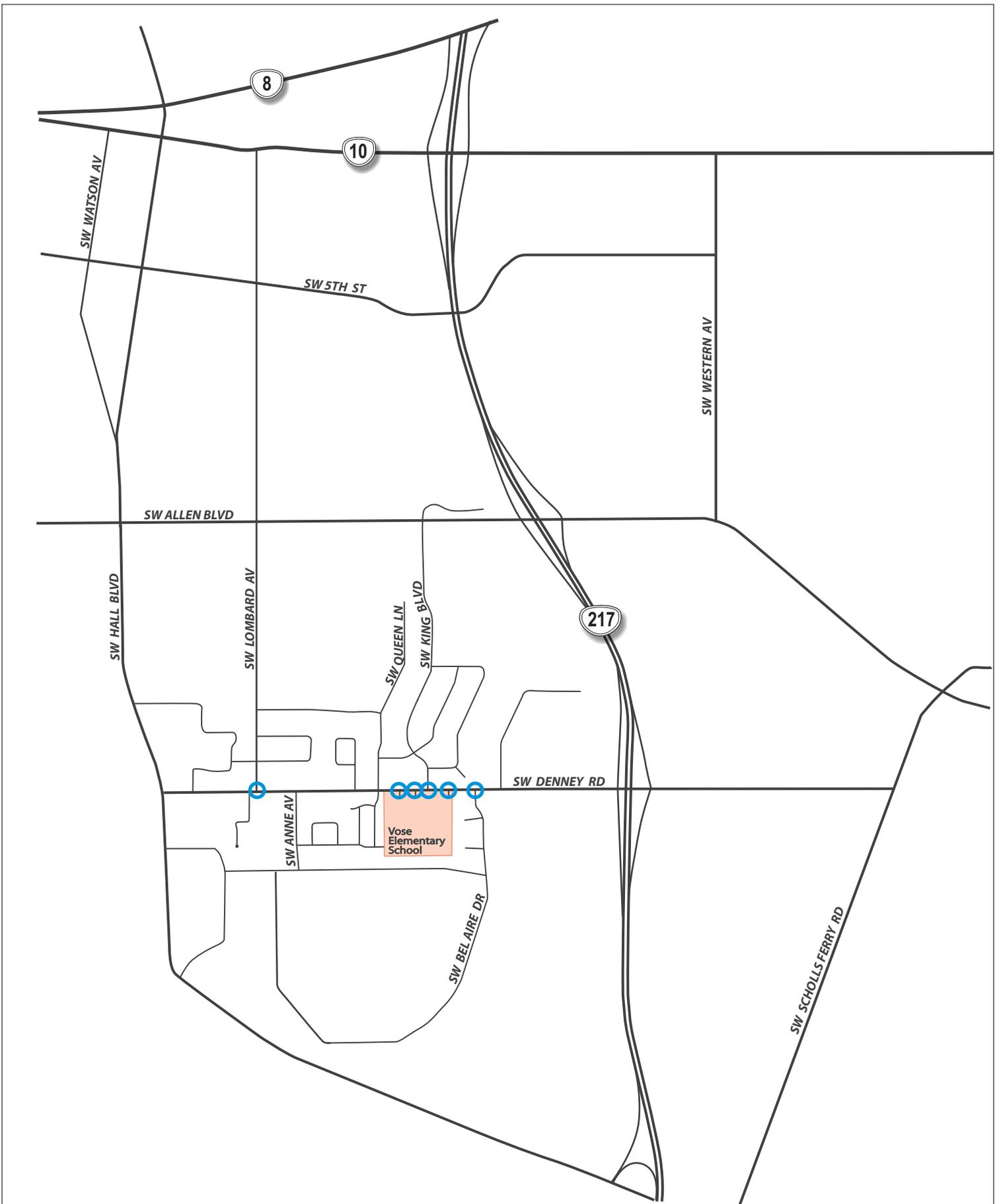
The study area in the vicinity of Vose elementary school is shown in Figure 1, while the current version of the site plan is shown in Figure 2. Transportation impacts were evaluated at the following six study intersections, all of which are under the jurisdiction of the City of Beaverton:

1. SW Denney Road/SW King Boulevard
2. SW Denney Road/West School Driveway (existing)
- 2a. SW Denney Road/Middle School Driveway (existing)
3. SW Denney Road/East School Driveway (existing)
4. SW Denney Road/SW Lombard Avenue
5. SW Denney Road/SW Bel Aire Drive

This chapter provides an introduction to the project and the steps taken to analyze the associated impacts on the transportation network. It highlights important elements of the remaining chapters, including a description of the project site and a summary of the project site evaluation. Table 1 lists important characteristics of the study area and the proposed project.

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<sup>1</sup> Traffic Impact Analysis Requirements, City of Beaverton, August 2008.



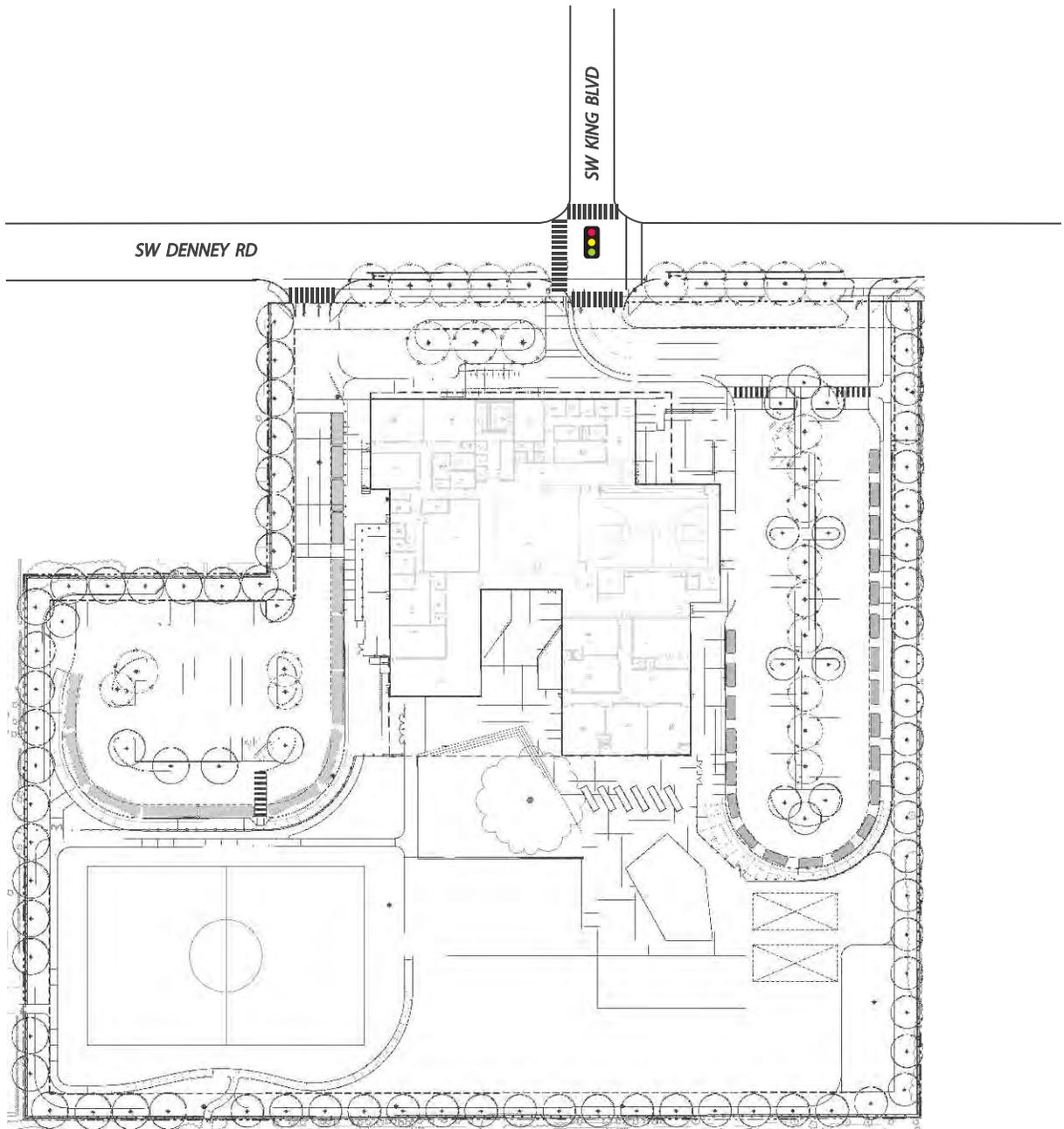
**LEGEND**

○ - Study Intersections

**DKS**

**Figure 1**

Vicinity Map &  
Study Intersection Influence Area  
Beaverton Vose Elementary School



**LEGEND**

-  - Traffic Direction Flow
-  - Traffic Signal

**DKS**



No Scale

*Figure 2*

**PROPOSED SITE PLAN**

Source: DLR Group and Cameron McCarthy

**Table 1: Key Study Area and Proposed Project Characteristics**

Characteristics	Information
<b>Study Area</b>	
Number of Study Intersections	Five (Six existing)
Analysis Period	Weekday AM peak hour (one hour from 7-9 am) Weekday Afternoon School Peak hour (one hour from 2-4 pm) Weekday PM peak hour (one hour from 4-6 pm)
<b>Project Development</b>	
Size and Land Use	Elementary school with maximum 750 students and 77 staff members. Currently, 691 students and 72 staff on site (2015)
Additional Proposed Vehicle Trips at maximum 750 student enrollment (In Addition to Existing Traffic)	37 (21 in/16 out) a.m. peak hour trips 20 (9 in/11 out) afternoon school peak hour trips 4 (1 in/3 out) p.m. peak hour trips
Vehicle Access Points	One full access at SW King Boulevard (staff /visitor), one full access west of SW King Boulevard (staff and buses only) and one restricted right-out only access on SW Denney Road (staff/visitor). Project proposes to add south leg to SW Denney Road/SW King Boulevard traffic signal (staff/visitor).
<b>Other Transportation Facilities</b>	
Pedestrian Facilities	Sidewalks are currently available along SW Denney Road adjacent to the study site. Sidewalks will be relocated along project frontage of SW Denney Road with recommended half street improvements to the City of Beaverton’s collector cross-section.
Bicycle Facilities	Bike lanes are not currently provided along SW Denney Road adjacent to the project site. Bike lanes are proposed along project frontage of SW Denney Road with recommended half street improvements to City of Beaverton collector cross-section, although they are not likely to be striped as bike lanes since they will not be continuous to adjacent properties.
Nearest Transit Stop	The nearest TriMet bus stop is located approximately one-half mile to the west from the project site (Routes 76 & 78) on Hall Boulevard and over three-quarters of a mile to the east along SW Scholls Ferry Road (Routes 56 & 92).

## Existing Intersection Operations

Existing traffic operations at the study intersections were determined for the a.m., afternoon school, and p.m. peak hours based on the 2000 Highway Capacity Manual methodology for signalized and unsignalized intersections.<sup>2</sup> The estimated level-of-service (LOS) and volume-to-capacity (V/C) ratio of each study intersection is shown in Table 2 for existing conditions and compared to City of Beaverton intersection mobility targets. The City V/C standard applies to the critical lane group.

As shown, all study intersections currently meet City of Beaverton operating standards during the three peak hours analyzed, with the exception of SW King Boulevard/SW Denney Road during the a.m. peak hour. The intersection of SW King Boulevard/SW Denney Road currently experiences long delays and queues along the eastbound approach during the a.m. peak hour due to a lack of stacking area on the existing Vose Elementary School site and a “keep clear” area at the middle school driveway, which causes vehicles to back up onto Denney Road to the west of the school site and does not allow efficient throughput at the traffic signal. This condition occurs for about 20-30 minutes, only on school days.

**Table 2: 2015 Existing Intersection Operations – Peak Hour**

Intersection	Mobility Target	AM Peak			Afternoon School Peak			PM Peak		
	City	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
SW Lombard Ave/ SW Denney Rd	45 sec delay	7.2	C	0.66	4.4	B	0.33	5.7	C	0.46
West School Driveway		0.4	A	0.50	0.2	A	0.31	0.0	A	0.43
Middle School Driveway		5.1	A	0.58	1.3	A	0.28	0.1	A	0.43
SW King Blvd/ SW Denney Rd**	0.98 V/C*, 65 sec delay	<b>92.6</b>	<b>F</b>	0.88	10.5	B	0.50	13.1	B	0.74
East School Driveway	45 sec delay	0.6	A	0.48	0.5	A	0.27	0.2	A	0.42
SW Bel Aire Dr/ SW Denney Rd		3.8	A	0.44	1.5	A	0.27	1.5	A	0.42

Delay = average intersection vehicle delay (sec), LOS = intersection level of service, V/C = worst lane group volume-to-capacity ratio for worst lane group

**Bold and Red** indicates intersection does not meet mobility target

\* Applies to each lane group at intersection

\*\*V/C reported for eastbound lane group during a.m. peak, westbound lane group during afternoon school peak and westbound lane group during p.m.peak.

<sup>2</sup> 2000 Highway Capacity Manual, Transportation Research Board, Washington DC, 2000.

## **2017 Total Traffic Conditions**

### **2017 Background Volumes**

The new Vose Elementary School is anticipated to be open and fully operational by September 2017. Frontage improvements are proposed to be constructed as part of the project. These improvements include closure of the existing site driveways, widening of SW Denney Road to the City of Beaverton's collector street three-lane standard, adding a south leg to the existing SW King Boulevard/SW Denney Road traffic signal, which will serve as the primary visitor and staff access, a new bus and staff only access at the west end of the site, and a right-out only access at the east end of the site. Existing traffic volumes were redistributed to the planned accesses based on the proposed use of each access.

To account for background growth and future development in the area, a one percent yearly average linear growth rate was used to forecast the future background traffic volumes, based on input from City of Beaverton staff.<sup>3</sup>

### **2017 Trip Generation**

Due to travel characteristics of elementary schools, the traffic study evaluates three peak period scenarios. The a.m. and p.m. peak periods are typical peak periods for a transportation impact analysis since this is when traffic volumes are greatest on surrounding roadways. The a.m. peak period is typically the peak travel period for elementary school traffic (school drop-off activity) and aligns with the a.m. peak of the adjacent transportation system. The p.m. peak period for an elementary school however does not typically align with the p.m. peak of the adjacent transportation system. The typical elementary school afternoon peak typically falls between 2 p.m. and 4 p.m. during school release, whereas the p.m. peak of the transportation system typically falls between 4 p.m. and 6 p.m. As a result, this study will evaluate both the afternoon school peak to capture the peak school release demand as well as the p.m. peak for the adjacent transportation system.

Traffic counts were collected at the three existing Vose Elementary School site driveways on three separate days during the three peak periods analyzed<sup>4</sup>. Table 3 summarizes the existing trip generation to the site. Site observations indicate that some student pick-up activity occurs off-site on the adjacent public street system. To account for this, a parking inventory was collected along Queen Lane, King Boulevard, Princess Avenue, and Imperial Drive during the afternoon school release time. Approximately 41 vehicles were observed using the adjacent public street system for student pick-up; therefore, this value was added to the traffic counts at the site driveways to capture the total trip generation for the afternoon school peak period.

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<sup>3</sup> Based on information provided by Jabra Khasho, October 16, 2015.

<sup>4</sup> Traffic counts collected on May 13, May 14, and May 19, 2015.

