Seattle Department of Transportation

Lander Street Grade Separation Transportation Discipline Report

August 29, 2016

SDOT
Seattle Department of Transportation

COWI

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1. Introduction

1.1 Project Purpose and History

The City of Seattle (City) envisioned the S Lander St Grade Separation project nearly 20 years ago. It was one of the original Freight Action Strategy (FAST) Corridor projects,[1] intended to improve railroad crossings along the Everett-Seattle-Tacoma rail corridor.

Prior studies have evaluated the best location for a grade-separated rail crossing in the SODO neighborhood. There are two existing grade-separated crossings in the north end of SODO—at S Royal Brougham Wy and Edgar Martinez Dr (SR 519). Both were constructed as part of the FAST Corridor. To the south, the Spokane Street Viaduct provides a route that passes above this set of railroad tracks, but surface Spokane St retains an at-grade railroad crossing. Between those two extents, S Lander St is the most viable of the remaining grade separation options because of its wide right-of-way, the distance between railroad tracks and adjacent streets, and the relatively small railroad crossing width. These factors allow for a shorter crossing that has sufficient space to reach the necessary clearance requirements.

The S Lander St Grade Separation project is a high-priority project in the *2015 Plan to Move Seattle*, the ten-year City strategic plan for increasing safety, reducing congestion, and balancing modal needs. The plan elevated the S Lander St project as a City priority not only because of its safety, congestion, and multimodal access benefits, but also because of its role in the regional freight network. Based on available state and local data, more than half of the BNSF Railway railcars that move through Washington State go through the S Lander St crossing, which is part of a street network that serves the largest manufacturing and industrial centers in the state, including the Port of Seattle's (Port's) nearby seaport terminals.

This Transportation Technical Report for the S Lander St Grade Separation project evaluates the proposed configuration of the roadway, local access connections, and multimodal operations. It first documents the existing and future conditions in the project vicinity if the grade separation project is not built. This is the "No Build" condition. The analysis then compares traffic and multimodal operations between a No Build condition and the proposed grade-separated condition.

1.2 Changes Since 2008 Lander St Study

The original Type, Size and Location (TS&L) Study for S Lander St was performed in 2002, and the traffic analysis for the previous design was performed in 2008.[2] Since the last update, the following changes to the SODO road network have occurred:

- SR 519 Phase 2 is now complete – it was in its initial planning stages in 2008. That project constructed a new grade-separated crossing of the railroad tracks at Royal Brougham Way and added access ramps between I-90 and Edgar Martinez Drive. That project was completed in 2010.
- A new ramp from eastbound Spokane Street Viaduct to 4th Ave S was constructed in 2012.

[1] *FAST Project Report,* Texas Transportation Institute*,* March 1997.
[2] *South Lander St Grade Separation Project Transportation Technical Report – 2008 Update,* Heffron Transportation, Inc., February 15, 2008.

- Link light rail service to the SODO Station commenced in 2009, which increased pedestrian traffic along S Lander St to reach the SODO Station.
- There have been substantial changes to transit routing through the neighborhood.

In addition, the design of the Alaskan Way Viaduct (AWV) Replacement Project, which is currently under construction, has changed since the original TS&L Study. The project is now constructing a bored tunnel instead of a cut-and-cover tunnel that was proposed at the time of the prior Lander St study. With the bored tunnel, the South Access interchange with SR 99 has changed substantially from what was assumed in 2008; the design now includes ramps to Alaskan Way instead of to and from 1st Ave S. Toll rates through the SR 99 tunnel will likely be substantially lower than previously assumed,[3] and the segment between Spokane St and SR 519 will not be tolled. As a result, fewer vehicles are expected to divert through SODO with the completed tunnel than previously assumed. Additional changes to transit are also expected once the new South Access interchange is complete.

Changes to the transportation system have reduced vehicular traffic volumes on S Lander St compared to those used in the 2008 analysis (four versus five lanes). The changes in traffic volumes are presented later in Section 2.2.3. Reductions in existing and forecast demand allow the proposed grade separation to have fewer vehicular lanes than previously assumed. The proposed project is described in the next section and evaluated herein. The proposed design would accommodate the expected traffic volumes and would improve traffic operations compared to the existing at-grade configuration.

1.3 Project Description

The following sections describe the various elements of the proposed S Lander St Grade Separation project. Table 1 summarizes the project elements, including alternatives and options related to the bridge alignment, local access, and multimodal facilities for transit, bicyclists and pedestrians. Each of these elements is described in detail in the following sections.

[3] Analysis performed for the *Alaskan Way Viaduct Replacement Project, Environmental Impact Statement* had assumed relatively high toll rates (ranging between $3 and $5 during the AM and PM peak hours depending on the direction of travel). In March 2014, the *Advisory Committee on Tolling and Traffic Management* (Tolling Committee) recommended a $1 per trip toll 24 hours per day with a $1.25 toll during the 6 to 9 A.M. and 3 to 6 P.M. peak periods to reduce potential diversion trips.

Table 1. Sumary of Project Alternatives and Design Options

Project Element	Alternative 1 – Centered Alignment	Alternative 2 – Shifted Alignment
Bridge alignment	Bridge centered along existing S Lander St centerline.	Bridge centerline shifted 6 feet north of existing S Lander St centerline.
Cross section	68-foot total width (including exterior walls and railings), with one 12-foot outside lane and one 11-foot inside lane in each direction, 14-foot width of non-motorized facilities, and 2 feet of buffers/barriers between vehicular and non-motorized traffic, and 2-foot exterior barriers.	
Non-motorized facilities	Option 1 – 14-foot wide two-way shared use path on north side of the bridge. Option 2 – 7-foot sidewalk on each side of the bridge.	
Bridge profile	To meet the railroad track-clearance requirement of 23.5 feet and a desired maximum grade of 7%, the bridge would be 8 to 9 feet above Occidental Ave S, eliminating the ability to retain the location of its existing intersection with S Lander St. Two options to relocate or eliminate this intersection were evaluated and defined for "Local access west of railroad tracks" below.	
Local access west of railroad tracks	Option A – "Realigned Occidental Ave S" crosses under bridge Option B – "Dead-end Occidental Ave S" on each side of bridge	
Local access east of railroad tracks	"One-Way Loop" – one-way surface street on each side of bridge; maintains all local access.	"Two-Way Connection" – two-way surface street along south side of bridge, crossing under bridge to Seattle Public Schools site.
S Lander St intersections at 1st and 4th Ave S	1st Ave S – one left-turn lane, one thru-lane, one right-turn lane in westbound direction 4th Ave S – one left-turn lane, one thru-lane, one thru-right-turn lane in eastbound direction	

1.3.1. Bridge Alignment

Two basic bridge alignments are being evaluated for S Lander St: Alternative 1 would center the bridge in the existing right-of-way and Alternative 2 would shift the bridge to the north by six feet. Each alternative would have the same cross section, as well as the same options for non-motorized facilities and local access west of the railroad tracks. However, the location of the bridge does change the local access options on the east side of the railroad tracks.

1.3.2. Bridge Cross Section

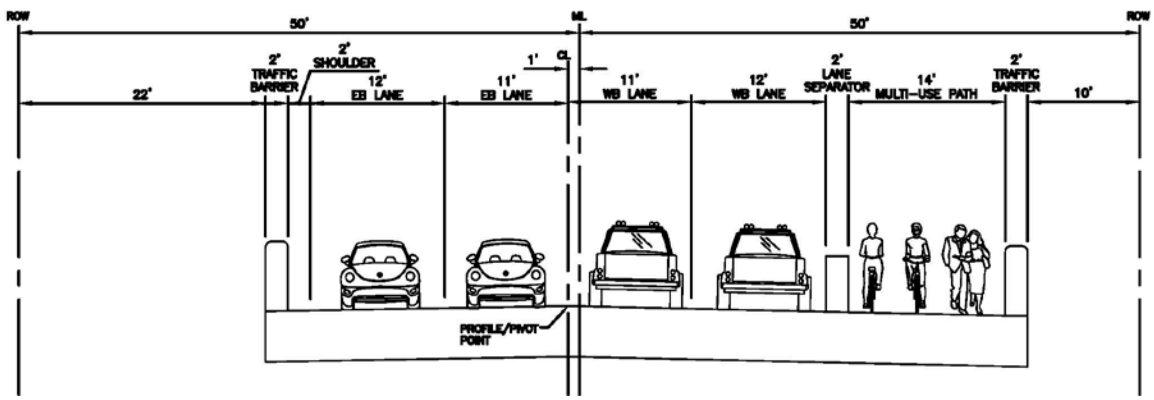
A four-lane bridge is proposed for the S Lander St Grade Separation project. As previously described in Section 1.2, there have been many changes to the area's transportation system that have reduced traffic demand on the corridor compared to prior analyses. A four-lane bridge would accommodate the expected demands. The total width of the bridge is proposed at 68-feet (measured from outside structure to outside structure) with a cross section that would include a 14-foot width of non-motorized facilities, one 12-foot lane (curbside) and one 11-foot lane in each direction, 2-foot buffers adjacent to vehicle lanes, and 2-foot exterior barriers.

The minimum bridge structure was determined to be four lanes. This is dictated by the need for three lanes approaching the 1st Ave S and 4th Ave S intersections to accommodate the expected traffic volumes. The combination of the queue storage for the left turn movements plus the transition taper from the left turn lane to the adjacent through lane would require that the four lanes be provided across the railroad tracks.

1.3.3. Non-Motorized Facilities

Two options are being considered to serve pedestrians and bicyclists on the bridge. **Option 1** would create a 14-foot two-way shared-use path on the north side of the bridge separated from the vehicle lanes by a 2-foot barrier. **Option 2** would provide 7-foot sidewalks on each side of the bridge; no separate bicycle facilities would be provided. The proposed cross-section with the shared-use path option is shown on **Figure 1**.

Figure 1. Proposed Bridge Cross Section with Shared-Use Path Option



Source: Perteet Engineering, July 25, 2016. Section is looking west.

1.3.4. Bridge Profile and Grade

The proposed bridge must clear all BNSF railroad tracks by 23.5 feet and a future expansion track by 22.5 feet[4], and the desired maximum grade for the roadway is 7%. Given those design parameters, the bridge approaches would meet Occidental Ave S about 8 to 9-feet above the existing street grade, which would eliminate the existing intersection. There is more horizontal distance between the railroad tracks and 3rd Ave S to the east, and it would be possible to retain the intersection at S Lander St/3rd Ave S by raising 3rd Ave S by 3 to 6 feet (depending on the type of bridge girders used). The bridge profile and grade would be the same for either of the bridge alignment alternatives.