**Table 3: Vose Elementary School Trip Generation Rates – Peak Hour**

Date	Peak Hour	Rate (trips/student)	Directional Distribution		Current Vehicle Trips		
			In	Out	In	Out	Total
Average	Morning	0.62	56%	44%	238	191	429
	Afternoon School	0.34	47%	53%	110	123	233
	Evening	0.06	27%	73%	12	33	45

Trip generation is typically based on rates published in the *ITE Trip Generation Manual*<sup>5</sup> unless there is reason to suspect that local data may differ from the published rates or there are minimal studies. The trip rates measured from traffic counts collected at Vose Elementary School as part of this study were compared to national published elementary school trip rates shown in Table 4.

**Table 4: ITE Trip Generation Rates – Peak Hour**

Source	Peak Hour	Rate (trips/student)	In %	Out %
<i>ITE Trip Generation Manual</i> (Code 520)	Morning	0.45	55%	45%
	Afternoon School	0.28	45%	55%
	Evening	0.15	49%	51%

The *ITE Trip Generation Handbook*<sup>6</sup> provides a methodology for determining if the ITE rates, local rates, or a combination of the rates should be used for analysis (see Appendix for the methodology). If the measured local rates are within 15% of the ITE rates, then the ITE rates are valid for local use. If not, the local rates should be applied solely, if warranted, or in combination with the ITE rates. The local data used for this study is not within 15% of the ITE rates. Therefore, the *ITE Trip Generation Handbook* suggests that local rates should be used. Furthermore, since the use and site are both existing, evaluation of the current site should provide the best representation of anticipated travel characteristics and mode split.

The school expects to enroll approximately 750 students when it reaches capacity. As a worst case scenario, it was assumed that the school would accommodate 750 students when it opens in 2017, which is an additional 59 students as compared to current enrollment. Table 5 presents the resulting trip generation for Vose Elementary School.

<sup>5</sup> *ITE Trip Generation Manual*, Institute of Transportation Engineers, 9<sup>th</sup> Edition, 2012.

<sup>6</sup> *ITE Trip Generation Handbook*, Institute of Transportation Engineers, 2<sup>nd</sup> Edition, 2004.

**Table 5: New Vose Elementary School Trip Generation – 2017 Peak Hour**

Study Period	Expected Student Enrollment	Trip Rate (per student)	In %	Out %	2017 Trip Generation		
					In Trips	Out Trips	Total Trips
AM Peak	59 (Net New Enrollment)	0.62	56%	44%	21	16	37
Afternoon School Peak		0.34	47%	53%	9	11	20
PM Peak		0.06	26%	74%	1	3	4

**2017 Total Traffic Intersection Operations**

The study intersection operating conditions for the 2017 background with project trips scenario during the a.m., afternoon school, and p.m. peak hours are listed in Table 6. Intersection operations include the frontage improvements proposed to be constructed as part of the project, described previously.

The eastbound queuing issues on Denney Road are expected to be significantly improved with consolidation of driveways at the SW King Boulevard/SW Denney Road traffic signal and better on-site circulation for the school morning drop-off operation. As indicated, all study intersections would meet the City of Beaverton’s mobility targets during all three peak hours analyzed. This is discussed in further detail in the “Traffic Impacts” section below.

**Table 6: 2017 Total Intersection Operations – Peak Hour**

Intersection	Mobility Target	AM Peak			Afternoon School Peak			PM Peak		
	City	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
SW Lombard Ave/ SW Denney Rd	45 sec delay	4.3	D	0.36	3.5	B	0.33	4.5	C	0.47
West Project Driveway		0.4	A	0.51	0.7	A	0.31	0.2	A	0.43
SW King Blvd/ SW Denney Rd	0.98 V/C*, 65 sec delay	23.2	C	0.89	17.0	B	0.85	18.5	B	0.82
East Project Driveway	45 sec delay	0.8	A	0.42	0.3	A	0.29	0.0	A	0.44
SW Bel Aire Dr/ SW Denney Rd		3.5	B	0.45	1.4	A	0.28	1.3	A	0.43

Delay = average intersection vehicle delay (sec), LOS = intersection level of service, V/C = worst lane group volume-to-capacity ratio

**Bold and Red** indicates intersection does not meet mobility target

\* Applies to each lane group at intersection: V/C reported for eastbound lane group during a.m. peak hour, westbound left lane group during school afternoon peak and westbound during p.m. peak hour.

**2035 Total Traffic Conditions**

**Background Traffic Volumes**

The new Vose Elementary School is anticipated to reach its maximum enrollment of 750 students, and as a worst case scenario, it was assumed that the school would reach its capacity by 2017, so no change is expected to traffic volumes to and from the school site by 2035. However, to account

for background growth and future development in the area, a one percent annual average linear growth rate was assumed for through traffic on Denney Road.

**2035 Total Traffic Intersection Operations**

Future operating conditions were analyzed at the study intersections for the long-range forecast year (2035 total volume scenario which includes project trips). The study intersection operating conditions for the 2035 total traffic scenario during the all analyzed peak hours are listed in Table 7. As shown, all study intersections continue to meet City mobility targets for each of the peak periods analyzed, which is consistent with the 2035 background scenario.

**Table 7: 2035 Total Traffic Intersection Operations – Peak Hour**

Intersection	Mobility Target	AM Peak			Afternoon School Peak			PM Peak		
	City	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
SW Lombard Ave/ SW Denney Rd	45 sec delay	4.6	E	0.42	3.4	C	0.37	4.9	D	0.54
West Project Driveway		0.4	B	0.58	0.7	A	0.34	0.2	A	0.50
SW King Blvd/ SW Denney Rd	0.98 V/C*, 65 sec delay	28.4	C	0.93	17.4	B	0.81	23.0	C	0.91
East Project Driveway	45 sec delay	0.7	A	0.48	0.3	A	0.33	0.0	A	0.50
SW Bel Aire Dr/ SW Denney Rd		3.9	B	0.51	1.4	A	0.31	1.2	A	0.49

Delay = average intersection vehicle delay (sec), LOS = intersection level of service, V/C = worst lane group volume-to-capacity ratio

**Bold and Red** indicates intersection does not meet mobility target

\* Applies to each lane group at intersection: V/C reported for eastbound lane group during a.m. peak hour, westbound left lane group during school afternoon peak and westbound during p.m. peak hour.

**Site Plan**

The site plan provided by the Beaverton School District was reviewed to evaluate site access, intersection sight distance, bus loading and access, pedestrian and bicycle access, student pick-up/drop-off areas, site circulation, and parking needs. The evaluation of these issues includes the identification of associated on-site project modifications or improvements, which are explained in detail in Chapter 4 of this report and summarized in the “Project Mitigation Summary” section below.

## Project Mitigation Summary

The following list summarizes the key transportation impact findings associated with the proposed new Vose Elementary School.

### ***SW King Boulevard/SW Denney Road Mitigations***

- The existing traffic signal at SW King Boulevard/SW Denney Road currently does not include a south leg of the intersection. A south leg of this intersection will be added to serve as the main visitor/staff access to the site.

### ***East Project Access/SW Denney Road Mitigations***

- A proposed east school access on SW Denney Road that currently provides full access is not expected to meet City of Beaverton sight distance requirements due to a vertical curve to the east of the project site and due to sight obstructions on the property immediately east of the school site. However, a right-out only access does meet sight distance requirements to the west and is proposed to relieve congestion at the SW King Boulevard/SW Denney Road traffic signal, providing egress for visitors leaving the site toward OR 217.

### ***West Project Access***

- Sight distance at the west project access is restricted by vegetation on the property to the west of the school site. The Beaverton School District should work with the adjacent property owner and the City of Beaverton to provide (and maintain) clear sight distance at the proposed access.

### ***Site Improvements***

- It is recommended that guide signage be provided along SW Denney Road to direct staff, parents, buses, and visitors to the appropriate access locations during school hours.
- Half street improvements should be provided along the school's frontage of SW Denney Road. Frontage improvements should conform to the City of Beaverton's collector roadway standard<sup>7</sup> for a three lane cross-section, which includes 74 feet of right-of-way and a 46 foot paved section. The project would add approximately six feet to the paved section and construct new sidewalks along the frontage.
- A new approach to the existing SW King Boulevard/SW Denney Road intersection is recommended as part of the proposed project. This new approach, which is recommended to include one southbound lane (entering) and two northbound lanes (left and through/right) exiting the site would require modification to the existing traffic signal at SW King Boulevard/SW Denney Road.
- It is recommended that two lanes be provided on the south leg of the SW King Boulevard/SW Denney Road intersection for at least 200 feet, to make efficient use of the

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<sup>7</sup> City of Beaverton Engineering Standard Drawings. Minimum Collector Street Widths, 3 lanes.

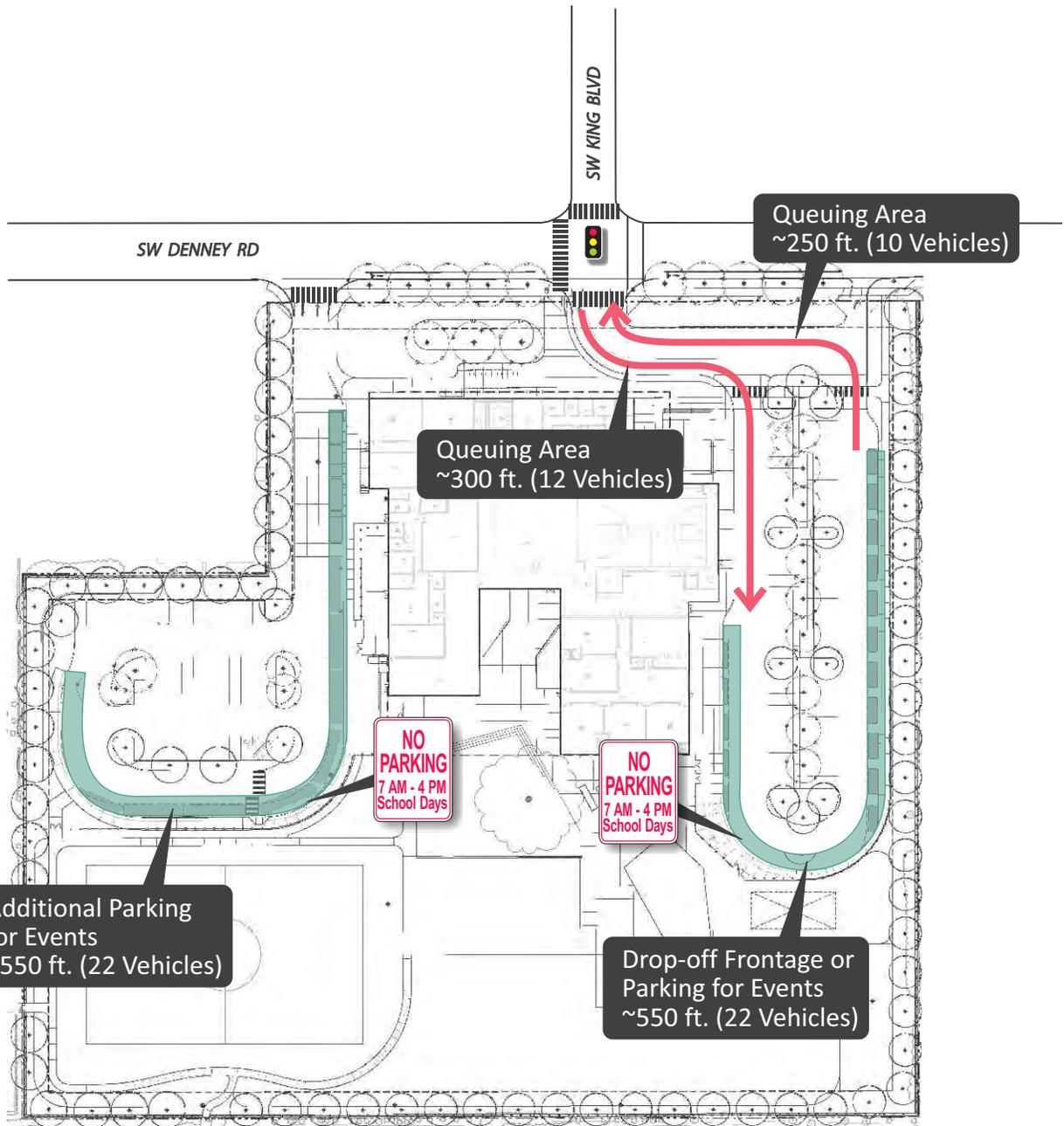
traffic signal by providing stacking for the number of vehicles that could exit the site during one signal cycle.

### **Site Access**

- The west site access is intended only for use by some staff (based on the available staff parking) and bus traffic during a typical school day. It is recommended that staff be assigned to the west parking lot to maximize parking efficiency and to avoid staff using the City street system as circulation to find a parking spot. This access should also be signed to indicate that it is for staff and bus use only during school hours. This lot would be available after school hours for non-staff vehicles.
- Signs should be provided on Denney Road adjacent to the west site access indicating that vehicles should keep clear of the driveway area to facilitate vehicles entering and/or exiting the west driveway during congested periods.
- It is recommended that the proposed eastern access on SW Denney Road be restricted to right-out only to help relieve operations at the SW King Boulevard/SW Denney Road traffic signal and to allow a secondary exit for vehicles heading east. A traffic separator should be constructed on Denney Road to restrict disallowed turn movements. Sight distance restrictions at this location preclude the ability for left-turns out of the site.
- It is recommended that a path analysis be conducted on site to ensure that buses can make the necessary turn maneuvers.
- An Engineering Design Modification will be required to the driveway spacing standards, since there are several driveways within the City's access spacing standard of 180 feet on a collector roadway.
- The Beaverton School District should direct school buses to travel via SW Allen Boulevard and SW Lombard Avenue to access Vose Elementary School during the afternoon school peak hour in order for buses to enter the site on a right-turn movement.

### **Site Circulation and Parking**

- The current site plan shows 107 parking spaces, including approximately 77 parking spaces, for staff at full occupancy, and 30 visitor spaces. To accommodate parking needs for events, it is recommended that the internal drop-off areas be utilized during events, adding up to 44 spaces, for a net total of up to 151 spaces, including drop-off areas in both the west and east parking lots.
- Approximately 550 feet of total drop-off frontage is provided, however, approximately 300 feet of queuing space is available between the site access and the drop-off area, and approximately 250 feet of queuing space is available between the drop-off area and the site egress (see Figure 3). This allows for a total of approximately 1,100 feet of on-site queuing/drop-off area, which could accommodate as many as 44 vehicles on-site at once. It is anticipated that most queuing associated with student drop-off and pick-up will be accommodated on-site. The signal timing of the SW King Boulevard/SW Denney Road traffic signal can be adjusted during school peaks to provide efficient access to and from the school during these periods.



**LEGEND**

 - Traffic Signal

**DKS**



No Scale

**Figure 3**

**PROPOSED SITE PLAN  
ON-SITE VEHICLE CAPACITY**

Source: DLR Group and Cameron McCarthy

***Pedestrian and Bicycle Access/School Crosswalks***

- A minimum of 84 bicycle parking spaces should be provided near primary school entrances to meet City of Beaverton Code.<sup>8</sup>
- Sidewalks along the project frontage of SW Denney Road should be planned to accommodate both pedestrians (including those with disabilities) and bicyclists at a width of six feet, based on the City's collector street standard.

***Transportation Demand Management***

- The draft Transportation Demand Management (TDM) Plan is provided in Appendix M.