1.3.5. Local Access Options West of Railroad Tracks

As described in the prior section, the bridge approaches would be elevated above S Occidental Ave west of the railroad tracks, which would eliminate the ability to connect these two streets. The project includes the following two options to maintain local access at S Occidental Ave, illustrated on **Figure 2**:

- Option A, "Realigned Occidental Ave S," would maintain the connection under the S Lander St Bridge that could provide a connection for north-south through traffic.
- Option B, "Dead-end Occidental Ave S," would dead-end Occidental Ave S on both the north and south sides of the bridge; the street would not cross under the bridge.

Either of these options could be paired with either of the bridge alignment alternatives.

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[4] Future expansion track would be located west of the existing rail lines. The clearance of 22.5 feet would require a variance.

The new structure would also alter or eliminate vehicular access to businesses on S Lander St and between Occidental Ave S and the railroad tracks since the roadway would be elevated above these sites. With Option A (Realigned Occidental Ave S), parking for the South Lander Business Park would be provided along the north side of the new surface street. For Frye Lander Station on the south side of S Lander St, the access would need to be moved from S Lander St to Occidental Ave S. For Option B (Dead-end Occidental Ave S), the driveways to both of these buildings would need to be moved to Occidental Ave S. With both options, access to the arterial network would be provided through the S Forest St/1st Ave S intersection to the south and S Stacy St/1st Ave S intersection to the north. Both of those intersections are signalized and provide access from all directions.

1.3.6. Local Access Options East of Railroad Tracks

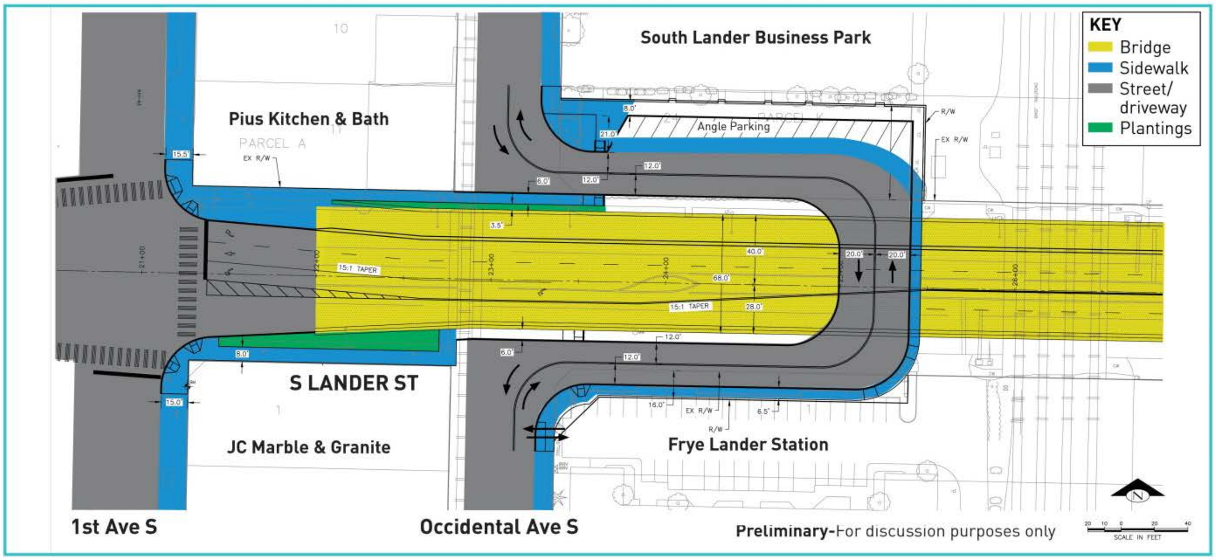
For the segment between the railroad tracks and 3rd Ave S, different local access configurations have been identified for the two bridge alignment alternatives, shown on **Figure 3. Alternative 1**, with the bridge structure centered in the right-of-way, would provide a one-way surface street adjacent to each side of the bridge. The westbound surface street would connect from 3rd Ave S on the north side of the structure, and the eastbound surface street would connect to 3rd Ave S on the south side of the structure. Inbound traffic to this local roadway would arrive from the north on 3rd Ave S, and outbound traffic would exit to the south on 3rd Ave S. **Alternative 2**, which shifts the bridge to the north side of the right-of-way, would provide a surface street connecting between 3rd Ave S south of S Lander St and the Seattle Public Schools site. Other local access configurations are possible, and the Seattle Department of Transportation (SDOT) will continue to evaluate and coordinate local access with specific properties. For the purpose of this analysis, the option evaluated would be the most restrictive (in terms of traffic that must divert from S Lander St) so that the impact on alternative access routes could be assessed.

1.3.7. Intersections at 1st and 4th Aves S

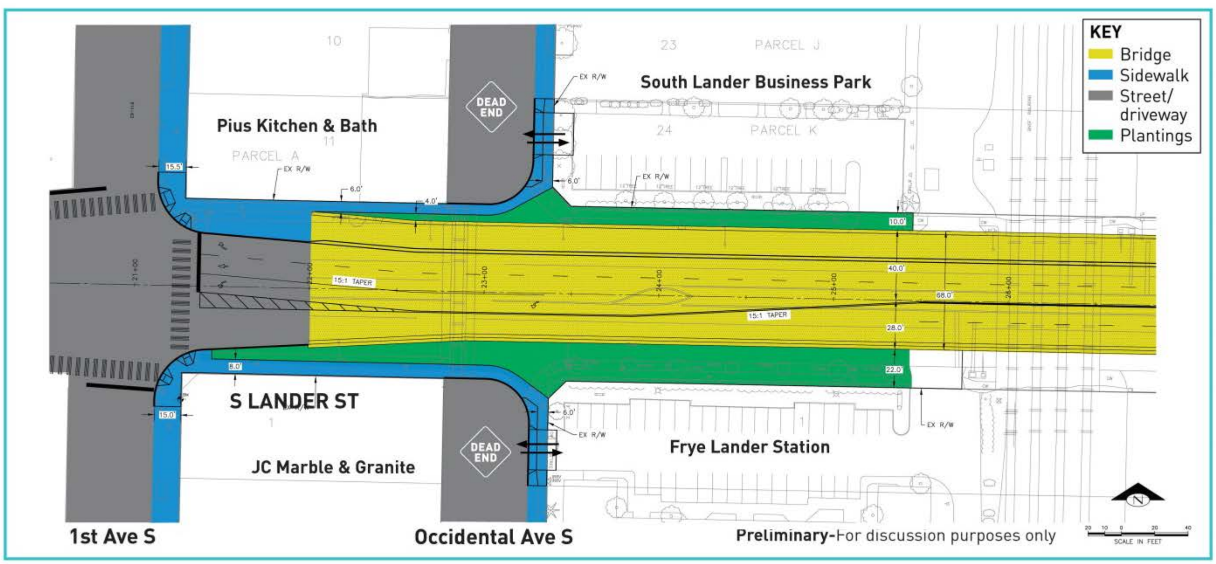
The intersection at **S Lander St/1st Ave S** would be designed with three westbound lanes: a left-turn lane, thru lane, and right-turn lane. The left-turn lane would allow the intersection to operate with protected or protected-permissive left turn phasing, consistent with current operations. A right-turn-only lane would allow the pedestrian crossing of the intersection's north leg to be separated from right-turn traffic using signal phasing, if desired. Only one eastbound departure lane (east of 1st Ave S) is proposed, but it would have a buffer to accommodate a large truck (WB-67 class vehicle). The intersection at **S Lander St/4th Ave S** would have three eastbound lanes: a left-turn lane, thru lane, and a thru-right-turn lane. The intersection configurations would be the same for any of the bridge alignment alternatives or local access options. The analysis herein determined that these configurations would accommodate the forecast demand, and have additional capacity to accommodate increased traffic associated with events or additional diversions.