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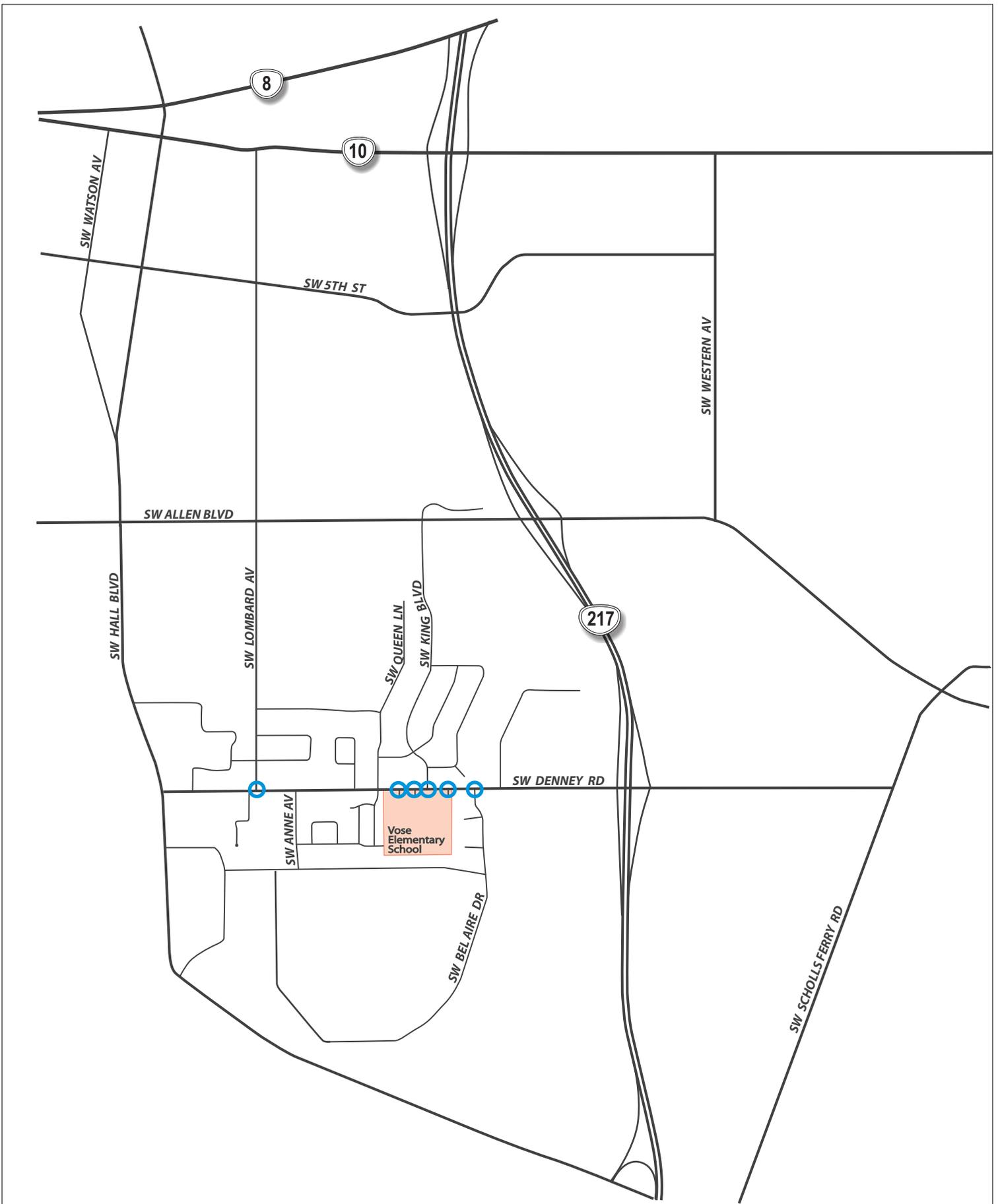
<sup>8</sup> Beaverton Development Code, Section 60.30.10.5.B, Parking Ratio Requirements for Bicycles. No Short Term parking required. Long Term required: 1 space per 9 students.

## I. PROPOSED DEVELOPMENT

The project involves constructing a new elementary school for the Beaverton School District on the site of the existing Vose Elementary School, which will be replaced, located on the south side of the SW Denney Road/SW King Boulevard intersection in Beaverton, Oregon. The site is currently zoned R7 (Urban Standard Density Residential) by the City of Beaverton and the elementary school is considered a conditional use under this land use zoning.

The area that surrounds the proposed elementary school site is primarily made up of single family neighborhoods to the south, west and north of the site with commercial/industrial land uses to the east of the school's site. Figure 4 shows the location of the land uses that surrounds the proposed project site. The elementary school is anticipated to open in September 2017. The proposed elementary school would have a maximum student enrollment of 750 students and approximately 77 staff members. This student capacity would be similar to other elementary schools within the Beaverton School District. The site would also house playground and athletic facilities including an indoor gymnasium and a U12 soccer field.

Proposed access to the site would be reconfigured to utilize the SW King Boulevard/SW Denney Road traffic signal as the primary access to the site for staff and visitors. Two additional driveways will be provided, with a driveway west of the traffic signal providing access for buses and some staff parking. A driveway to the east of the traffic signal will be configured as a right-out only access, allowing convenient egress from the site for vehicles heading eastbound on SW Denney Road.



**LEGEND**

○ - Study Intersections

**DKS**

**Figure 4**

**Vicinity Map &  
Study Intersection Influence Area**

**Beaverton Vose Elementary School**

## II. EXISTING CONDITIONS

This chapter provides documentation of existing study area transportation conditions, including the project site, study area roadway network, pedestrian and bicycle facilities, and existing traffic volumes and intersection operations. Supporting details are provided in the Appendix.

### Influence Area

The study area was selected per City of Beaverton guidelines<sup>9</sup> and is intended to capture transportation impacts related to the proposed project. The proposed development is a reconstructed elementary school on the south side of the SW Denney Road/SW King Boulevard intersection within the Beaverton School District. Figure 1 shows the project site and surrounding study area including the following six study intersections:

1. SW Denney Road/SW King Boulevard
2. SW Denney Road/West School Driveway (existing)
- 2a. SW Denney Road/Middle School Driveway (existing)
3. SW Denney Road/East School Driveway (existing)
4. SW Denney Road/SW Lombard Avenue
5. SW Denney Road/SW Bel Aire Drive

### Pedestrian, Bicycle, and Transit Systems

The study area is serviced by TriMet, however, the nearest bus routes are approximately a half mile away (Routes 76 – Beaverton/Tualatin & 78 – Beaverton/Lake Oswego, both traveling north-south on Hall Boulevard) and over three-quarters of a mile away (Routes 56 – Scholls Ferry Road & 92 – South Beaverton Express, both traveling north-south on Scholls Ferry Road). All of these routes travel at approximately ½ hour headways, and the South Beaverton Express (Route 92) provides weekday rush-hour service only (morning to Portland City Center and evening to Murrayhill). The Beaverton School District provides bus service for students before and after school.

Existing peak period (7-9 a.m., 2-6 p.m.) traffic counts at nearby intersections show that very few bicyclists travel along SW Denney Road during the afternoon school peak hour (2:30-3:30 p.m), typically fewer than five. Similar numbers of bicyclists were counted along SW Denney Road during the morning and evening peak hour<sup>10</sup>. Bike lanes are currently only provided along SW Denney Road adjacent to more recent developments. Pedestrian activity along the collector roadway is much higher, particularly near the school site. The intersection of SW Denney Road/SW King Boulevard experienced the most pedestrian activity, primarily associated with the

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<sup>9</sup> City of Beaverton guidelines indicate that the impact area include intersections where site generated traffic equals or exceeds 5% of peak hour traffic.

<sup>10</sup> Intersection turn movement counts collected at study intersections on May 13, 14 & 19, and October 13-15, 2015 between 7-9 a.m., 2-4 p.m. and 4-6 p.m.

existing Vose Elementary School, with a peak of about 330 pedestrians crossing the intersection during the school peak hour.

The intersection of SW Denney Road/SW King Boulevard is signalized and features ADA ramps and controlled pedestrian crossings with pushbuttons and pedestrian countdown timers across the north and west legs. The pedestrian crossing along the east leg is closed. Existing pedestrian and bicycle roadway facilities are summarized in Table 8.

## Study Area Roadway Network Characteristics

Key roadways in the study area are summarized in Table 8 along with their existing characteristics. As shown, all surrounding roadways within the study area network are under the jurisdiction of the City of Beaverton.

**Table 8: Existing Roadway Network Characteristics**

Roadway	Roadway Jurisdiction	Roadway Classification <sup>11</sup>	Cross-Section	Posted Speed	Pedestrian Facilities	Bicycle Facilities
SW Denney Rd	City of Beaverton	Collector	3 Lanes	35 mph	Sidewalks	None
SW King Boulevard	City of Beaverton	Neighborhood Route	2 Lanes	25 mph	Sidewalks	None
SW Bel Aire Drive	City of Beaverton	Neighborhood Route	2/3 Lanes	25 mph	Sidewalks	None
SW Lombard Avenue	City of Beaverton	Collector	2/3 Lanes	35 mph	None	Bike Lanes
SW Queen Lane	City of Beaverton	Local	2 Lanes	25 mph	None	None

## Study Peak Period Scenarios

Due to travel characteristics of elementary schools, this traffic study evaluates three peak period scenarios. The a.m. and p.m. peak periods are typical peak periods for a transportation impact analysis since this is when traffic volumes are typically greatest on surrounding roadways. The a.m. peak period is typically the peak travel period for elementary school traffic (school drop-off activity) and aligns with the a.m. peak of the adjacent transportation system. The p.m. peak period for an elementary school however does not typically align with the p.m. peak of the adjacent transportation system. The typical elementary school peak usually falls between 2 p.m. and 4 p.m. during school let out, whereas the p.m. peak of the transportation system usually falls between 4 p.m. and 6 p.m. As a result, this study evaluates all three periods including the afternoon school peak to capture the peak end-of-school demand and the surrounding transportation system p.m. peak.

<sup>11</sup> 2020 Washington County Transportation System Plan, Figure 4E, May 2013.

## Existing Traffic Volumes

Existing a.m., afternoon school, and p.m. peak period traffic operations were analyzed at the following study intersections:

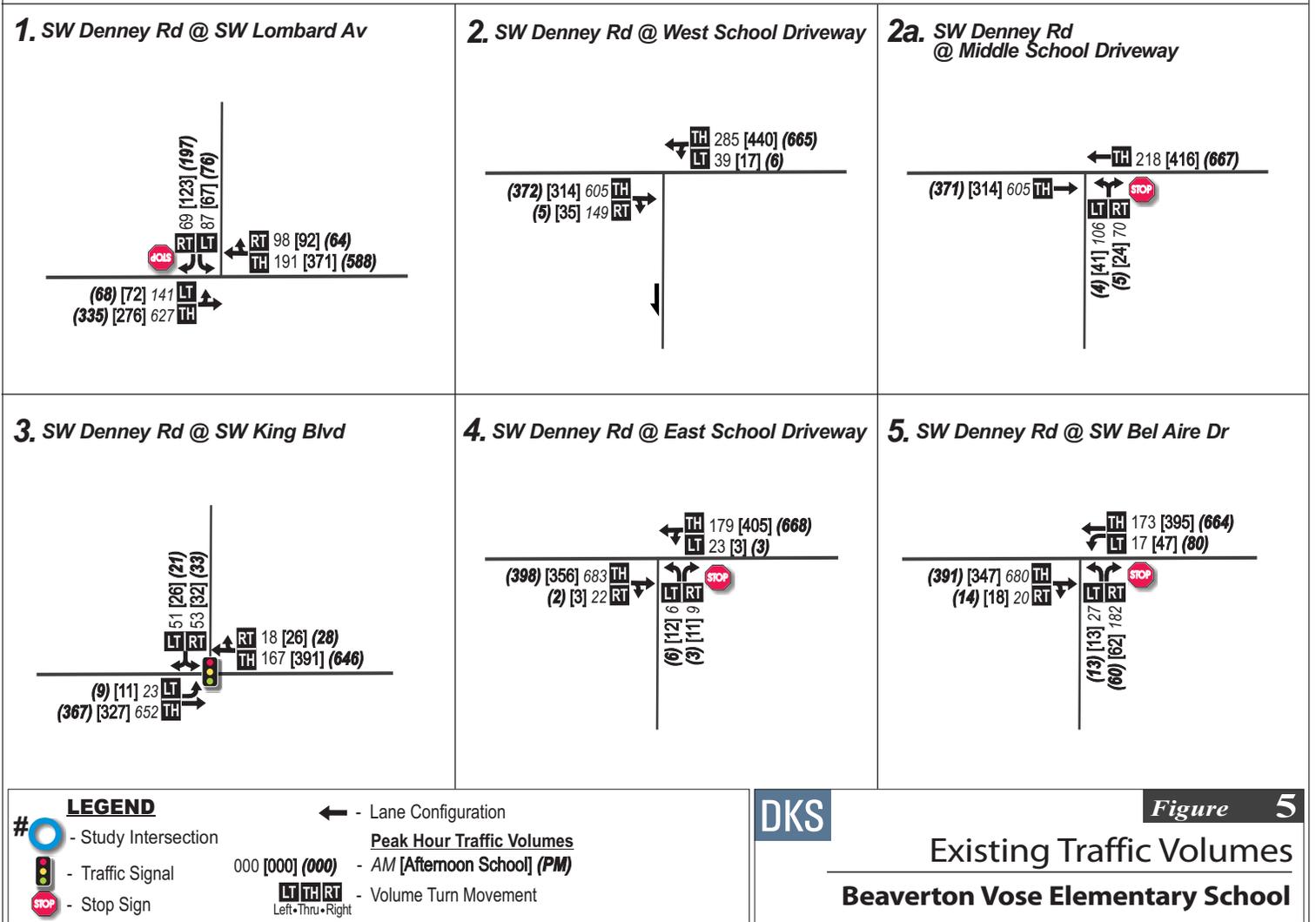
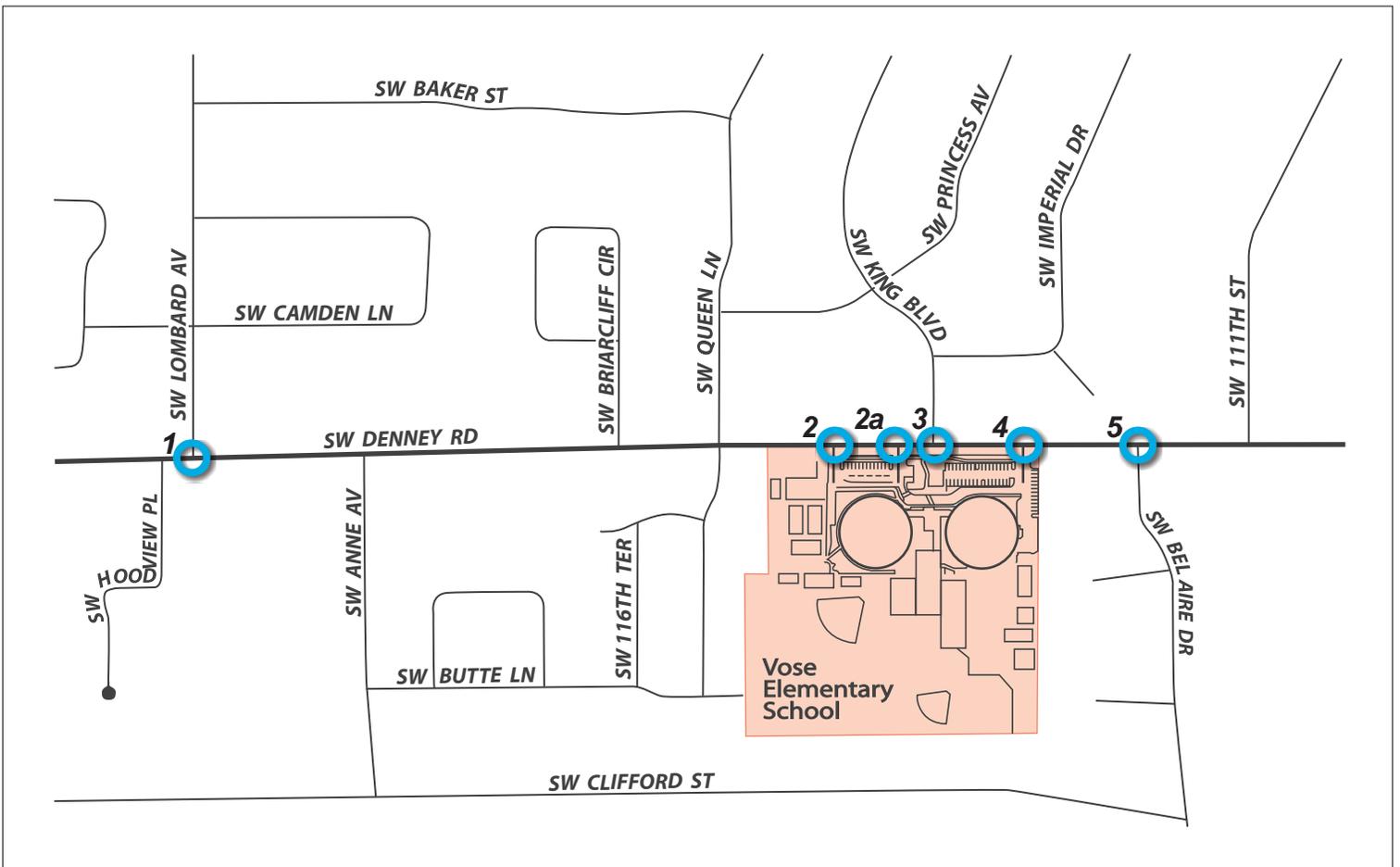
1. SW Denney Road/SW King Boulevard
2. SW Denney Road/West School Driveway (existing)
- 2a. SW Denney Road/Middle School Driveway (existing)
3. SW Denney Road/East School Driveway (existing)
4. SW Denney Road/SW Lombard Avenue
5. SW Denney Road/SW Bel Aire Drive