Figure 2. Local Access Options West of Railroad Tracks

Option A – Realigned Occidental Ave S



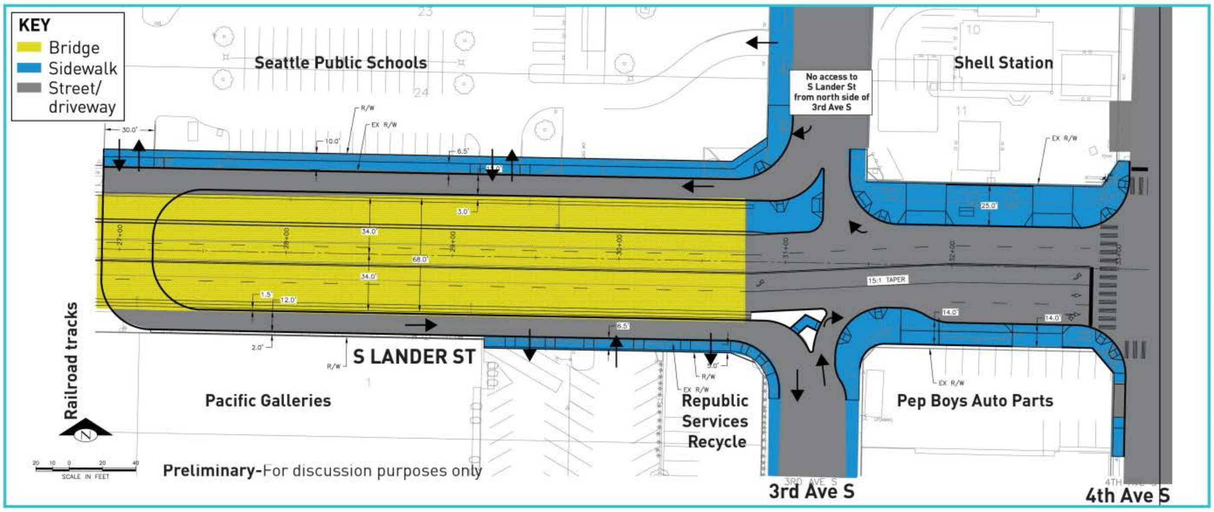
Option B – Dead-end Occidental Ave S



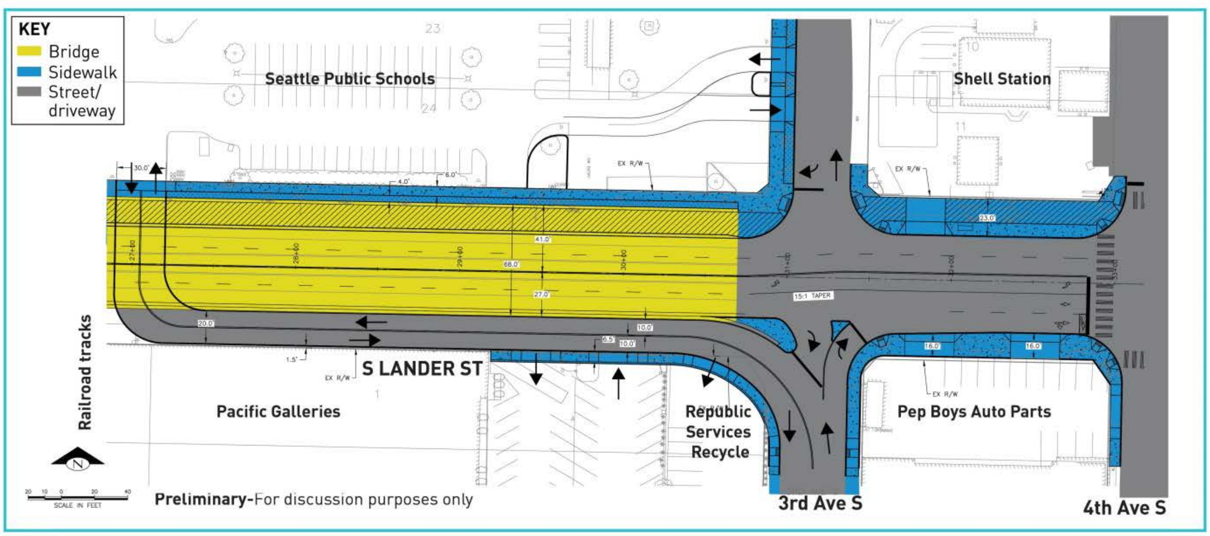
Source: EnviroIssues, August 25, 2016.

Figure 3. Local Access Alternatives East of Railroad Tracks

Alternative 1 – One-way Loop



Alternative 2 – Two-way Connection



Source: EnviroIssues, August 25, 2016.

2. No Build Conditions

This section presents information about the existing and future transportation system in SODO if S Lander St continues to cross the railroad tracks at grade, including information related to the existing road and rail network, future changes in the system, traffic volumes, rail traffic, traffic operations, non-motorized travel, safety, and freight.

2.1 SODO Road and Rail Network

2.1.1. Existing Conditions

Figure 4 shows the roadway network in Seattle's SODO neighborhood. The BNSF Railway's mainline tracks are oriented in a north-south alignment through the heart of the neighborhood. Freight trains, Amtrak passenger trains, and Sound Transit commuter trains share these tracks. North of S Holgate St, the tracks are grade-separated from all street crossings by a series of elevated roadways and a tunnel under downtown Seattle. The next grade crossing north of downtown is at Wall St. There are four east-west streets in SODO that cross the mainline tracks at grade: S Holgate St, S Lander St, S Horton St, and S Spokane St. There are also many rail siding and switching tracks in the neighborhood that spur off of the mainline to reach local businesses or rail maintenance facilities. One switch track crosses S Lander St to reach the Republic Services recycling center and MacMillan Piper distribution center at 150 S Horton St. Multiple tracks cross S Holgate St to serve the Amtrak and Sound Transit maintenance facilities.

Two north-south Principal Arterials—1st Ave S and 4th Ave S—flank each side of the mainline tracks. These arterials connect from the Duwamish River to the south through downtown to the north. Two local streets—Occidental Ave S and 3rd Ave S—provide local access to businesses located west and east of the tracks, respectively. **Figure 5** shows the existing transportation features along S Lander St. Modal designations for S Lander St are summarized in **Table 2**.

Table 2. Modal Designations for S Lander St

Modal Classification	Description
Arterial Classification [a]	Minor Arterial
Transit Classification [a]	Transit Way
Freight Classification [a]	Major Truck Street in the Draft Freight Master Plan, and part of the designated Heavy Haul Network
Bicycle Designation [b]	Not a designated bicycle route in 2015 *Bicycle Master Plan*
Pedestrian Designation [c]	Not located in a pedestrian-designated zone

a. *Source: SDOT, based on 2004 Comprehensive Plan. From http://www.seattle.gov/transportation/Stclassmaps.htm, accessed June 6, 2016.*
b. *Source: SDOT, Bicycle Master Plan, April 2014.*
c. *Source: SDOT, Pedestrian Master Plan,* September 2009.

There are many driveways along S Lander St that serve adjacent businesses**.** Most of the businesses have alternate access on an adjoining north-south street. The exception is Pacific Galleries, which has two parking lot driveways and an inactive, permanently-disabled freight-loading door on S Lander St with no alternative access. The Frye Lander Station and South Lander Business Park also have driveways on S Lander St east of Occidental Ave S.

Figure 4. SODO Neighborhood Map

Source: SDOT, Fastlane Application, April 2016.

Figure 5. Existing S Lander St Project Corridor

Source: GoogleMaps, June 2016.

2.1.2. Future Changes to Transportation System

Several major transportation infrastructure projects are under construction or in the planning stages that will affect traffic patterns in SODO. The largest are the AWV Replacement Project, and the Seattle Waterfront project, which will reconstruct Alaskan Way along the waterfront. These projects are expected to affect travel patterns through SODO by making it easier to access the south end of downtown and Alaskan Way using SR 99 and the new South Access interchange between S Atlantic St and S King St (the existing Viaduct now has ramps at Seneca St and Columbia St further north). The proposed toll in the downtown tunnel and elimination of the downtown access ramps at Seneca St and Columbia St could also divert some traffic to other north-south routes such as 1st Ave S and 4th Ave S. The proposed changes were reflected in the regional travel demand models used for this analysis.

Another major potential infrastructure project is Sound Transit's proposed ST3 program, which includes many projects to improve and extend high-capacity transit infrastructure. One of the projects would extend Link Light Rail from downtown Seattle to West Seattle with an elevated guideway through SODO on the E-3 Busway (located at approximately 5th Ave S). This line would share a stop at the SODO Station. Increases in commuter rail service on the South Sounder line are also proposed. The ST3 program requires voter approval, and is scheduled for a public vote in November 2016.

There are several other projects proposed for SODO in the City's Capital Improvement Program (CIP) and Move Seattle program, approved by voters in 2015. In addition to the S Lander St Grade Separation Project, planned improvements in SODO include:

- Repaving 4th Ave S from S Spokane St to SR 519 (Edgar Martinez Drive). This project is scheduled for 2017.
- Upgrading East Marginal Wy S from S Michigan St to S Atlantic St to improve facilities for pedestrians and bicyclists, and improve the pavement in the designated Heavy Haul Corridor. This project is in preliminary planning and no construction schedule has yet been determined.

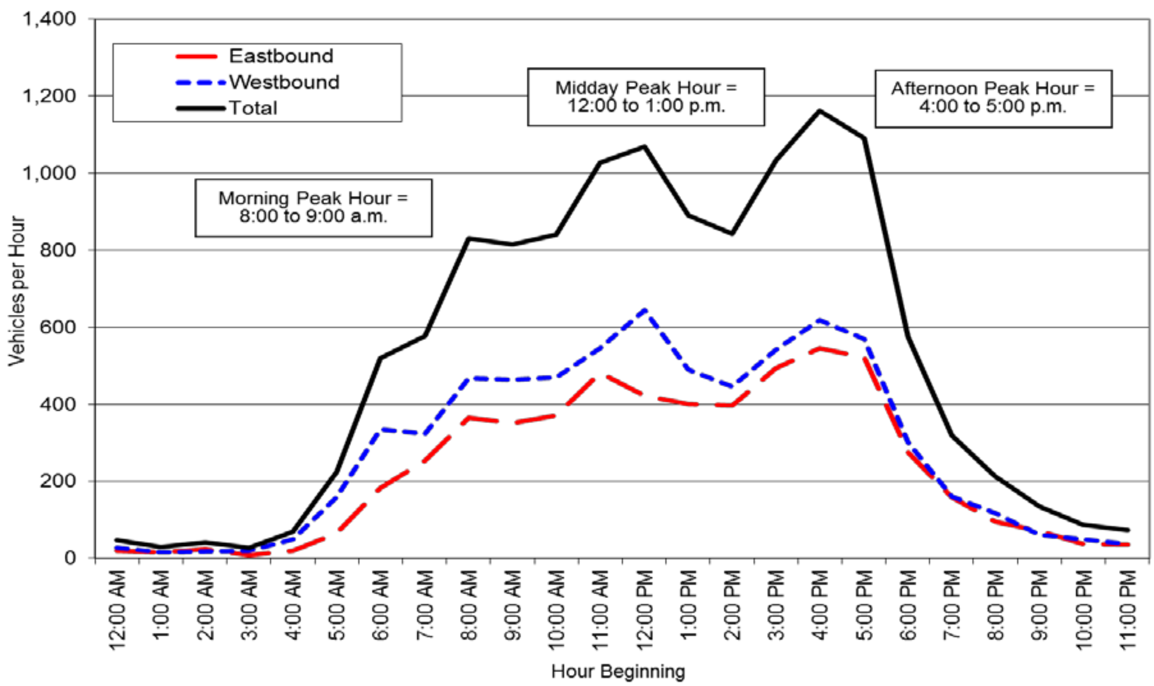
2.2 Traffic Volumes

2.2.1. Existing Traffic Volumes

SDOT performed new traffic counts along the S Lander St corridor in January, March and May 2016. The counts included seven-day machine counts on S Lander St and intersecting streets as well as turning movement counts at the four key intersections along S Lander St.

Figure 6 shows the weekday traffic volumes that cross the railroad tracks on S Lander St during each hour on a weekday. Unlike most arterial streets in Seattle, there are no distinct directional peak periods on S Lander St; the westbound traffic volumes are higher than the eastbound volumes for all hours of the day. This is likely because eastbound traffic from West Seattle can cross the railroad tracks by staying on the Spokane Street Viaduct to the 4th Ave S off-ramp. There is no companion westbound on-ramp to the Spokane Street Viaduct at 4th Ave S so some westbound traffic uses S Lander St to reach the Viaduct's 1st Ave S on-ramp. This is likely also why there is no distinct AM peak hour on S Lander St since the morning traffic can disperse directly to the north-south arterials of 1st and 4th Aves S using the Spokane Street Viaduct off-ramps.