To perform the intersection analysis, traffic counts were collected during the a.m. (7:00 to 9:00 a.m.), afternoon school (2:00 to 4:00 p.m.) and p.m. (4:00 to 6:00 p.m.) peak periods over three weekdays in the spring and fall of 2015<sup>12</sup>. Intersection turn movement volumes were found to be consistent over the analysis period; therefore turn movement counts were averaged over the three days of collection and are shown in Figure 5. Existing turn movement counts are included in Appendices B through E.

The purpose of intersection analysis is to determine if the transportation network operates within desired performance levels as required by City of Beaverton mobility targets. Intersections are the focus of the analysis because they are the controlling bottlenecks of traffic flow and the ability of a roadway system to carry traffic efficiently is nearly always diminished in their vicinity.

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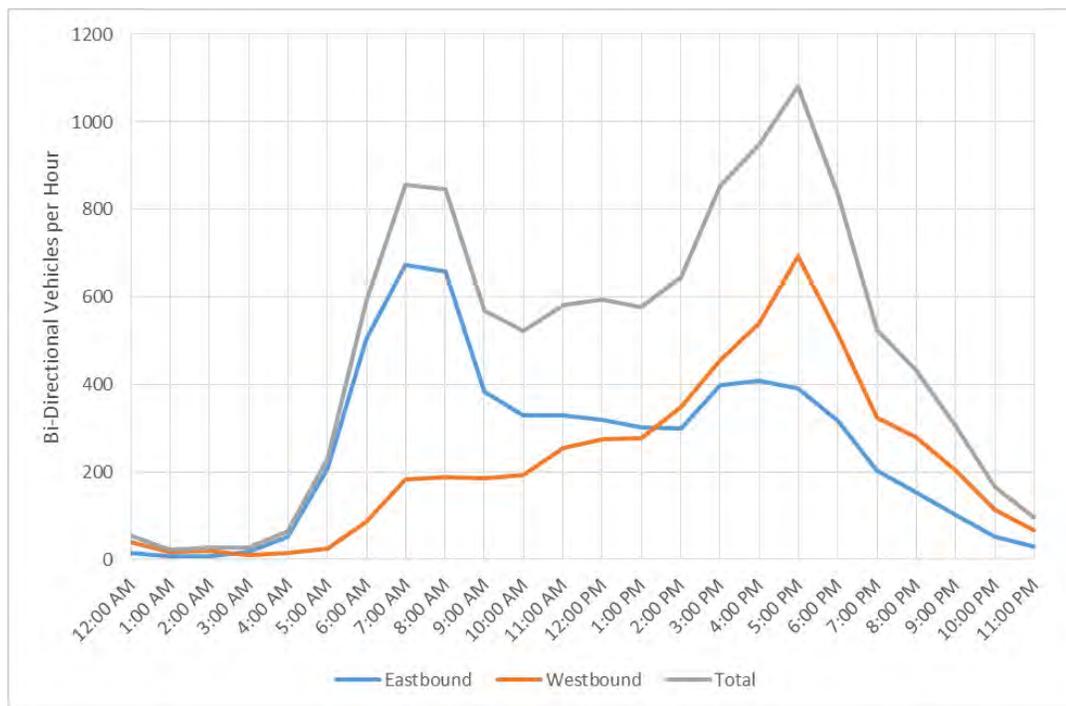
<sup>12</sup> The intersections at SW King Boulevard and the existing driveways were conducted on May 13<sup>th</sup>, 14<sup>th</sup> and 19<sup>th</sup>, 2015 (Tuesday, Wednesday, Tuesday) and the intersections at SW Lombard Avenue and SW Bel Aire Drive were conducted on October 13<sup>th</sup>, 14<sup>th</sup> and 15<sup>th</sup>, 2015 (Tuesday – Thursday).



**Existing Daily Traffic Volumes**

Daily traffic volumes (24-hour) were collected along SW Denney Road to understand travel characteristics in the study area from October 13th to October 15th, 2015. These counts are included in Appendix E.

The roadway counts were collected east of the east school driveway and west of SW Bel Aire Road on SW Denney Road. Figure 6 shows a weekday traffic volume plot (a three-day average from Tuesday through Thursday) for SW Denney Road. The time referenced in the figure is the hour beginning. As shown, traffic volumes along SW Denney Road are greater in the p.m. peak than in the a.m. peak. Bi-directional traffic volumes during these peaks reach almost 1,100 vehicles per hour while weekday daily traffic volumes reach over 11,000 vehicles (bi-directional). Along SW Denney Road, traffic volumes peak around 850 vehicles per hour in the a.m. peak, and increase to nearly 1,100 vehicles per hour in the p.m. peak (bi-directional). Traffic volumes drop significantly during the midday period (9:00 a.m. to 2:00 p.m.). Around 2:00 p.m., traffic volumes begin to climb to the p.m. peak hour before dropping off substantially after 6:00 p.m. The a.m. peak hour was found to be between 7:00 to 8:00, the afternoon peak is between 3:00 and 4:00 p.m., and the p.m. peak hour is from 5:00 to 6:00 p.m.



**Figure 6: Weekday Hourly Traffic Volumes for SW Denney Road (east of project site and west of SW Bel Aire Avenue)**

**Existing 85<sup>th</sup> Percentile Speeds**

The posted speed along SW Denney Road adjacent to the project site is posted at 35 miles per hour (mph), with a school speed zone of 20 miles per hour when school is in session. As part of the data collection, 24-hour vehicle speeds were collected along SW Denney Road from October 13 to October 15, 2015. The data was collected on SW Denney Road just east of the school site and just west of SW Bel Aire Drive. Table 9 indicates the measured 85<sup>th</sup> percentile speeds (commonly used to set posted speed limits) along this facility.

**Table 9: Measured 85<sup>th</sup> Percentile Speeds**

Roadway	Posted Speed	85 <sup>th</sup> Percentile Speed	
SW Denney Road	35 mph with 20 mph School Zone adjacent to School	Eastbound	34 mph
		Westbound	33 mph

As shown in the table, speeds on SW Denney Road were found to be consistent with the posted speeds during the collection period (includes weekday traffic).

**Intersection Operations**

Before the analysis results of the study intersections are presented, discussion is provided for two important analysis topics: intersection performance measures (definitions of typical measures) and required operating standards (as specified by the agency with roadway jurisdiction).

**Intersection Performance Measures**

Level of Service (LOS) and volume-to-capacity (V/C) ratios are two commonly used performance measures that provide a gauge of intersection operations. Agencies often incorporate these performance measures into their mobility targets. Descriptions are included in Appendix H and summarized below:

- **Level of Service (LOS):** A “report card” rating (A through F) based on the average delay (seconds per vehicle) experienced by vehicles at the intersection. LOS A, B, and C indicate conditions where traffic moves without significant delays over periods of peak hour travel demand. LOS D and E are progressively worse operating conditions. LOS F represents conditions where average vehicle delay has become excessive and demand has exceeded capacity; this condition is typically evident in long queues.
- **Volume-to capacity (V/C) ratio:** A decimal representation (between 0.00 and 1.00) of the proportion of capacity that is being used at a turn movement, approach leg, or intersection. A lower ratio indicates smooth operations and minimal delays. As the ratio approaches 1.00, congestion increases and performance is reduced. If the ratio is greater than 1.00, the turn movement, approach leg, or intersection is oversaturated and usually results in excessive queues and long delays.

### Agency Mobility Targets

Agencies typically have established targets for intersection operations during peak periods, which are commonly known as mobility targets. The study intersections along SW Denney Road fall under the jurisdiction of the City of Beaverton. The City of Beaverton’s Development Code<sup>13</sup> indicates that a signalized intersection should operate with a peak hour average control delay no longer than 65 seconds per vehicle and with a V/C ratio no greater than 0.98 for each lane group. For an unsignalized intersection (two-way or an all-way stop controlled intersection), the peak hour average control delay shall be no greater than 45 seconds per vehicle.

### Existing Operating Conditions

Existing traffic operations at the study intersections were analyzed for the a.m., afternoon school, and p.m. peak hours based on the 2000 Highway Capacity Manual methodology for signalized and unsignalized intersections.<sup>14</sup> All intersections, with the exception of SW King Boulevard/SW Denney Road are unsignalized (two-way stop controlled) intersections. The intersection of SW King Boulevard/SW Denney Road is signalized. Existing peak hour operating results are compared with the City of Beaverton’s mobility targets as shown in Table 10.

**Table 10: 2015 Existing Intersection Operations – Peak Hour**

Intersection	Mobility Target	AM Peak			Afternoon School Peak			PM Peak		
	City	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
SW Lombard Ave/ SW Denney Rd	45 sec delay	7.2	C	0.66	4.4	B	0.33	5.7	C	0.46
West School Driveway		0.4	A	0.50	0.2	A	0.31	0.0	A	0.43
Middle School Driveway		5.1	A	0.58	1.3	A	0.28	0.1	A	0.43
SW King Blvd/ SW Denney Rd	0.98 V/C*, 65 sec delay	<b>92.6</b>	<b>F</b>	0.88	10.5	B	0.50	13.1	B	0.74
East School Driveway	45 sec delay	0.6	A	0.48	0.5	A	0.27	0.2	A	0.42
SW Bel Aire Dr/ SW Denney Rd		3.8	A	0.44	1.5	A	0.27	1.5	A	0.42

Delay = average intersection vehicle delay (sec), LOS = intersection level of service, V/C = worst lane group volume-to-capacity ratio

**Bold and Red** indicates intersection does not meet mobility target

\* Applies to each lane group at intersection: V/C reported for eastbound lane group during a.m. peak, westbound lane group during afternoon school peak and westbound lane group during p.m. peak.

All study intersections currently meet the City of Beaverton’s mobility standards during the a.m., afternoon school, and p.m. peak hours, except the SW King Boulevard/SW Denney Road intersection during the a.m. peak hour when the Vose Elementary School is open. To validate existing peak hour intersection operations, a site visit was conducted on May 14, 2015 to observe

<sup>13</sup> Beaverton Development Code, Special Requirements, Section 60.55.10.7, June 2012.

<sup>14</sup> 2000 Highway Capacity Manual, Transportation Research Board, Washington DC, 2000.

operations at study intersections during each of the three peak periods analyzed, and again on October 27, 2015 during the a.m. peak period. Field observations noted extensive vehicle queue lengths during the a.m. peak hour. The eastbound queue at SW King Boulevard/SW Denney Road was estimated to extend back to SW Anne Avenue, or further, several times over a 15-20 minute period between 7:30-8:00 a.m. when school is in session. However, once school starts, eastbound queues are virtually non-existent.

The eastbound queue on Denney forms because there is inadequate stacking on the existing Vose Elementary School site for student drop-off in the morning, and due to the close spacing of the Vose Elementary School egress driveway and the SW King Boulevard/SW Denney Road traffic signal, which are separated by less than 50 feet. Denney Road is signed "Do Not Block Intersection" in front of the middle school driveway, which creates inefficiencies in getting eastbound through traffic through the traffic signal. Many vehicles queued eastbound are through vehicles that are queued behind vehicles waiting to turn into the Vose parking lot.

The Vose parking lot is striped with two lanes for drop-off. The inside lane, closest to the school is used for student drop-off, while the outside lane is occasionally used to bypass the inside lane. However, most vehicles don't use the bypass lane due to lack of stacking space at the SW Denney Road access, instead waiting for vehicles ahead of them to unload. A typical vehicle takes about 1-1 ½ minutes to enter the site, drop off their student(s) and approach SW Denney Road and there is only room for about five vehicles in the drop-off line at a time. Significant delays and queues were not observed during the afternoon school or p.m. peak hours.

## Safety Evaluation

The most recent three years of crash records (2012-2014) for the study area intersections were obtained from the Oregon Department of Transportation (ODOT) crash database and are included in Appendix G.<sup>15</sup> During this three year period, there were a total of three reported crashes located at two of the six existing study intersections. One injury C (possible injury) crash was reported at the intersection of Lombard Avenue/SW Denney Road where a vehicle failed to observe a stop sign, resulting in a turning crash. No fatal crashes were reported at any of the study intersections during this time period.

Observed crash rates at the study intersections were calculated to identify problem areas in need of safety mitigation. The total number of crashes experienced at an intersection is typically proportional to the number of vehicles entering it. Therefore, a crash rate describing the frequency of crashes per million entering vehicles (MEV) is used to evaluate the intersection. This observed crash rate at each site was then compared to a calculated critical crash rate that is unique to each site and based on the critical crash rate procedure in the Highway Safety Manual

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<sup>15</sup> Oregon Department of Transportation, Crash Data System, <https://zigzag.odot.state.or.us>

(HSM) Network Screening chapter.<sup>16</sup> Intersections that exceed their respective critical crash rate are flagged for further review.