Figure 6. S Lander St Weekday Traffic Volumes by Time of Day - 2016

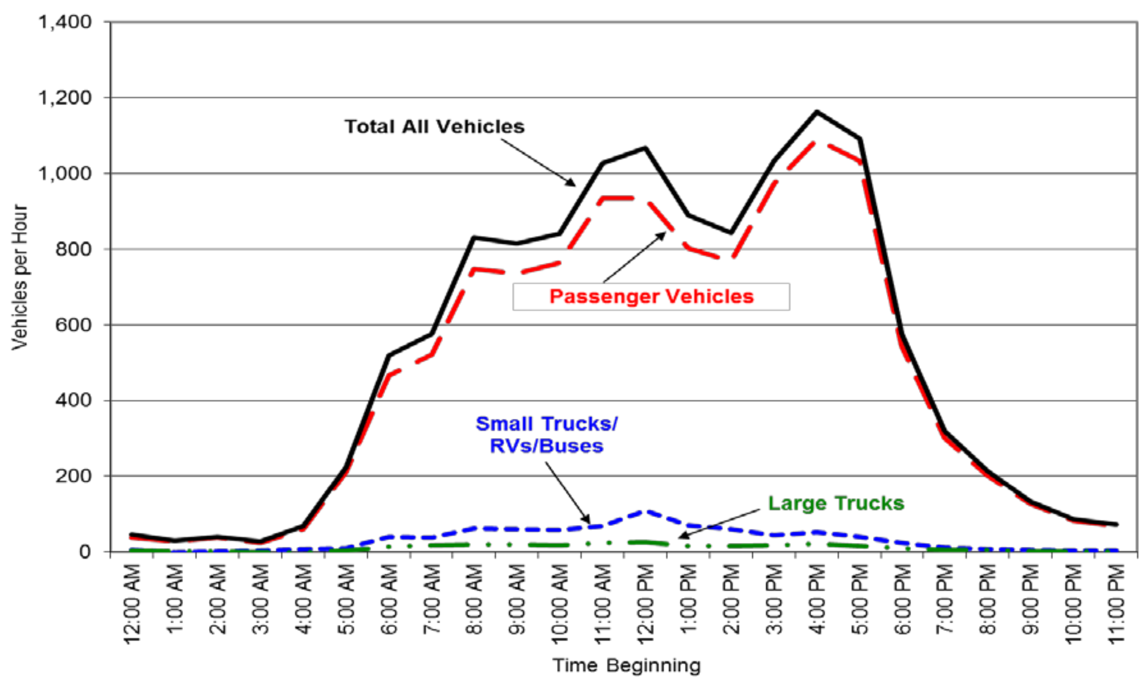


Source: SDOT, January 2016, Volumes shown on the average of counts on Tuesday, January 13, 2016 and Wednesday, January 14, 2016.

2.2.2. Existing Truck Volumes

The existing counts also include vehicle classification data based on the number and spacing of axles. The vehicle classification data were compiled to show small and large trucks as a proportion of the total traffic volume. **Figure 7** shows the types of vehicles traveling on S Lander St by time of day. Over the full day, small trucks and buses account for approximately 6% of all vehicles while large trucks (those with five or more axles) account for about 2% of all vehicles. During the midday peak hour, these types of vehicles account for a combined 12% of the vehicles (10% small trucks/buses and 2% large trucks).

Figure 7. S Lander St Vehicle Classifications by Time of Day - 2016



Source: SDOT, January 2016, Volumes shown on the average of counts on Tuesday, January 13, 2016 and Wednesday, January 14, 2016.

2.2.3. Changes in Traffic Volumes since 2008 Lander St Study

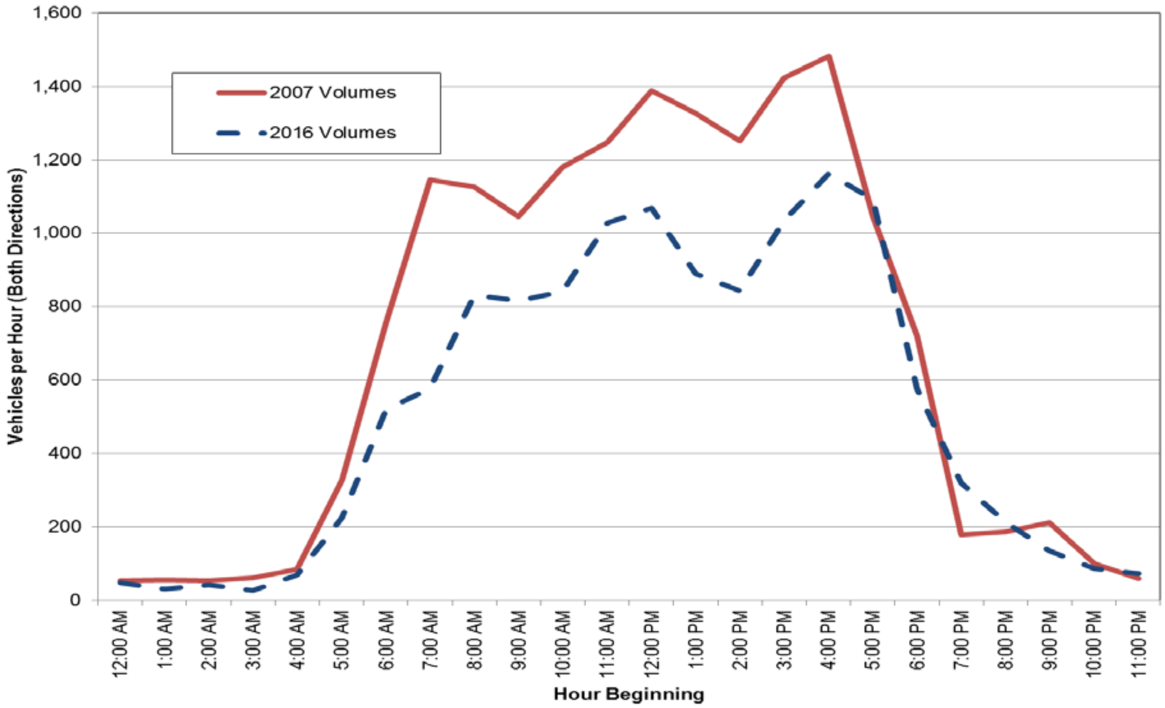
As noted in Section 1.2, there have been several changes in the transportation system since the prior traffic study was completed in 2008 that have likely affected traffic patterns. Traffic counts performed in April 2007 were compared to those taken in January 2016. Daily volumes presented in **Table 3** show that volumes have decreased by about 24% during that time, with similar reductions in both directions of travel. Peak hour volumes have experienced similar reductions, which range from 21% to 28%, as shown on **Figure 8**.

Table 3. Comparison of Daily Traffic Volumes - 2007 vs 2016

	Eastbound	Westbound	Total
April 2007	7,408	9,095	16,503
January 2016	5,609	6,932	12,541
Net Change	-24%	-24%	-24%

Source: 2007 Traffic Counts performed by All Traffic Data on April 5, 2007, a day with no Mariners game. 2016 Counts performed by SDOT on January 13 and 14, 2016.

Figure 8. Comparison of S Lander St Hourly Volumes – 2007 vs 2016



Source: 2007 Traffic Counts performed by All Traffic Data on April 5, 2007, a day with no Mariners game. 2016 Counts performed by SDOT on January 13 and 14, 2016.

2.2.4. Future Traffic Volumes

Traffic analysis for S Lander St was performed for future year 2040 conditions. Future traffic forecasts were derived using output of the *Container Terminal Area Traffic Analysis Tool*, which was developed for the Port's Container Terminal Access Study.[5] This tool was used since it provides future forecasts consistent with the City and region's long-range growth plans, and provides truck volume estimates that are not typically provided by other modelling tools. Future regional non-Port travel demand was based upon trip tables obtained from the Puget Sound Regional Council (PSRC) 2040 Emme model, and the Port-generated demand was accounted for separately using Port truck trip forecasts and distribution projections. The forecasts account for growth in the neighborhood associated with new development under approved zoning. The *Container Terminal Area Traffic Analysis Tool* utilizes the Dynameq software, which is a "mesoscopic" model that utilizes a simulation-based dynamic trip assignment method that accounts for congestion and detailed operational characteristics of a network. It provides dynamic traffic assignment that takes into account roadway and intersection congestion; accounts for delays encountered by railroad crossings, bridge closures and ramp metering; and includes detailed roadway network attributes such as lane configurations and signal phasing. The model area included four railroad crossings between 1st Ave S and 4th Ave S, at S Holgate St, S Lander St, S Horton St, and S Spokane St. The model was calibrated to traffic volume and speed data obtained from several City, State, and Port sources.

The major roadway network changes assumed for 2040 conditions included completion of the Alaskan Way Viaduct Replacement project, the Mercer Corridor project, and Waterfront Seattle project. Further information about the model and forecast volumes is provided in **Appendix A.**

5 Transpo Group, Container Terminal Area Traffic Analysis Tool, Model Development and Application, July 2015.

The results of the modelling show that total traffic on S Lander St is expected to increase by about 0.1% per year, but truck traffic is expected to increase at a faster rate of about 1.3% per year. Through traffic on 1st Ave S is predicted to slightly decline in the future (-0.4% per year), likely a result of improvements to SR 99 that will allow traffic to exit SR 99 south of downtown; truck traffic on that corridor is projected to increase (2.0% per year). On 4th Ave S, slight increases in total traffic (0.3% per year) and truck traffic (0.9% per year) are forecast.

For the purpose of this analysis, non-truck volumes at study area intersections were assumed to increase by 0.3% per year and trucks (small and large) were assumed to increase by 1.3% per year. Overall, this relates to a weighted average growth rate of 0.4%. Heavy vehicle percentages would increase by 1 to 2% of all vehicles depending on the time of day. **Table 4** summarizes S Lander St traffic volumes at the railroad tracks.

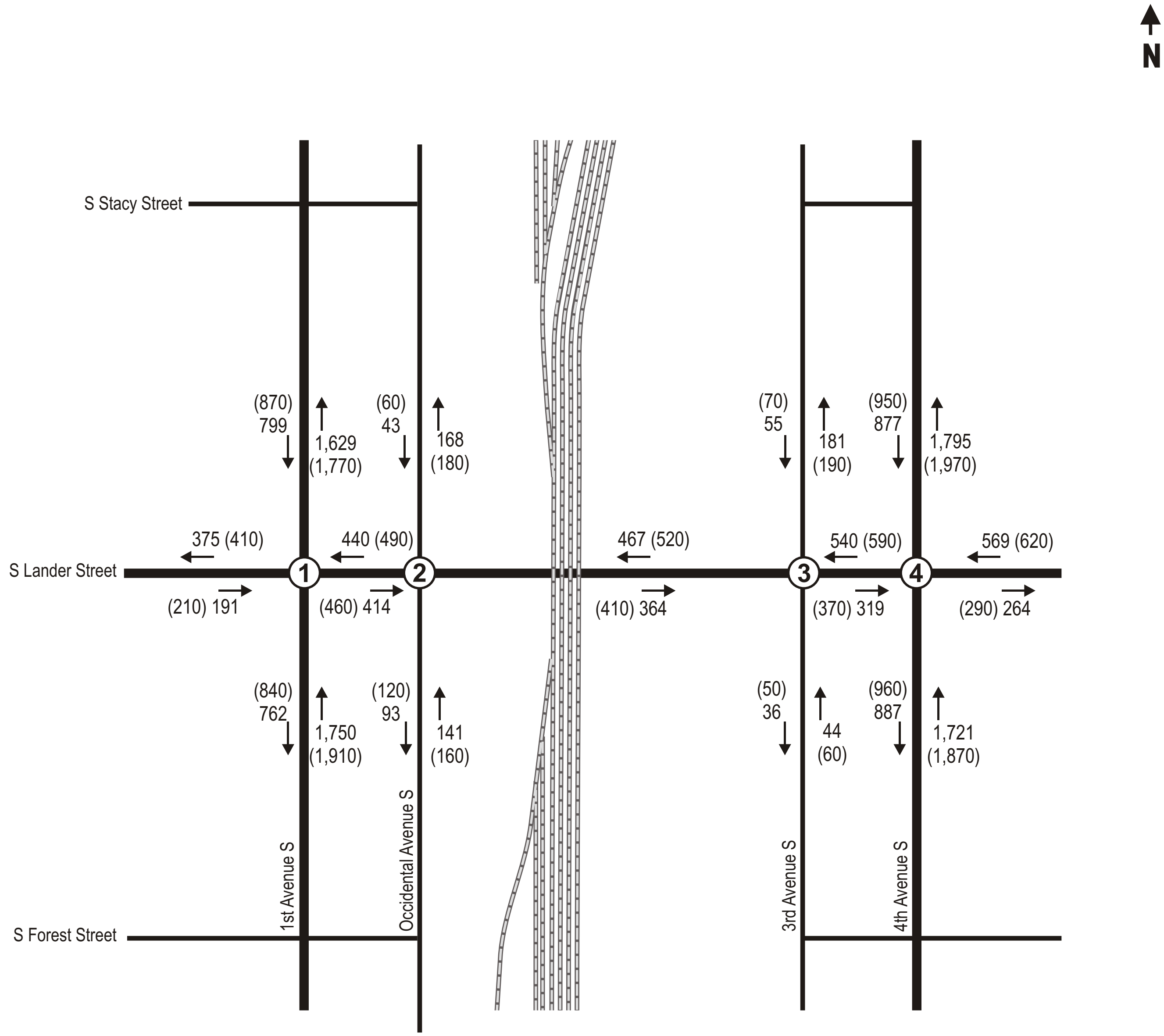
Table 4. Existing (2016) and Future (2040) No Build Volumes – S Lander St at RR Crossing

	Existing (2016) Traffic Volumes				Future (2040) Traffic Volumes			
	EB	WB	Total	HV%	EB	WB	Total	HV%
Weekday (24 hours)	5,593	6,914	12,507	8.2%	6,100	7,500	13,600	9.3%
AM Peak Hour (8 AM - 9 AM)	364	467	831	9.8%	410	520	930	10.9%
Midday Peak Hour (12 PM - 1 PM)	423	645	1,068	12.4%	460	710	1,170	14.1%
PM Peak Hour (4 PM - 5 PM)	545	618	1,163	6.2%	600	680	1,280	7.0%

Source: Existing volumes from counts performed by SDOT, January 2016. Future forecasts assume a 0.3% per year increase in non-truck traffic and 1.3% per year increase in truck traffic.

2.2.5. Intersection Volumes

Intersection turning movement counts were compiled to evaluate traffic operations, and to determine how grade separation options would affect local traffic patterns. The existing 2016 traffic volumes and growth rates presented above were used to forecast year 2040 conditions. AM, midday and PM peak hour traffic volumes for both the existing and 2040 No Build conditions are shown on **Figure 9**, **Figure 10**, and **Figure 11**, respectively.



KEY

(XX) XX → Existing (2040 No Build) Traffic Volumes

1 S Lander St / 1st Ave S

(100) 93; (620) 571; (150) 135	165 (180); 126 (140); 149 (170)
(90) 84; (70) 65; (50) 42	156 (170); 1,380 (1,500); 214 (240)

2 S Lander St / Occidental Ave S

(20) 15; (20) 13; (20) 15	18 (20); 381 (420); 68 (80)
(60) 57; (380) 345; (20) 12	44 (50); 93 (100); 4 (10)

3 S Lander St / 3rd Ave S

(40) 33; (10) 4; (20) 18	95 (100); 431 (470); 14 (20)
(70) 67; (320) 279; (20) 18	3 (10); 19 (20); 22 (30)

4 S Lander St / 4th Ave S

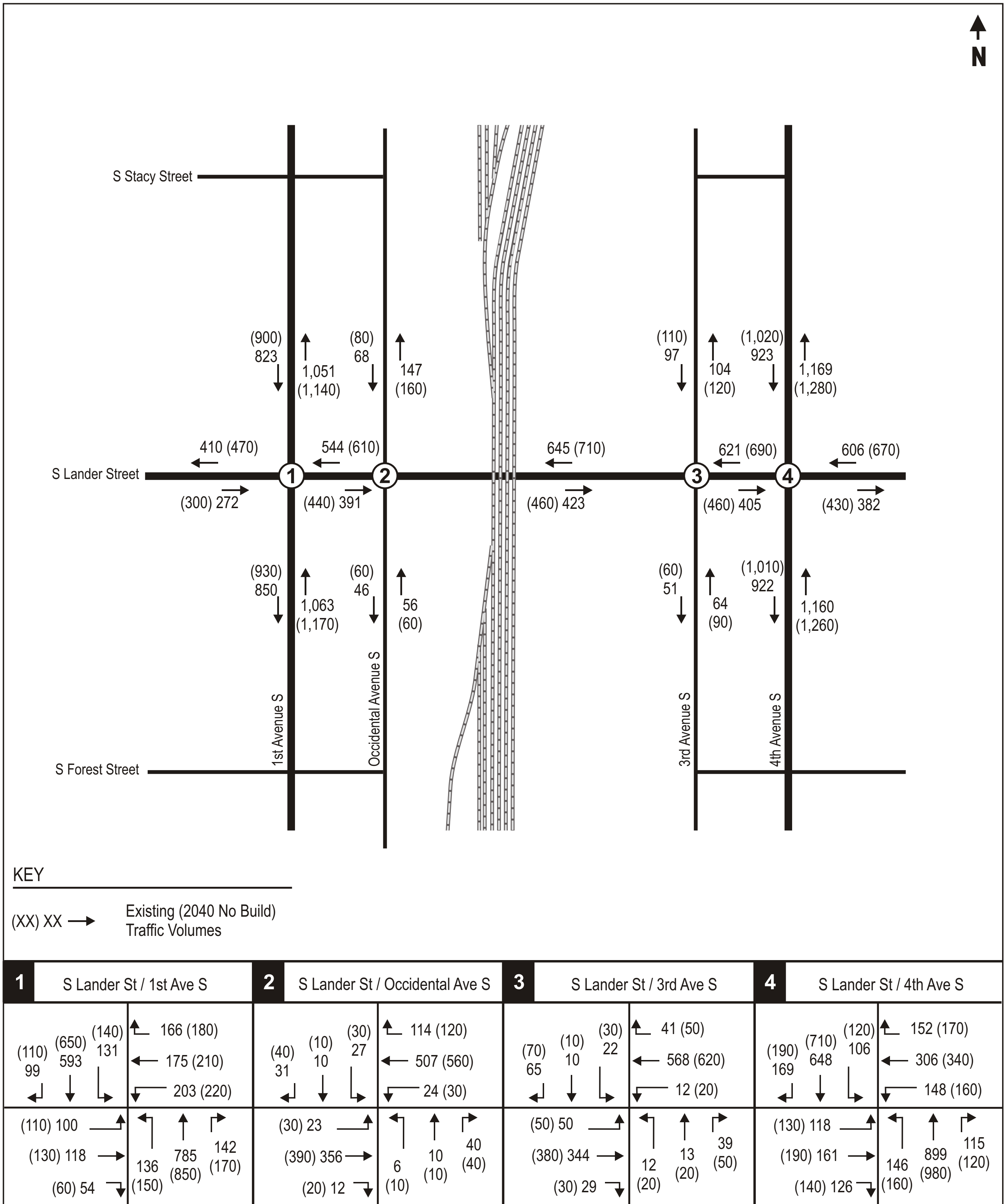
(80) 74; (810) 744; (60) 59	165 (180); 327 (360); 77 (80)
(150) 123; (150) 130; (70) 66	139 (150); 1,507 (1,640); 75 (80)

LANDER STREET Grade Separation

Figure 9
AM Peak Hour Traffic Volumes Existing (2016) and Year 2040 No Build Conditions

heffron transportation, inc.