Table 11 shows total reported collisions at each study intersection as well as the calculated observed and critical crash rates. As shown, neither intersection had an observed crash rate that exceeded the respective critical crash rate; therefore it is recommended that no further safety analysis is required.

**Table 11: Crash History and Calculated Crash Rates (2011-2013)**

Intersection	Reported Crashes				Observed Crash Rate	Critical Crash Rate
	Fatal	Injury	PDO	Total		
SW Lombard Ave/SW Denney Rd	0	1	1	2	0.13	0.293
SW Bel Aire Ave/SW Denney Rd	0	0	1	1	0.07	0.293

**Bold and Red** indicate intersection observed crash rate exceeds the calculated critical crash rate based on HSM methodology.

### **Corridor Safety Evaluation**

The most recent three years of crash records (2012-2014) for the SW Denney Road corridor within the study vicinity were also obtained from the Oregon Department of Transportation (ODOT) crash database and are included in Appendix G.<sup>17</sup> During this three year period, there were a total of three reported crashes located along SW Denney Road from west of SW Lombard Street to east of SW Bel Aire Drive. No injury A (incapacitating injury) or injury B (evident injury) crashes were reported, however, there was one injury C (possible injury).

<sup>16</sup> 2010 *Highway Safety Manual* (HSM), Chapter 4, Page 4-11: The critical crash rate is a threshold value that allows for relative comparison among site with similar characteristics. The critical crash rate depends on the average crash rate at similar sites, traffic volume, and a statistical constant that represents a desired level of significance.

<sup>17</sup> Oregon Department of Transportation, Crash Data System, <https://zigzag.odot.state.or.us>

### III. BACKGROUND TRAFFIC FORECAST

This chapter provides documentation of the expected background traffic volumes and intersection operations analysis for the 2017 (Fall) year of opening.

#### 2017 Year of Opening

The reconstructed Vose Elementary School is anticipated to be open and be fully operational by September 2017. Based on conversations with City staff<sup>18</sup>, there are no approved but not yet built projects within the study area. Therefore; to account for background growth and future development in the area, a one percent yearly linear average growth rate was used to forecast the future background traffic volumes. **Error! Reference source not found.**

### IV. TRAFFIC IMPACTS

This chapter documents the impacts that the new elementary school would have on the surrounding transportation system. This analysis includes project trip generation, distribution, and future operating conditions with the proposed project. The focus of the impact analysis is on the existing study intersections, which have been previously documented including the following three modified site access points:

1. SW Denney Road/SW King Boulevard (Main Site Access – Staff/Visitors)
2. SW Denney Road/West School Driveway (Bus and Staff Access)
3. SW Denney Road/East School Driveway (Restricted to Right-Out Only)
4. SW Denney Road/SW Lombard Avenue
5. SW Denney Road/SW Bel Aire Drive

The proposed east access along SW Denney Road is proposed to be restricted to right-out only due to sight distance restrictions. The proposed SW King Boulevard access along SW Denney Road is proposed to provide access to the main visitor and staff parking lot, while the west access would provide bus access to site along with a bus and staff only parking lot (only a portion of the staff would park in this lot). Additionally, a right-out only access is proposed at the east end of the site along SW Denney Road.

#### Proposed Reconstructed Elementary School

The proposed development is a new elementary school on the south side of SW Denney Road within the Beaverton School District. The elementary school will replace an existing elementary school on the site, which has an existing enrollment of 691 students, and will have a maximum enrollment (capacity) of 750 students. The site plan is shown in Figure 10 and provided in Appendix A shows the modified access locations.

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<sup>18</sup> Email from City of Beaverton staff, October, 16, 2015.

### Trip Generation

Trip generation is typically based on rates published in the *ITE Trip Generation Manual*<sup>19</sup> unless there is reason to suspect that local data may differ from the published rates or there are minimal studies. Because local data was available for the existing school site, they were compared to ITE rates. Trip generation rates were developed from new traffic counts collected at the existing Vose Elementary School as part of this study (see Appendix K). The local rates are compared to rates from the *ITE Trip Generation Manual* in Table 12.

**Table 12: Elementary School Trip Generation Rates Peak – Peak Hour**

Source	Study Period	Trip Rate (per student)	In%	Out %
<i>ITE Trip Generation Manual</i> (Code 530)	AM Peak	0.45	55%	45%
	Afternoon School Peak	0.28	45%	55%
	PM Peak	0.15	49%	51%
Local Data	AM Peak	0.62	56%	44%
	Afternoon School Peak	0.34	47%	53%
	PM Peak	0.06	26%	74%

The *ITE Trip Generation Handbook*<sup>20</sup> provides a methodology for determining if the ITE rates, local rates, or a combination of the rates should be used for analysis (see Appendix K for the methodology). If the measured local rates are within 15% of the ITE rates, then the ITE rates are valid for local use. If not, the local rates should be applied solely, if warranted, or in combination with the ITE rates. The local data used for this study is not within 15% of the ITE rates. Therefore, the *ITE Trip Generation Handbook* suggests that local rates should be used. Furthermore, since the use and site are both existing, evaluation of the current site should provide the best representation of anticipated travel characteristics and mode split.

The school expects to enroll approximately 750 students at capacity and, as a worst case scenario, the full capacity was assumed when it re-opens in 2017, which is an additional 59 students as compared to current enrollment. Table 13 presents the resulting trip generation for Vose Elementary School.

**Table 13: Vose Elementary School Trip Generation (AM/PM Peak Hour)**

Peak Hour	Enrollment Increase	Rate (trips/student)	Directional Distribution		New Project Generated Trips		
			In	Out	In	Out	Total
Morning	59	0.62	56%	44%	21	16	37
Afternoon		0.34	47%	53%	9	11	20
Evening		0.06	26%	74%	1	3	4

<sup>19</sup> *ITE Trip Generation Manual*, Institute of Transportation Engineers, 9<sup>th</sup> Edition, 2012.

<sup>20</sup> *ITE Trip Generation Handbook*, Institute of Transportation Engineers, 2<sup>nd</sup> Edition, 2004.

## Trip Distribution

Trip distribution provides an estimation of where the additional project trips would be coming from and going to. It is given as percentages at key gateways to the study area and is used to route project trips through the study area intersections. Trip distribution percentages are shown in Figure 7 and the resulting additional project traffic volumes for the year of opening (2017 total volume scenario) are shown in Figure 8.

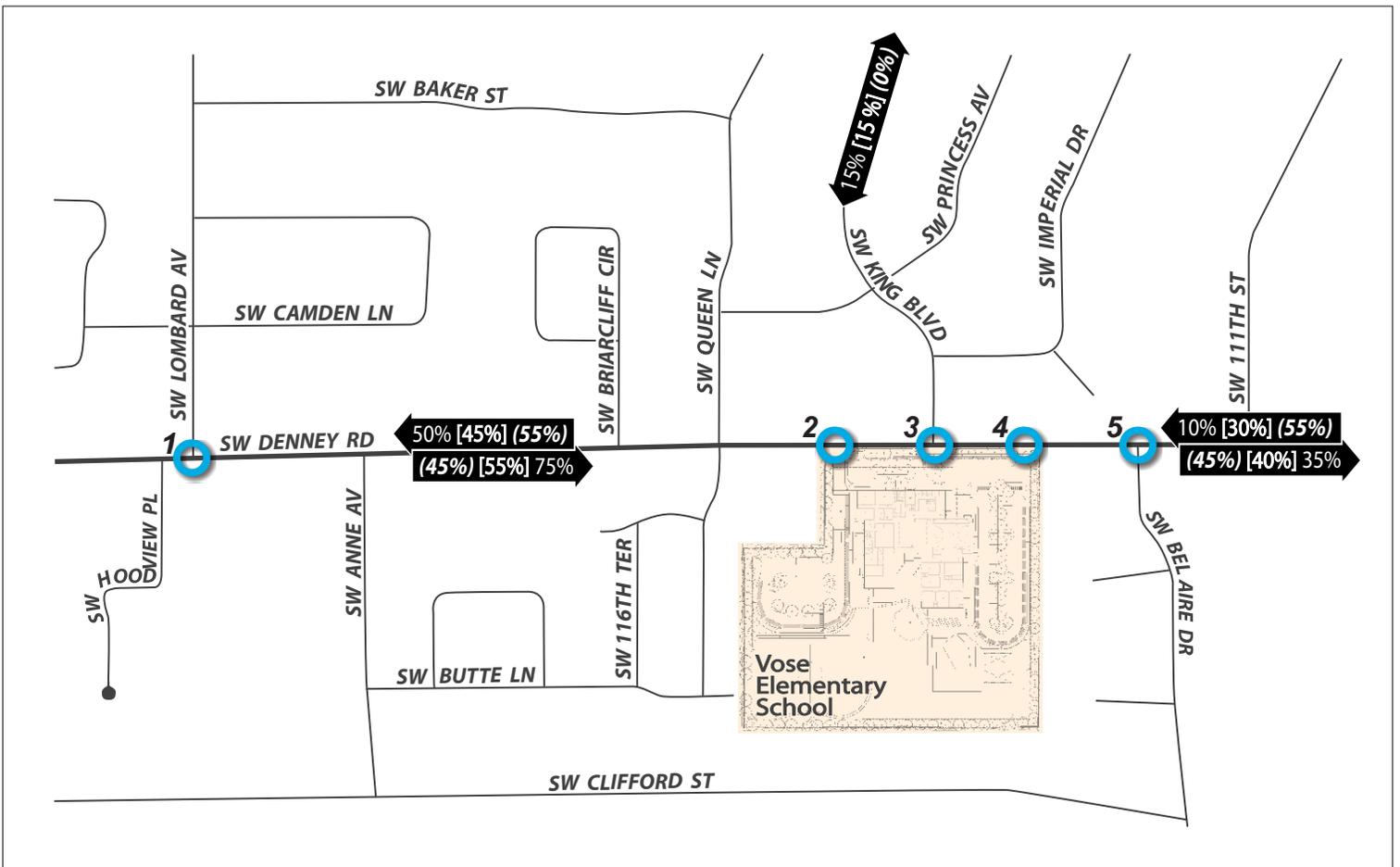
Trip distribution was estimated based on existing traffic counts in the vicinity of the proposed elementary school, combined with an estimate of the trips that would shift from the neighborhood to the north due to the availability of more on-site parking and improved circulation.

Bus routing information to and from the school was provided by the Beaverton School District during all peak hours analyzed. During the a.m. peak hour, all buses arrive from the west after picking up students and exit to the east (to McKay Elementary School on Scholls Ferry Road). During the afternoon school peak hour the buses are assumed to arrive from the west along SW Denney Road. They are coming from the 5<sup>th</sup> Avenue yard and the school district should direct them to travel to Vose Elementary via either SW Lombard Avenue or SW Hall Boulevard, so they can enter the site on a right-turn. Leaving the site, buses would turn left onto SW Denney Road to drop students off during the afternoon school peak.

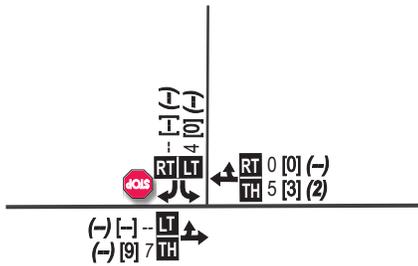
School related trips would be expected to increase daily traffic volumes along SW Denney Road by less than five percent during the a.m. peak hour, and less than one percent during the afterschool and p.m. peak hours.

## 2017 Total Traffic Volumes

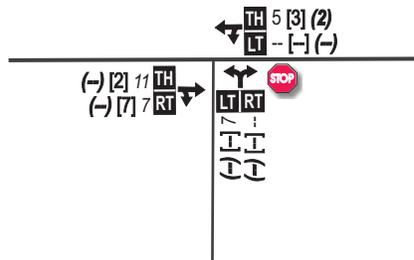
Future operating conditions were analyzed at the study intersections for the year of opening (2017 total volume). Future traffic volumes were estimated at the study intersections in order to access traffic conditions with future growth and project traffic. Future year 2017 total traffic volume forecasts were developed using a one percent per year growth and include the trips generated from the worst case enrollment of 750 students at day of opening. The weekday a.m., afternoon school, and p.m. peak hour traffic volumes used to analyze the 2017 total traffic scenario are shown in Figure 8. The heavy vehicle percentage was adjusted for select movements to account for the school buses impact on intersection operations.



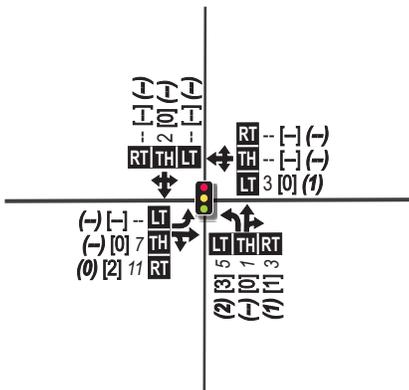
**1. SW Denney Rd @ SW Lombard Av**



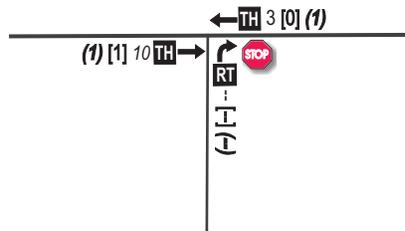
**2. SW Denney Rd @ West School Driveway**



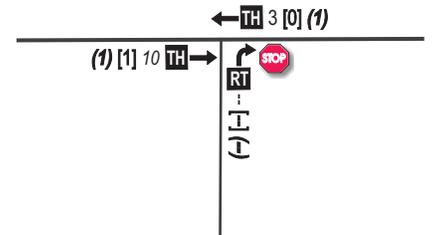
**3. SW Denney Rd @ SW King Blvd**



**4. SW Denney Rd @ East School Driveway**



**5. SW Denney Rd @ SW Bel Aire Dr**



**# LEGEND**

- Study Intersection
- Traffic Signal
- Stop Sign

- Lane Configuration
- 000 [000] (000) - Peak Hour Traffic Volumes  
AM [Afternoon School] (PM)
- Volume Turn Movement  
Left • Thru • Right

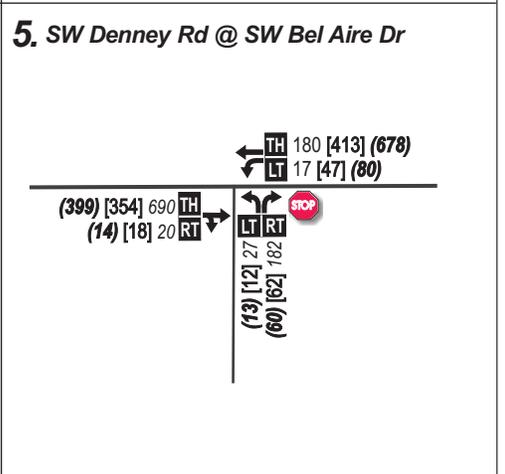
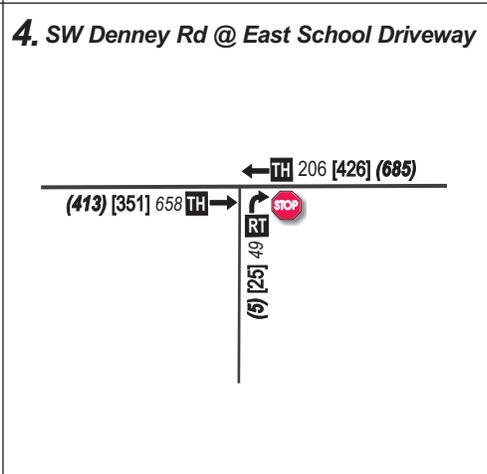
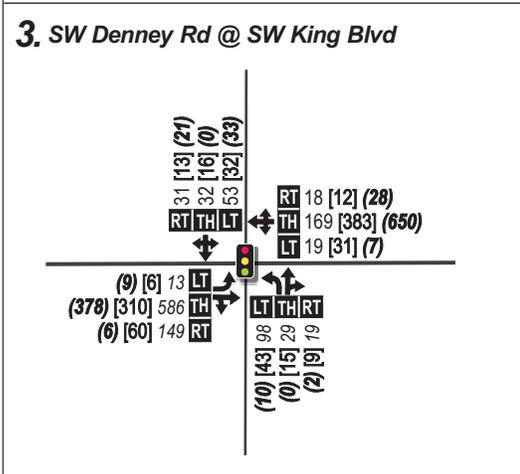
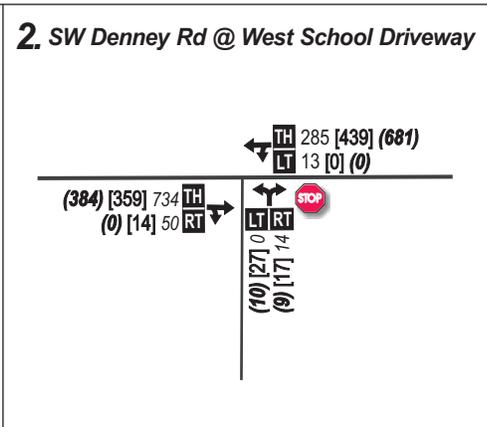
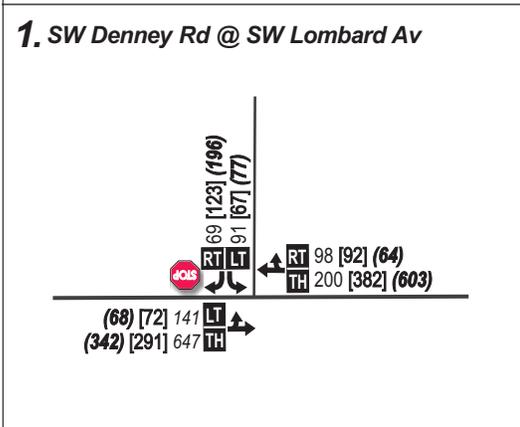
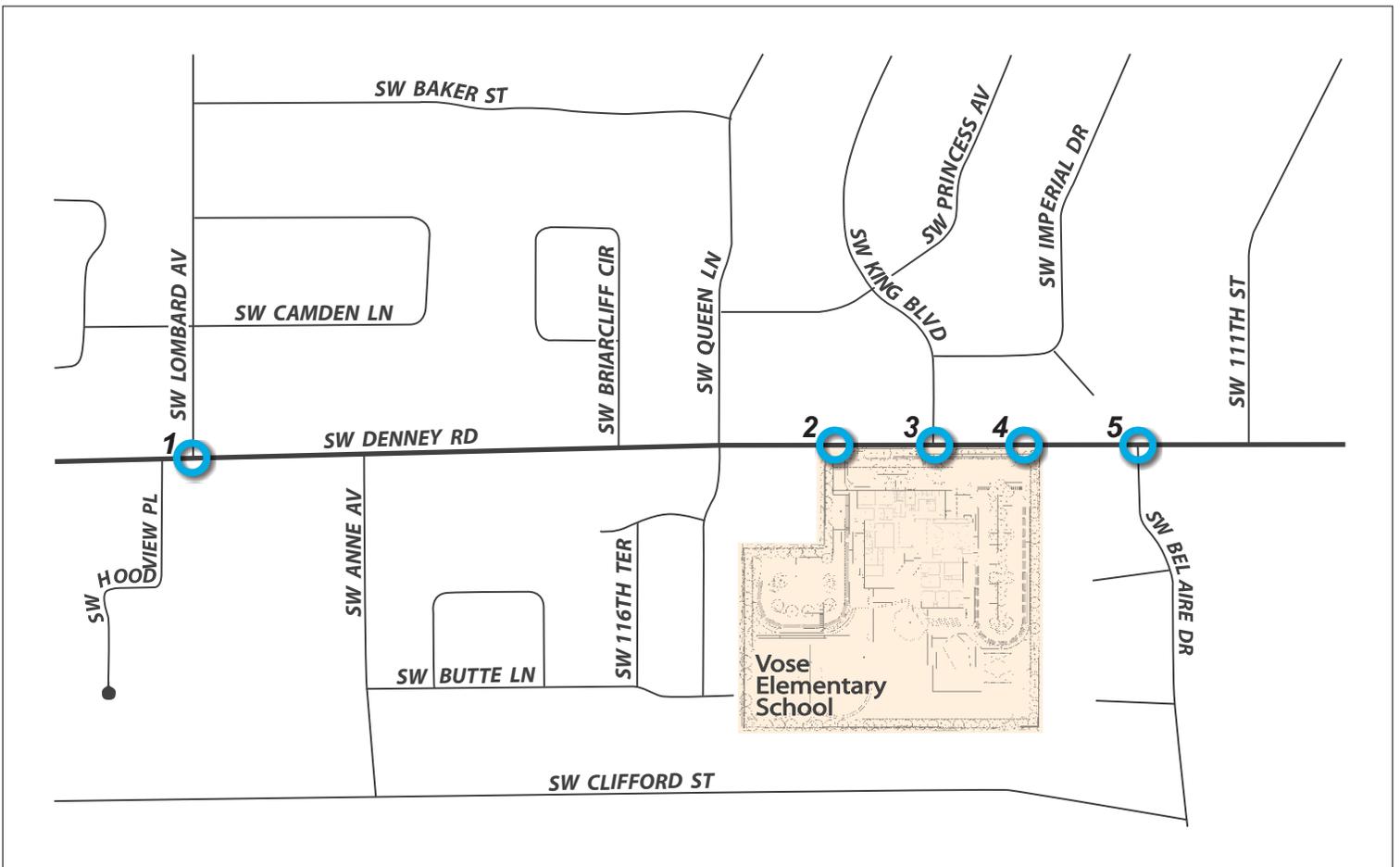
**Project Trip Distribution**



**DKS**

**Figure 7**

**Additional Project Trips**  
**Beaverton Vose Elementary School**



**#** - Study Intersection

- Traffic Signal

- Stop Sign

**LEGEND**

← - Lane Configuration

Peak Hour Traffic Volumes

000 [000] (000) - AM [Afternoon School] (PM)

LT TH RT - Volume Turn Movement

Left-Thru-Right

**DKS**

**Figure 8**

2017 Total Traffic Volumes (Background+Project)

**Beaverton Vose Elementary School**

## Frontage Improvements

The City of Beaverton's Transportation System Plan identifies improvements along SW Denney Road which consists of widening it to a 3-lane collector cross-section along the project's frontage.

The City of Beaverton's Development Code requires that half street improvements be constructed along the site's frontage of existing collector roads which abut the site and are not improved in accordance with the City of Beaverton Transportation System Plan and Engineering Standard Drawings<sup>21</sup>. Therefore; it is proposed that this project widen the existing Denney Road cross-section to a 46 foot section along the site frontage. This half-street improvement would include a bike lane which will not be striped as such, since it will not connect to bike lanes to the east or west of the project site. The revised site access would require modification to the existing traffic signal at the intersection of SW King Boulevard/SW Denney Road.

## 2017 Total Traffic Intersection Operations

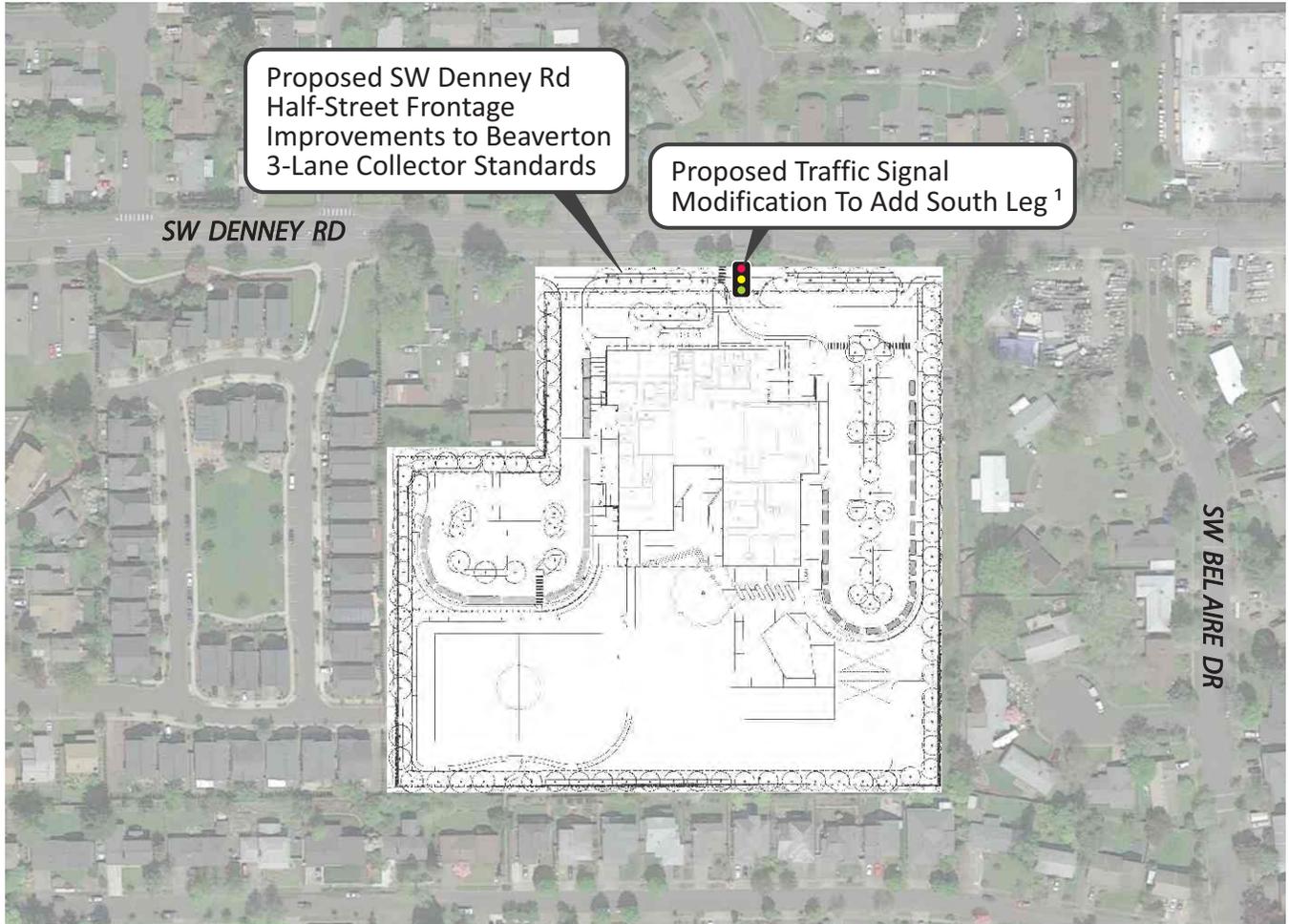
The study intersection operating conditions for the 2017 Total traffic scenario (a.m., afternoon school, and p.m. peak hours) are listed in Table 14. Intersection operations assume the frontage improvements proposed to be constructed as part of the project. Analysis was performed based on *2000 Highway Capacity Manual*<sup>22</sup> methodology for signalized and unsignalized intersections to determine operations that reflect 2017 Total Traffic peak hour operations. Table 14 lists intersection operations for the 2017 Total Traffic scenario with calculations provided in Appendix J. As expected, all intersections experience a slight increase in delay associated with the additional background traffic loadings, with the exception of SW King Boulevard/SW Denney Road, which is expected to improve with better throughput at the traffic signal. All study intersections would meet the City's mobility target during all peak periods.

Queuing on SW Denney Road is expected to improve significantly since the capacity for drop-offs on-site is more than doubled (10-12 vehicles can drop off their students at once compared to only five previously). In addition, there is room for 10-11 vehicles to stack between the traffic signal and the beginning of the drop-off area, allowing up to 22 vehicles to queue on site between the traffic signal and the drop-off area. The drop-off area is expected to operate such that vehicles pull in and out of the circulation aisle, making efficient use of the curbside loading area. In addition, there is room for at least 16 vehicles to queue beyond the drop-off area (between the drop-off area and either the right-out only onto Denney Road or the traffic signal at SW King Boulevard/SW Denney Road). Therefore, after a vehicle drops its student(s) off, it can easily pull out of the drop-off area, allowing an additional vehicle to pull in, keeping the queue moving. In the existing configuration, there was only room for one vehicle to wait at the exit driveway, so this represents a significant improvement in on-site vehicle storage.

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<sup>21</sup> Beaverton Comprehensive Plan, Chapter Six, Figure 6.4 – Functional Classification, and City of Beaverton Engineering Standard Drawings, Minimum Collector Street Widths.

<sup>22</sup> *2000 Highway Capacity Manual*, Transportation Research Board, Washington DC, 2000.



1. Provides northbound left and through/right lane configuration.

**LEGEND**

 - Traffic Signal

**DKS**



No Scale

*Figure* **9**

**NEW VOSE ELEMENTARY SCHOOL SYSTEM FRONTAGE IMPROVEMENTS**

Source: DLR Group and Cameron McCarthy

**Table 14: 2017 Total Traffic Intersection Operations – Peak Hour**

Intersection	Mobility Target	AM Peak			Afternoon School Peak			PM Peak		
	City	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
SW Lombard Ave/ SW Denney Rd	45 sec delay	4.3	D	0.36	3.5	B	0.33	4.5	C	0.47
West Project Driveway		0.4	A	0.51	0.7	A	0.31	0.2	A	0.43
SW King Blvd/ SW Denney Rd	0.98 V/C*, 65 sec delay	23.2	C	0.89	17.0	B	0.85	18.5	B	0.82
East Project Driveway	45 sec delay	0.8	A	0.42	0.3	A	0.29	0.0	A	0.44
SW Bel Aire Dr/ SW Denney Rd		3.5	B	0.45	1.4	A	0.28	1.3	A	0.43

Delay = average intersection vehicle delay (sec), LOS = intersection level of service, V/C = worst lane group volume-to-capacity ratio

**Bold and Red** indicates intersection does not meet mobility target

\* Applies to each lane group at intersection

\*\*V/C reported for eastbound lane group during a.m. peak hour, westbound left lane group during school afternoon peak and westbound during p.m. peak hour.

### Site Plan Review

The site plan provided by the Beaverton School District and shown in Figure 10 was reviewed to evaluate site access, future queuing and storage needs, access spacing, intersection sight distance, bus loading and access, pedestrian and bicycle access/school crosswalks, bicycle parking, student drop-off area, site circulation and parking needs, and reduced school speed zones. The evaluation of each of these issues includes the identification of associated on-site project modifications or improvements.