06.20.16

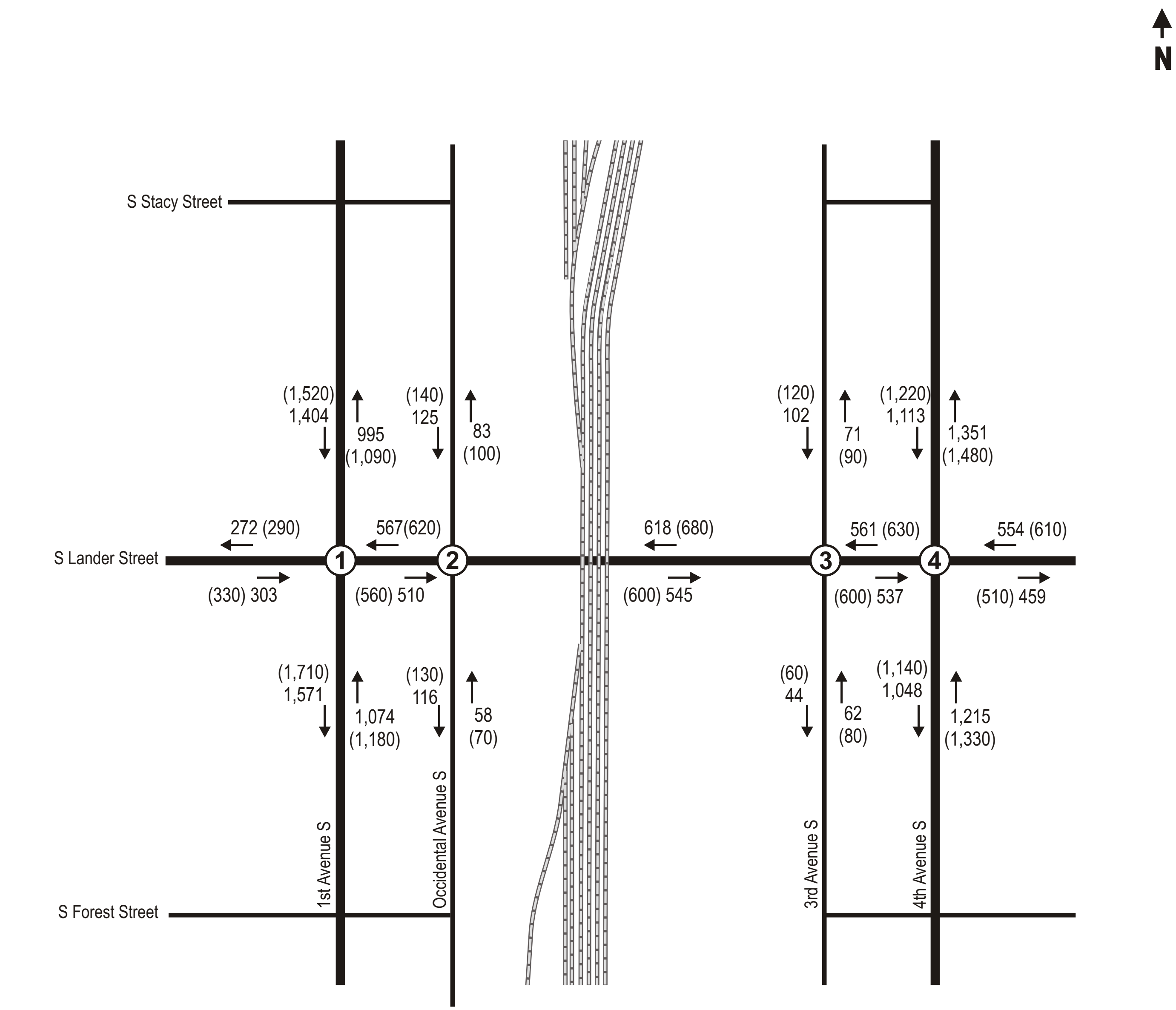


LANDER STREET
Grade Separation

Figure 10
Midday Peak Hour Traffic Volumes
Existing (2016) and
Year 2040 No Build Conditions

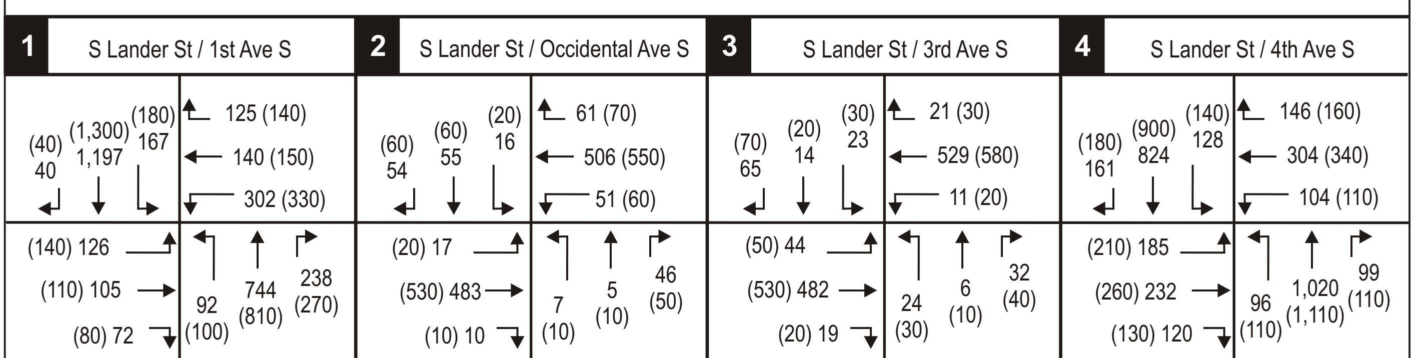
heffron transportation, inc.

06.20.16



KEY

(XX) XX → Existing (2040 No Build) Traffic Volumes



LANDER STREET Grade Separation

Figure 11
PM Peak Hour Traffic Volumes Existing (2016) and Year 2040 No Build Conditions

heffron transportation, inc.

06.20.16

2.3 Train Crossings and Closure Duration

There are four existing rail tracks that cross S Lander St at grade. There are flashing signals and gates that close in advance of a train crossing. This section describes the types of train movements, number of train crossings, typical durations of gate closures, and resulting vehicle delay.

2.3.1. Number and Types of Train Movements

Freight trains, Amtrak passenger trains, and Sounder Commuter Rail trains cross S Lander St. Video surveillance of the S Lander St rail crossings was performed in late January 2016.[6] Data for a 72-hour period were compiled to determine the types, numbers and durations of closings. The crossing was closed an average of 115 times per day over the three-day period, including 20 Sounder trains, 8 Amtrak trains, and 62 freight trains. Switching movements across S Lander St also occur due to activity and train repositioning in the nearby Republic Services rail yard, accounting for an average 13 closures per day. In addition, the gates may close several times a day when a train does not pass the crossing. These "ghost closures" are caused by upstream switching into and out of the Amtrak Yard near S Holgate St, and resulted in an average 12 closures per day.

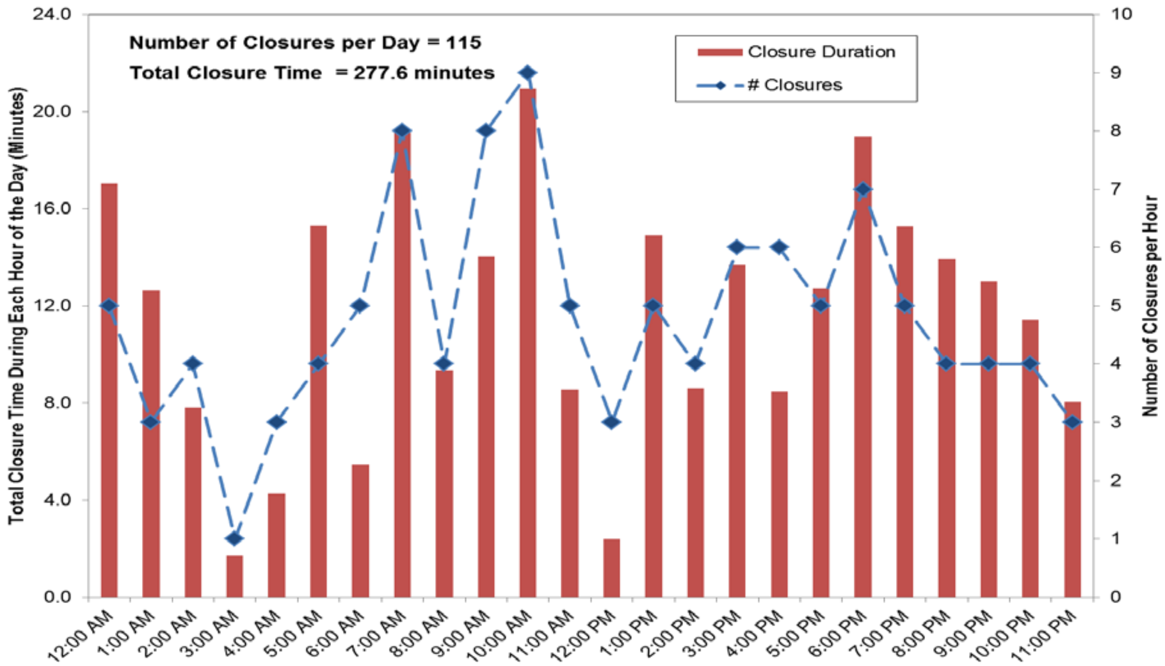
2.3.2. Closure Durations

Total closure time for each event was determined from the 72-hour video data. The closure time starts when the gates are lowered and ends when the gates are raised and vehicle movement resumes. The average closure durations by hour of the day are shown on **Figure 12**. The duration of each closure ranged from 33 seconds to over 13 minutes. The average closure lasted 2.4 minutes. As shown, the number and duration of the closures is highest during the morning, with the peak occurring during the 10:00 A.M. hour. **Figure 13** illustrates the range of closure durations for an average day.

It is noted that during the video surveillance period, a gate malfunction occurred and the gates were set to their emergency recall position for 2.5 hours (no vehicular access across tracks). This gate-closure time was excluded from the averages shown below. However, it does highlight that the at-grade crossing is subject to incidents and maintenance issues that can substantially affect vehicular traffic.