### Site Access

There are three proposed access locations to the site. The proposed full access located along SW Denney Road at SW King Boulevard would provide signalized access to the proposed visitor and staff parking lot. This access would add a fourth leg to the south of the existing traffic signal. Bus and staff parking access is proposed to the site from a driveway approximately 180 feet to the west of the SW King Boulevard/SW Denney Road signal. No visitors are expected to use this access on a regular basis, although this access will be used for events since the staff parking lot will also serve as event parking. The proposed access along SW Denney Road at the east end of the site, approximately 165 feet east of SW King Boulevard, is proposed to be restricted to right-out only for the visitor and staff parking lot. It is recommended that guide signage be provided along SW Denney Road to direct staff, parents, buses, and visitors to the appropriate access locations during school hours.

Since no vehicle connection would be provided between the staff/visitor and staff-only parking lots, it is recommended that staff be assigned to one parking lot or the other to make efficient use

of the parking allocation and to prevent using the public street system as a proxy for site circulation.

**Future Queuing and Storage Needs**

Queuing analysis was performed for the a.m. and afternoon school peak hours under 2017 total traffic conditions to determine the recommended turn lane storage lengths at the full access intersection at SW King Boulevard/SW Denney Road. The queuing analysis was based on the anticipated number of vehicles entering and exiting the site during the peak 15-minutes prior to school beginning and after school lets out at the intersection of SW King Boulevard/SW Denney Road to estimate storage demand associated with the increase in bus and vehicle traffic.

SimTraffic software was used with low peak hour factors (0.50 for the a.m. peak and 0.40 for the midday school peak<sup>23</sup>) for turn movements associated with school traffic, reflecting the 20-30 minute periods before school starts and after school lets out (see Appendix N).

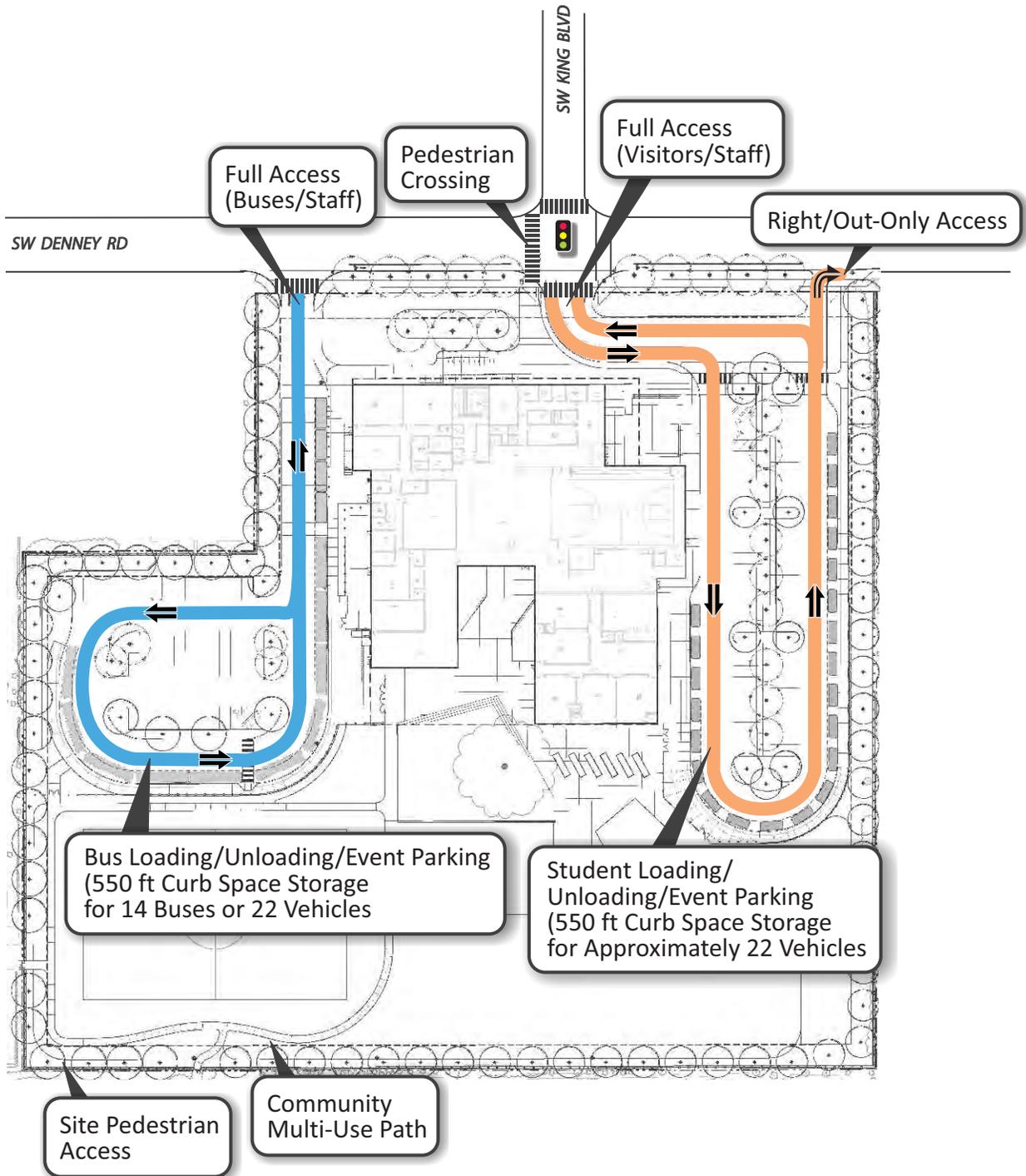
The estimated storage lengths required for future turn lanes at the school access points and at the intersection of SW King Boulevard/SW Denney Road are listed in Table 15. The northbound approach at SW King Boulevard/SW Denney Road would consist of two approach lanes, with one left-turn lane and one through/right-turn lane.

**Table 15: Recommended Storage Bays under 2017 Total Traffic Conditions**

Intersection Approach	Movement	Recommended Storage Length
<i>SW King Boulevard/SW Denney Road (main staff/visitor site access)</i>		
Northbound	Left	125 ft
Eastbound	Left	75 ft
Westbound	Left	75 ft
<i>SW Denney Rd/West Site Access (bus/staff full access)</i>		
Westbound	Left	50 ft

The existing storage for the eastbound left turn at the intersection of SW King Boulevard/SW Denney Road should be restriped to 75 feet. A continuous two-way left-turn lane would serve the westbound left-turns at the west site driveway. The approximately 180 foot distance between the two intersections would be adequate to accommodate the anticipated storage needs for both turns with the proposed site configuration since each movement only requires queuing for about two to three vehicles.

<sup>23</sup> Based on average peak hour factors for existing school-related traffic.



**LEGEND**

- Traffic Direction Flow
- Traffic Signal

**DKS**



No Scale

**Figure 10**

**NEW VOSE ELEMENTARY SCHOOL  
SITE PLAN**

Source: DLR Group and Cameron McCarthy

**Access Spacing**

SW Denney Road is classified as a collector by the City of Beaverton. Beaverton’s code requires a minimum access spacing of 180 feet for any direct access to a collector roadway.<sup>24</sup> This includes spacing from both intersections and adjacent access points.

The proposed main visitor/staff site access along SW Denney Road is proposed to be aligned opposite the SW King Boulevard intersection. There are several driveways in the vicinity of the proposed school site within 180 feet of the west and east accesses. Since these driveways do not meet the City’s access spacing standard, a modification to the driveway spacing standard will be needed. These driveway locations and spacing are summarized in Table 16. As indicated the west and east proposed accesses would require a modification to access spacing standards for collector roadways.

**Table 16: Access Spacing from Proposed School Driveways**

Driveway on Denney Road	Distance to West School Driveway			Distance to East School Driveway		
	Measurement	City of Beaverton Standard	Standard Met?	Measurement	City of Beaverton Standard	Standard Met?
<i>South Side of Denney</i>						
Commercial Building to West (2 accesses)	25 ft.	180 ft.	No			
	85 ft.		No			
Single Family Home to West	165 ft.	180 ft.	No			
Rock Sales Site to East				100 ft.	180 ft.	No
<i>North Side of Denney</i>						
Single Family Homes	<20 ft. Directly Opposite 95 ft.	180 ft.	No No No			

**Intersection Sight Distance**

To ensure safety at site accesses, intersection sight distance was examined during a field visit on October 27, 2015. Sight lines at the two proposed full access locations are shown in Table 17.

Intersection sight distance measurements at the proposed access points are summarized in Table 18. The measured sight distance is compared to the requirements set forth by the City of Beaverton and are based on the measured 85th percentile speeds along SW Denney Road near the

<sup>24</sup> City of Beaverton Engineering Design Manual, Section 210.13.

project site.<sup>25</sup> The measured 85th percentile speed for SW Denney Road traffic was 34 mph in the eastbound direction and 33 mph in the westbound direction.

**Table 17: Site Access Intersection Sight Distance**

SW Denney Road/West Site Access (Bus/Staff)	SW Denney Road/East Site Access (Staff/Visitor, Right-Out Only)
 <p>Looking West</p>	 <p>Looking West</p>
 <p>Looking East</p>	 <p>Looking East</p>

As summarized in Table 23, intersection sight distance would not be met at the west project driveway based on the posted speed on Denney Road (which is higher than the 85<sup>th</sup> percentile speed of 34 mph eastbound and 33 mph westbound). The Beaverton School District will need to work with the City of Beaverton and the property owner of the site immediately to the west to trim vegetation growth along the south side of Denney Road. It should also be monitored to ensure that sight lines stay clear. The sight distance restriction to the east is due to landscaping on the existing school site. This landscaping will be removed with the proposed project.

<sup>25</sup> City of Beaverton Engineering Design Manual, Section 210.10.

**Table 18: Intersection Sight Distance Summary for Proposed Access Points**

Criteria	Intersection Sight Distance	
	SW Denney Rd/ West Site Access	SW Denney Rd/ Restricted Site Access (Right-Out Only)
Field measurement (looking east)	260 ft	N/A
Field measurement (looking west)	300 ft	>400 ft
City of Beaverton Standard (35 mph)*	335 ft	335 ft
Standard Met?	<b>No**</b>	<b>YES</b>

\*City of Beaverton sight distance standards are based posted speed of 35 mph on Denney Road in Table IIc – Intersection Sight Distance in the Engineering Design Manual.

\*\* Sight distance to the east will be corrected with redevelopment of the school frontage. The Beaverton School District will need to work with the City of Beaverton and the property owner of the site to the west to trim vegetation growth along the south side of Denney Road and monitor it to makes rue sight lines remain clear.

To ensure that intersection sight distance will be met with the proposed site plan, parking, significant landscaping, and large signs should be restricted adjacent to the three school driveways.

**Bus Loading and Access**

It is anticipated that up to ten full-sized school buses (40 feet in length) and four special needs buses (24 feet in length) will transport students to and from Vose Elementary School during normal school hours. All buses will enter the school site via the west site access. All buses would also exit the site from the west site access.

As illustrated on the site plan, all bus loading and unloading is to occur on site. The new bus loading area includes approximately 550 feet of curb space in the circulating aisle, which is sufficient to accommodate ten full size and four SPED (special education) buses at once. Staff parking would be provided in the center of this circulating aisle. Sidewalks will be provided between the loading and unloading bus areas and the school entrances in order to ensure safe access.

**Pedestrian Access/School Crosswalks**

The site plan provided by the Beaverton School District is expected to provide adequate pedestrian and bicycle facilities on the site as long as sufficient bicycle parking is provided and all sidewalks are constructed to meet ADA requirements.<sup>26</sup> The existing traffic signal at SW King Boulevard/SW Denney Road provides a protected pedestrian crossing across the collector roadway directly to the front entrance of the school. The plan also shows sidewalks along the entire school frontage on SW Denney Road and provides pedestrian connections to adjacent neighborhoods to the south and west of the school via SW Clifford Street and SW Butte Lane.

<sup>26</sup> ADA Accessibility Guidelines for Buildings and Facilities, Federal Highway Administration, May 2012.

The Beaverton TSP shows a Proposed Trail along Denney Road from the existing Fanno Creek Trail crossing on Denney Road just east of SW 111<sup>th</sup> Street west to SW King Boulevard, where it heads north. Based on conversations with City staff, the trail is planned on the north side of SW Denney Road.<sup>27</sup>

### ***Bicycle Parking***

City of Beaverton Code requires that elementary schools provide one long-term bicycle parking space per nine students<sup>28</sup>. With a maximum capacity of 750 students for the proposed elementary school, one space per nine students equates to a minimum of 84 bicycle parking spaces. Long-term spaces are designed to accommodate persons that can be expected to leave their bicycle parked longer than two hours. School buildings are exempt from the City's requirement to provide cover or shelter for long term parking spaces.<sup>29</sup>

### ***Student Drop-Off Area***

The site plan provides a designated student drop-off area within the site that is separate from school bus loading areas. This area also provides for visitor and some staff parking and access would be provided from the SW King Boulevard/SW Denney Road traffic signal. Vehicles would circulate counter-clockwise around the proposed staff/visitor parking. The student drop-off area includes approximately 550 feet of curb space in the circulating aisle, which is sufficient to accommodate approximately 22 vehicles at once (based on average vehicle length of 25 feet). A walkway is proposed which would provide direct access from the drop off area to the primary school entrance.

Approximately 550 feet of total drop-off frontage is provided, however, approximately 300 feet of queuing space is available between the site access and the drop-off area, and approximately 250 feet of queuing space is available between the drop-off area and the site egress. This allows for a total of approximately 1,100 feet of on-site queuing/drop-off area, which could accommodate as many as 44 vehicles on-site at once, not including any vehicles that choose to park in one of the visitor spaces. With the 30 visitor parking spaces, up to 74 parent/visitor vehicles could be accommodated on-site.

### ***Site Circulation and Parking***

The City of Beaverton requires a minimum of 1.0 and a maximum of 1.5 parking spaces per staff member.<sup>30</sup> The Beaverton School District expects to employ up to 77 staff members. Therefore, Beaverton's Development Code requires the school to provide a minimum of 77 and a maximum of 116 parking spaces as indicated in Table 19.

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<sup>27</sup> Beaverton Transportation System Plan, Figure 6-5 Action Plan.

<sup>28</sup> Beaverton Development Code, Special Requirements, Section 60.30.10.5.B, June 2012.

<sup>29</sup> Beaverton Development Code, Special Requirements, Section 60.30.10.2.B, June 2012.

<sup>30</sup> Beaverton Development Code, Special Requirements, Section 60.30.10.5.A, June 2012.

**Table 19: School Parking Requirements – City of Beaverton Development Code**

Land Use	Proposed Staff	Parking Rate (Minimum – Maximum)	Total Parking
Elementary School	77	1.0 – 1.5/staff	77 - 116

To estimate typical parking demand for Vose Elementary School, parking was surveyed during the school day at the existing Vose Elementary school and in the adjacent neighborhood to the north, as summarized in Appendix F.<sup>31</sup> Current on-site and off-site (street) parking demand totals about 105 parking spaces today.<sup>32</sup> However, it is anticipated that at least half of the vehicles parked in the neighborhood to the north will chose to use the on-site pick-up area once it becomes available, which would reduce the existing demand to approximately 81 spaces, based on the current staff of 71. For the proposed 77 staff members, this would be equivalent to a demand of 88 parking spaces for the proposed reconstruction. The planned parking of 107 spaces, combined with the drop-off/pick-up area with room for 22 additional vehicles, for a total of 129 spaces, should adequately meet the typical daily parking demand for the school.

The school should also provide additional parking for special events, which can have higher parking demands than the typical school day. However, the elementary school does not need to provide enough parking spaces to fully accommodate special events. The vast majority of the time, parking would be underutilized. Preliminary site plan layouts indicate that approximately 107 total spaces could be provided on the school site, including 49 in the west parking lot (staff only) and 58 in the east parking lot (staff and visitors). This would accommodate typical school parking demand; small surges associated with most event needs, and would satisfy the 77 minimum spaces required by the City’s development code. With 107 spaces, 77 of the spaces should be dedicated to staff, with the remaining 30 spaces for parent/visitor parking. To accommodate parking needs for events, an additional 44 spaces could be provided on-site by utilizing internal pick-up/drop-off areas during events for a net total of up to 151 parking spaces.

**School Speed Zone**

There is an existing school speed zone (20 mph) on Denney Road adjacent to the existing school. The reduced speed limit is in effect during school hours, when flashing.



<sup>31</sup> Vehicle parking survey conducted between 7:00 and 8:30 a.m. and between 1:30 – 3:00 PM on May 14, 2015.

<sup>32</sup> Based on 56 vehicles observed on-site and a maximum 49 vehicles observed off-site during the school afternoon peak period (see Appendix F).

## V. 2035 LONG-RANGE FORECAST YEAR

The reconstructed Vose Elementary School is anticipated to have a maximum enrollment of 750 students. The 2035 background traffic volumes were forecasted for the study area assuming a one percent per year growth rate (average linear) on Denney Road. Based on the Beaverton Transportation System Plan, no future roadway improvements are planned in the vicinity of the project site.<sup>33</sup>

The Beaverton TSP shows a Proposed Trail along Denney Road from the existing Fanno Creek Trail crossing on Denney Road just east of SW 111<sup>th</sup> Street west to SW King Boulevard, where it heads north. Based on conversations with City staff, the trail is planned on the north side of SW Denney Road.<sup>34</sup>

### 2035 Trip Generation

The number of new peak hour trips accessing the project site was estimated based on the 750 students expected at capacity, which is the same number that was estimated for the year of opening (2017). These additional a.m., afternoon school, and p.m. peak hour vehicle trip generation estimates were added to 2035 Background volumes to develop 2035 Total trips, which include background and additional project related trips (see Figure 11).

### 2035 Traffic Operations with Project Trips

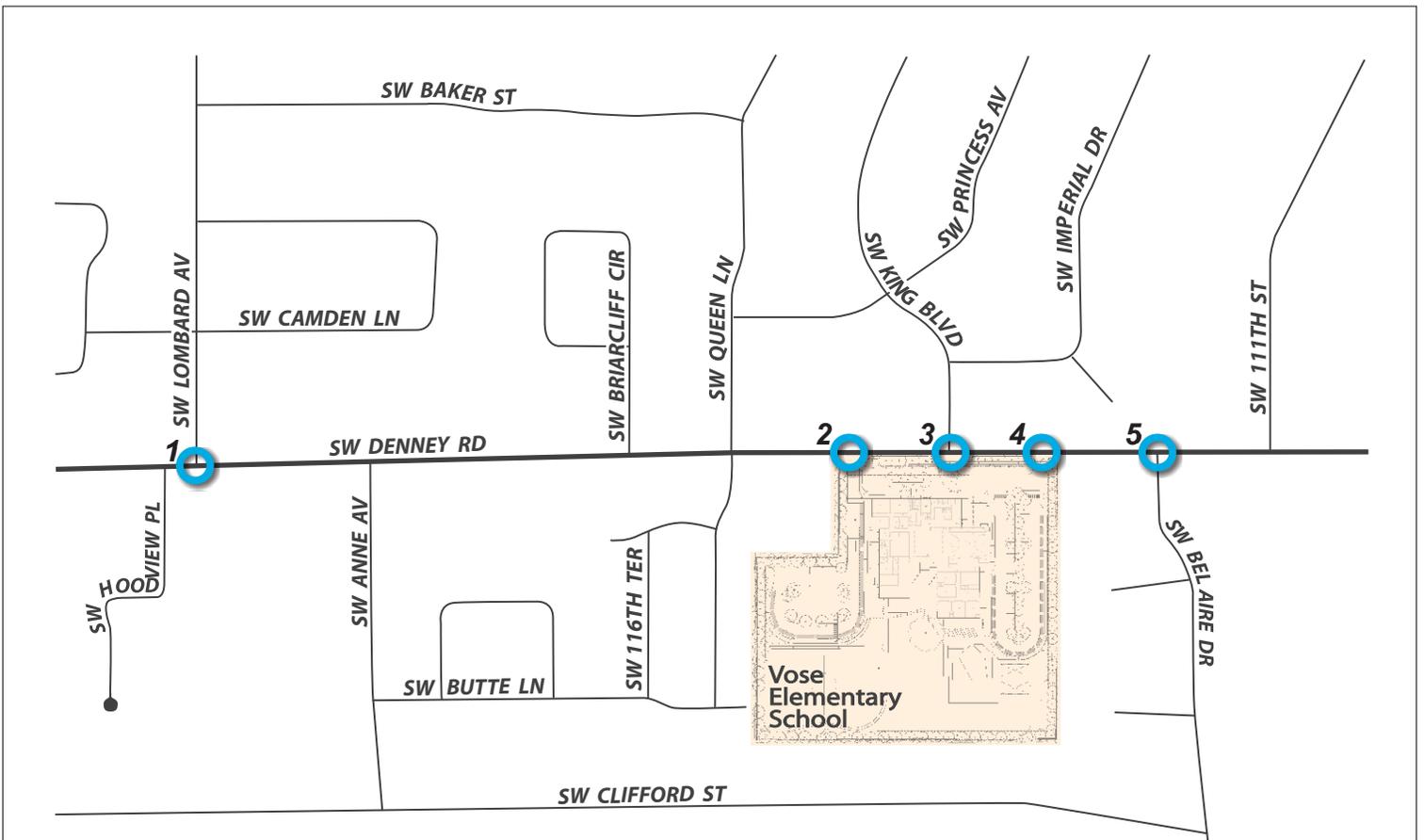
Future operating conditions were analyzed at the study intersections for the long-range forecast year (2035 total volume scenario which includes project trips). Future 2035 forecasts were developed as described previously.

The study intersection operating conditions for the 2035 total traffic scenario during the all analyzed peak hours are listed in Table 20. As shown, all study intersections continue to meet City mobility targets for each of the peak periods analyzed.

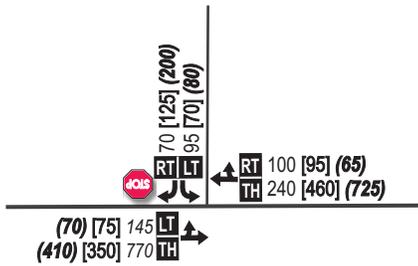
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<sup>33</sup> Chapter Six: Transportation Element, Beaverton Comprehensive Plan, Figure 6.5 Action Plan.

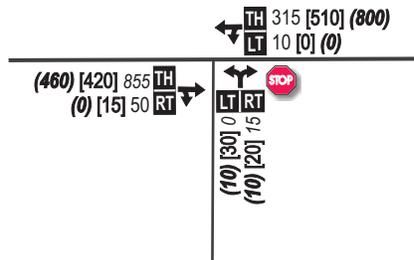
<sup>34</sup> Chapter Six: Transportation Element, Beaverton Comprehensive Plan, Figure 6.5 Action Plan.



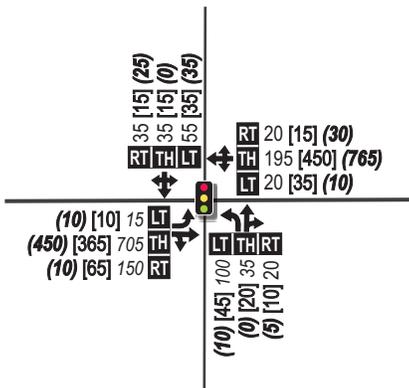
**1. SW Denney Rd @ SW Lombard Av**



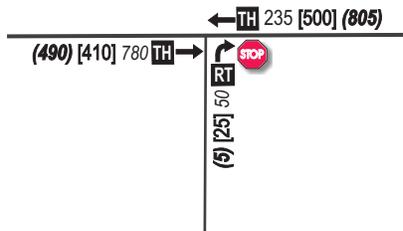
**2. SW Denney Rd @ West School Driveway**



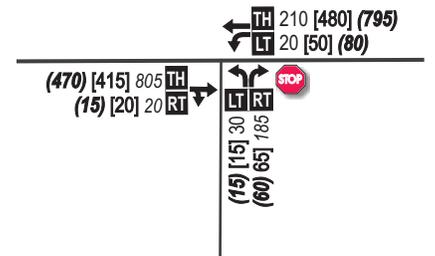
**3. SW Denney Rd @ SW King Blvd**



**4. SW Denney Rd @ East School Driveway**



**5. SW Denney Rd @ SW Bel Aire Dr**



**#** - Study Intersection  
 - Traffic Signal  
 - Stop Sign

**LEGEND**

← - Lane Configuration  
 Peak Hour Traffic Volumes  
 000 [000] (000) - AM [Afternoon School] (PM)  
 LT TH RT - Volume Turn Movement  
 Left-Thru-Right

**DKS**

**Figure 11**  
 2035 Total Traffic Volumes (Background+Project)  
 Beaverton Vose Elementary School

Table 20: 2035 Total Intersection Operations – Peak Hour

Intersection	Mobility Target	AM Peak			Afternoon School Peak			PM Peak		
	City	Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
SW Lombard Ave/ SW Denney Rd	45 sec delay	4.6	E	0.42	3.4	C	0.37	4.9	D	0.54
West Project Driveway		0.4	B	0.58	0.7	A	0.34	0.2	A	0.50
SW King Blvd/ SW Denney Rd	0.98 V/C*, 65 sec delay	28.4	C	0.93	17.4	B	0.81	23.0	C	0.91
East Project Driveway	45 sec delay	0.7	A	0.48	0.3	A	0.33	0.0	A	0.50
SW Bel Aire Dr/ SW Denney Rd		3.9	B	0.51	1.4	A	0.31	1.2	A	0.49

Delay = average intersection vehicle delay (sec), LOS = intersection level of service, V/C = worst lane group volume-to-capacity ratio

**Bold and Red** indicates intersection does not meet mobility target

\* Applies to each lane group at intersection

\*\*V/C reported for eastbound lane group during a.m. peak hour, westbound left lane group during school afternoon peak and westbound during p.m. peak hour.

## VI. RECOMMENDED MITIGATIONS

### Project Mitigation Summary

The following list summarizes the key transportation impact findings associated with the proposed new Vose Elementary School.

#### ***SW King Boulevard/SW Denney Road Mitigations***

- The existing traffic signal at SW King Boulevard/SW Denney Road currently does not include a south leg of the intersection. A south leg of this intersection will be added to serve as the main visitor/staff access to the site.

#### ***East Project Access/SW Denney Road Mitigations***

- A proposed east school access on SW Denney Road that currently provides full access is not expected to meet City of Beaverton sight distance requirements due to a vertical curve to the east of the project site and due to sight obstructions on the property immediately east of the school site. However, a right-out only access does meet sight distance requirements to the west and is proposed to relieve congestion at the SW King Boulevard/SW Denney Road traffic signal, providing egress for visitors leaving the site toward OR 217.

#### ***West Project Access***

- Sight distance at the west project access is restricted by vegetation on the property to the west of the school site. The Beaverton School District should work with the adjacent property owner and the City of Beaverton to provide (and maintain) clear sight distance at the proposed access.

#### ***Site Improvements***

- It is recommended that guide signage be provided along SW Denney Road to direct staff, parents, buses, and visitors to the appropriate access locations during school hours.
- Half street improvements should be provided along the school's frontage of SW Denney Road. Frontage improvements should conform to the City of Beaverton's collector roadway standard<sup>35</sup> for a three lane cross-section. This includes 74 feet of right-of-way and a 46 foot paved section. A new approach to the existing SW King Boulevard/SW Denney Road intersection is recommended as part of the proposed project. This new approach, which is recommended to include one southbound lane (entering) and two northbound lanes (left and through/right) exiting the site would require modification to the existing traffic signal at SW King Boulevard/SW Denney Road.
- It is recommended that two lanes be provided on the south leg of the SW King Boulevard/SW Denney Road intersection for at least 200 feet, to make efficient use of the

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<sup>35</sup> City of Beaverton Engineering Standard Drawings. Minimum Collector Street Widths, 3 lanes.

traffic signal by providing stacking for the number of vehicles that could exit the site during one signal cycle.

### **Site Access**

- The west site access is intended only for use by some staff (based on the available staff parking) and bus traffic during a typical school day. It is recommended that staff be assigned to the west parking lot to maximize parking efficiency and to avoid staff using the City street system as circulation to find a parking spot. This access should also be signed to indicate that it is for staff and bus use only.
- Signs should be provided on Denney Road adjacent to the west site access indicating that vehicles should keep clear of the driveway area to facilitate vehicles entering and/or exiting the west driveway during congested periods.
- It is recommended that the proposed eastern access on SW Denney Road be restricted to right-out only to help relieve operations at the SW King Boulevard/SW Denney Road traffic signal and to allow a secondary exit for vehicles heading. A traffic separator should be constructed on Denney Road to restrict disallowed turn movements. Sight distance restrictions at this location preclude the ability for left-turns out of the site.
- It is recommended that a path analysis be conducted on site to ensure that buses can make the necessary turn maneuvers.
- An Engineering Design Modification will be required to the driveway spacing standards, since there are several driveways within the City's access spacing standard of 180 feet on a collector roadway.
- The Beaverton School District should direct school buses to travel via SW Allen Boulevard and SW Lombard Avenue to access Vose Elementary School during the afternoon school peak hour in order for buses to enter the site on a right-turn movement.

### **Site Circulation and Parking**

- The current site plan shows 107 parking spaces, including approximately 77 parking spaces, for staff at full occupancy, and 30 visitor spaces. To accommodate parking needs for events, it is recommended that the internal drop-off areas be utilized during events, adding up to 44 spaces, for a net total of up to 151 spaces, including drop-off areas in both the west and east parking lots.
- Approximately 550 feet of total drop-off frontage is provided, however, approximately 300 feet of queuing space is available between the site access and the drop-off area, and approximately 250 feet of queuing space is available between the drop-off area and the site egress. This allows for a total of approximately 1,100 feet of on-site queuing/drop-off area, which could accommodate as many as 44 vehicles on-site at once (see Figure 3). It is anticipated that most queuing associated with student drop-off and pick-up will be accommodated on-site. The signal timing of the SW King Boulevard/SW Denney Road traffic signal can be adjusted during school peaks to provide efficient access to and from the school during these periods.

***Pedestrian and Bicycle Access/School Crosswalks***

- A minimum of 84 bicycle parking spaces should be provided near primary school entrances to meet City of Beaverton Code.<sup>36</sup>
- Sidewalks along the project frontage of SW Denney Road should be planned to accommodate both pedestrians (including those with disabilities) and bicyclists at a width of six feet, based on the City's collector street standard.

***Transportation Demand Management***

- The draft Transportation Demand Management (TDM) Plan is provided in Appendix M.

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<sup>36</sup> Beaverton Development Code, Section 60.30.10.5.B, Parking Ratio Requirements for Bicycles. No Short Term parking required. Long Term required: 1 space per 9 students.