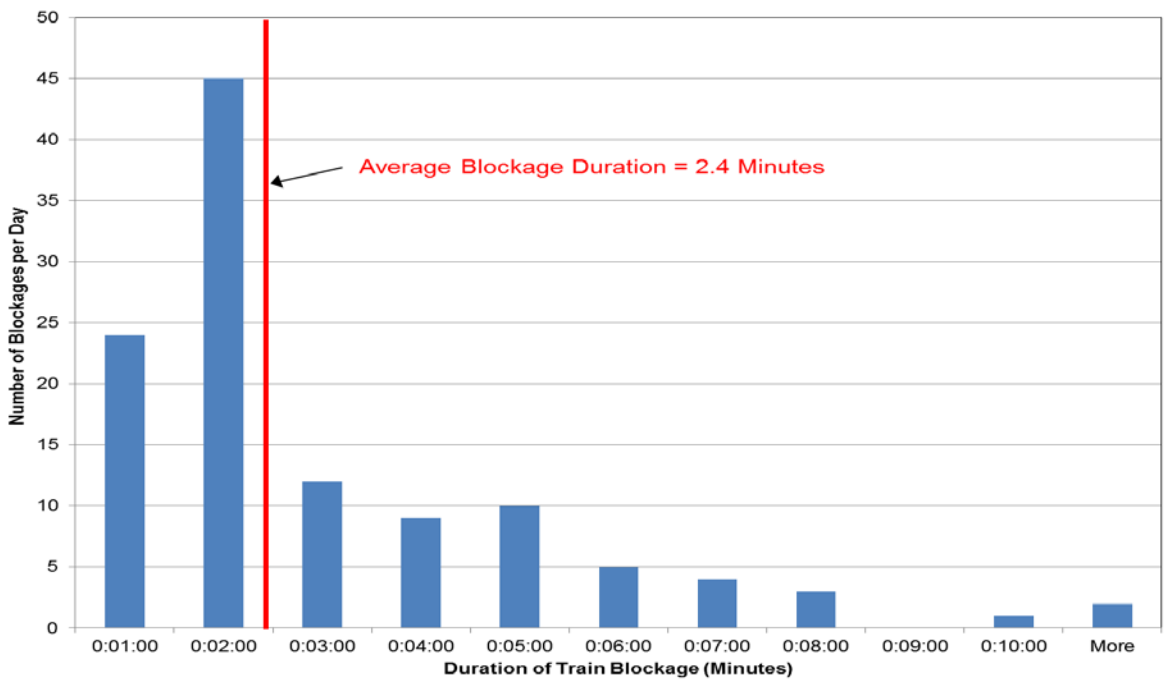
[6] Video data collected and compiled by SDOT for period from midday Tuesday, January 26, 2016 through midday Friday, January 29, 2016.

Figure 12. S Lander St Railroad Closures by Time of Day



Source: Average of 72-hours of video observations from January 26 to January 29, 2016. Data compiled by SDOT, and charted by Heffron Transportation, Inc.

Figure 13. Frequency and Duration of S Lander St Railroad Closures – Average Day



Source: Average of 72-hours of video observations from January 26 to January 29, 2016. Data compiled by SDOT, and charted by Heffron Transportation, Inc.

2.3.3. Closure Violations

The number of vehicles or pedestrians who crossed the railroad tracks after the gates had closed was recorded for two full days in January 2016. During that period, an average of about 300 vehicles per day, 180 pedestrians per day, and 14 bikes per day violated the crossing protection. Of particular concern were pedestrians who crossed the tracks immediately after one train had cleared, but in advance of another oncoming train. Given that there are four tracks at this crossing, sight lines to the oncoming train can be impaired by a train on a nearer track.

2.3.4. Forecast Increase in Train Crossings

Future train crossings of S Lander St were estimated based on expected changes in passenger rail service and future growth in freight rail demand. Sound Transit expects to increase commuter rail service on the line from 20 train trips per day to 26 train trips per day by 2040. Amtrak service is expected to increase from 8 train trips per day to 14 daily trips by 2018.

Increases in freight train activity were determined using information in the *Pacific Northwest Marine Cargo Forecast Update and Rail Capacity Assessment.*[7] This report presents train forecasts by region, including detailed estimates for the Auburn-to-Seattle segment that crosses S Lander St. Freight rail on this line is expected to grow at rates ranging from 2% per year through 2040 under average conditions with moderate growth, to 3.0% per year on a peak day with high growth (also accounting for potential increases in coal trains through Seattle). Switching movements across S Lander St were assumed to increase at 2% per year to reflect increases in waste handling and cargo distribution. The ghost closures, which are related to upstream switching at the Amtrak Yard, were assumed to increase in proportion to Amtrak passenger rail growth. **Table 5** summarizes the forecast 2040 train crossings of S Lander St; existing crossings are shown for comparison.

Table 5. Train / Gate Closure Activity at S Lander St

	Average Number of Closures per Day	
Purpose of Closure	January 2016 [a]	2040 No Build
Sounder Commuter Rail	20	26
Amtrak Passenger Trains	8	14
Freight trains	62	100 to 150 [c]
Switching movements	13	21
Ghost Closure (No Train) [b]	12	21
Total Closures	115	182 to 232

a. *Based on video observations for 72-hour period from January 26 to January 29, 2016. Values represent the average day. Data compiled by SDOT.*

b. *The gates will occasionally close due to upstream switching near S Holgate St when a train passes the trigger that signals a gate closure event.*

c. *Low end of the range reflects an average day at moderate growth and high end of the range reflects a peak day with high growth.*

To accommodate the future growth, two additional tracks are proposed through this section of SODO. The new bridge is being designed to provide space for these tracks.

[7] BST Associates and Mainline Management, December 2011. Analysis prepared for the Pacific Northwest Rail Coalition.

2.4 Traffic Operations

2.4.1. Vehicle Delay and Travel Time

Traffic operations with S Lander St train crossings were evaluated using the microsimulation model SimTraffic. A train crossing will delay traffic, and the resulting queue can back up through nearby intersections and exacerbate operations at the arterial intersections on 1st and 4th Aves S. Vehicle delay and travel time for westbound and eastbound traffic provide a measure to compare existing and future No Build conditions to conditions in the future with the proposed grade separation. Delay is experienced by all vehicles that arrive during the time that the rail crossing gates are closed, with the wait time varying from the first to the last vehicle in the queue. The total delay also includes the time it takes the queue to clear following a closure.

For the existing condition, the frequency of train crossings were assumed to be the same as shown previously on Figure 12 for the AM, midday, and PM peak hour conditions. Most of the train crossings were assumed to be relatively short-duration crossings (five 140-second crossings during the AM peak hour, four 48-second crossings during the midday hour, and six 137-second crossings during the PM peak hour); however, one train during each analysis hour was assumed to have a 10-minute blockage. In the future, the number of train blockages is expected to double, and two of the blockages were assumed to be long trains (10 minutes each). The rest of the trains were assumed to have the same average crossing time as existing. **Table 6** summarizes the vehicle delay and travel time associated with travelling on S Lander St between 1st and 4th Aves S. The metrics are reported for each direction of travel.

As shown in **Table 6**, westbound traffic has higher delays and travel times than eastbound traffic for all time periods. During the PM peak hour, which is the peak condition, the vehicles are delayed by an average 262 seconds (4.4 minutes), which reflects vehicles within the hour that are not stopped by a train as well as those that are. During this hour, a vehicle is projected to take an average of 350 seconds (5.8 minutes) to travel westbound through the corridor from 4th Ave S to 1st Ave S. These delays are expected to increase dramatically in the future with increased traffic volumes combined with increased train blockages. Delay could increase by up to 181% in the PM peak hour; smaller increases in delay and travel time are expected in the midday hours since the lower traffic volumes would more easily recover following a train blockage. By 2040, the average travel time for a vehicle traveling along this short segment of S Lander St during the PM peak hour is estimated at over 850 seconds (14.2 minutes).

Table 6. Vehicle Delay and Travel Time on S Lander St – Existing and 2040 No Build Condition

	Existing (2016) Conditions		Year 2040 No Build		% Increase from Existing to 2040	
	Average Vehicle Delay (seconds)	Average Travel Time (seconds)	Average Vehicle Delay (seconds)	Average Travel Time (seconds)	Average Vehicle Delay	Travel Time
AM Peak Hour						
Eastbound (1st Ave S to 4th Ave S)	179.9	231.3	403.9	454.4	125%	96%
Westbound (4th Ave S to 1st Ave S)	239.8	310.7	637.7	724.8	166%	133%
Midday Peak Hour						
Eastbound (1st Ave S to 4th Ave S)	124.3	171.4	210.7	257.6	70%	50%
Westbound (4th Ave S to 1st Ave S)	144.3	222.8	251.7	330.5	74%	48%
PM Peak Hour						
Eastbound (1st Ave S to 4th Ave S)	170.2	220.4	387.0	439.9	127%	100%
Westbound (4th Ave S to 1st Ave S)	262.0	350.8	735.2	853.4	181%	143%

Source: Synchro model developed Heffron Transportation, Inc., May 2016 using existing roadway geometry and signal timing protocols provided by SDOT. Signal cycle length and phase splits for optimized for future conditions with these protocols. Levels of service for signalized intersections were calculated using the SimTraffic module with an average of 5 model runs.

2.4.2. Intersection Operations

Intersection operations are evaluated using level of service (LOS) with six letter designations, "A" through "F." LOS A is the best and represents good traffic operations with little or no delay to motorists. LOS F is the worst and indicates poor traffic operations with long delays. Levels of service for area intersections were also determined using the SimTraffic micro-simulation model in order to account for the effects of queues extending from the railroad tracks. The No Build condition reflects the existing lane geometry and signal timing protocols along the 1st Ave S and 4th Ave S corridors, although signal timings were optimized within the set parameters.[8] The intersection levels of service are summarized in **Table 7**.

As shown, the S Lander St/1st Ave S intersection currently operates at LOS C during the AM and Midday peak hours and at LOS D during the PM peak hour. These conditions are expected to degrade to LOS E, D and F for the three peak hours, respectively for the 2040 No Build Condition. The S Lander St/4th Ave S intersection currently operates at LOS D for all three peak hours, and would degrade to LOS F in 2040. The two unsignalized intersections—at Occidental Ave S and 3rd Ave S—currently have LOS F operation for vehicles turning onto S Lander St from the side street. These movements would experience increased delay in the future due to growth in vehicle traffic and increased train blockages.

Table 7. Intersection Level of Service - Existing and 2040 No Build Conditions

Time Period / Intersection	Existing (Year 2016) Conditions		Year 2040 No Build Conditions	
	LOS [1]	Delay [2]	LOS [1]	Delay [2]
AM Peak Hour				
S Lander St/1st Ave S	C	31.3	E	77.1
S Lander St/4th Ave S	D	50.1	F	114.8
S Lander St/Occidental Ave S [3]	F	158.8	F	501.3
S Lander St/3rd Ave S [3]	F	196.7	F	439.3
Midday Peak Hour				
S Lander St/1st Ave S	C	26.4	D	41.5
S Lander St/4th Ave S	D	41.1	F	185.1
S Lander St/Occidental Ave S [3]	F	95.3	F	405.4
S Lander St/3rd Ave S [3]	F	98.4	F	175.8
PM Peak Hour				
S Lander St/1st Ave S	D	46.4	F	90.0
S Lander St/4th Ave S	D	48.2	F	136.3
S Lander St/Occidental Ave S [3]	F	278.1	F	886.7
S Lander St/3rd Ave S [3]	F	585.5	F	1,499.1

Source: Synchro model developed by Heffron Transportation, Inc., May 2016 using existing roadway geometry and signal timing protocols provided by SDOT. Signal cycle length and phase splits for optimized for future conditions with these protocols. Levels of service for signalized intersections were calculated using the SimTraffic module with an average of 5 model runs.

1. *Level of service.*
2. *Average seconds of delay per vehicle.*
3. *Delay for worst movement from side street stop sign.*

[8] Optimization is the process where the amount of green time allocated to each signal phase was adjusted using the Synchro 9.1 software program. The existing cycle lengths and maximum signal timings were retained.

2.5 Non-motorized Facilities

2.5.1. Existing Pedestrian and Bicycle Conditions

Currently, there are sidewalks on both sides of S Lander St. In most locations, the sidewalk is 5-feet wide with a 3- to 5-foot planter strip between the sidewalk and the curb. The narrowest sidewalks are located between 1st Ave S and Occidental Ave S, where the sidewalk is approximately 4-feet wide adjacent to buildings located on the property line. S Lander St is one of the primary pedestrian access routes to the SODO Link Light Rail Station, which is located along the E-3 Busway just north of S Lander St. Marked crosswalks exist on all legs of the signalized intersections at 1st Ave S and 4th Ave S. Although there are no marked crosswalks at Occidental Ave S or 3rd Ave S, they are legal crossing locations, and some pedestrians have been observed crossing S Lander St at those minor intersections.

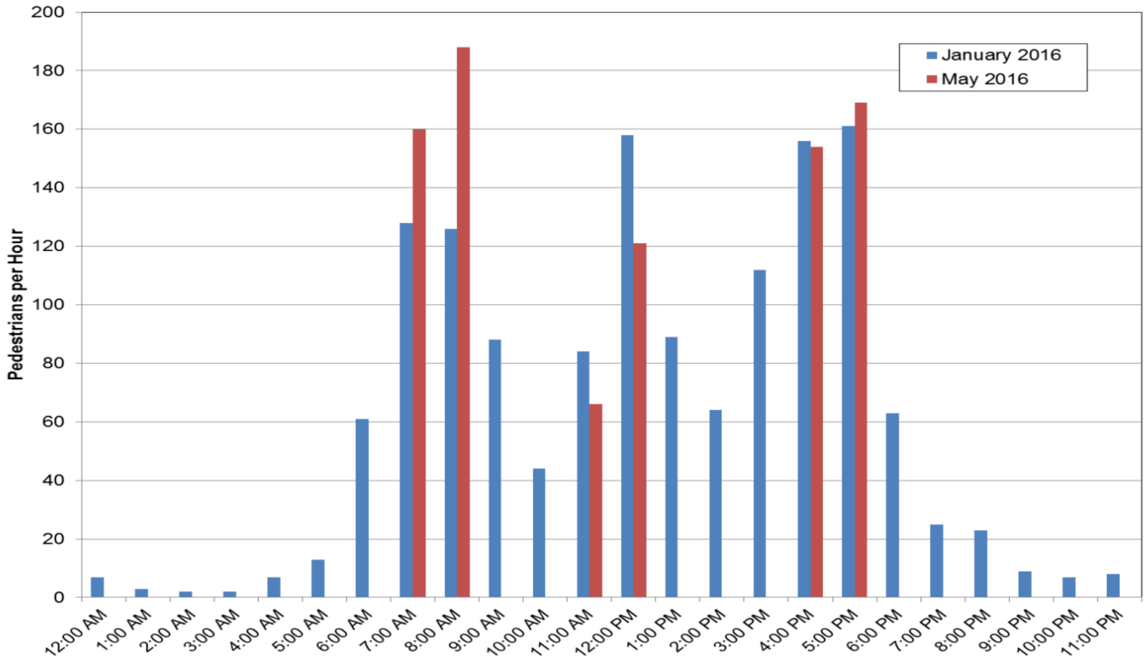
For bicyclists, there are "sharrows" painted in the outside travel lanes of S Lander St adjacent to the parking lane, which are shared-lane pavement markings placed in the roadway lane to highlight the shared space. Unlike a bicycle lane, a sharrow does not delineate a particular part of the roadway that a bicyclist should use. Bicyclists are allowed to take a lane on any road; sharrows serve as a reminder to vehicles.

The pedestrian and bicycle network in the SODO neighborhood was shown previously on **Figure 4**. The north-south arterials in SODO generally have continuous sidewalks. However, facilities are limited on other streets. Bicycle facilities in the area exist along the E-3 Busway to the east and East Marginal Way to the west. The latter is disconnected from the S Lander St area by SR 99, which is an access-controlled facility through SODO. To the north, the Mountains-to-Sound Greenway, which is the primary bicycle facility that crosses Lake Washington on I-90, connects to 1st Ave S via Royal Brougham Way.

Pedestrian and bicycle counts on S Lander St were conducted in January 2016 and again in May 2016 to measure the seasonal fluctuations in volumes; the May counts were only performed for the peak periods so comparison of daily volumes is not possible. The pedestrian volumes, shown on **Figure 14**, are highest during the morning peak hour when about 190 pedestrians per hour walked along S Lander St. During the peak hours, about 90% of the pedestrians walked along the north side of the street, which is along the direct walking route between the Starbucks Center, the Seattle Public Schools Headquarters, and the SODO Link Light Rail station.

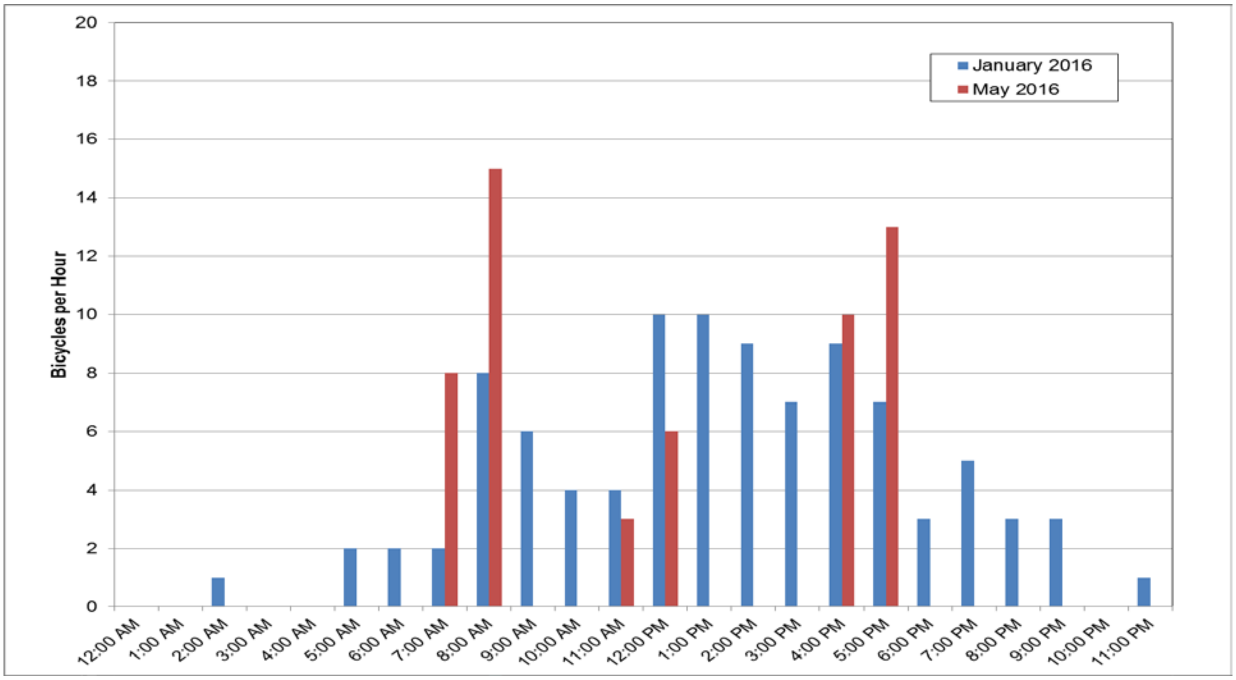
Shown on **Figure 15**, fewer than 20 bicycles per hour (total for both directions) were observed on S Lander St in May, which was Bike-to-Work month. All but one of the bicyclists rode in the street.

Figure 14. Pedestrian Volumes on S Lander St by Time of Day



Source: January data are the average of 72-hours of video observations from January 26 to January 29, 2016. May data are from morning, midday, and afternoon video counts at the S Lander St/Occidental Ave intersection performed on May 26, 2016. No data were available for the time periods without a red bar. Data compiled by SDOT, and charted by Heffron Transportation, Inc.

Figure 15. Bicycle Volumes on S Lander St by Time of Day



Source: January data are the average of 72-hours of video observations from January 26 to January 29, 2016. May data are from morning, midday, and afternoon video counts at the S Lander St/Occidental Ave intersection performed on May 26, 2016. No data were available for the time periods without a red bar. Data compiled by SDOT, and charted by Heffron Transportation, Inc.

2.5.2. Future Pedestrian and Bicycle Conditions

The *Draft Seattle Pedestrian Master Plan (PMP) Update*[9] prioritizes pedestrian improvements around public schools, transit stations and bus stops, and along streets, particularly arterials, where sidewalks are missing. In the vicinity of S Lander St, the PMP Update identifies 4th Ave S between S Lander St and S Hanford St and S Forest St from 4th Ave S to 8th Ave S as arterials that are missing sidewalks. S Lander St itself is also within the influence area of the SODO Light Rail Station.

The *Seattle Bicycle Master Plan*[10] has no adopted route designation for S Lander St.

2.5.3. Future Pedestrian and Bicycle Volumes

Future increases in pedestrian traffic are expected, and would primarily be related to increased activity generated by Link Light Rail service at the SODO Station. As the light rail network is extended north, south, and east, it will attract new riders to the area, who will then walk between the station and area businesses. In 2015, an average of 2,400 boardings per day occurred at the SODO Station. Sound Transit forecasts that this will increase to up to 4,300 boardings per day by 2021, an 80% increase.[11] At this rate, peak hour pedestrian activity along S Lander St is forecast to increase from about 190 pedestrians per hour to about 340 pedestrians per hour.

Bicycle volumes are also expected to increase. Information from the *Seattle Bicycle Master Plan* shows that bicycle trips into the core area of downtown have increased by 5.5% per year from 1995 to 2011. [12] That growth, which is higher than the population growth in the City, reflects a shift to bicycling from other modes of travel. Based upon that rate, bicycle volumes on S Lander St are expected to increase from less than 20 during the peak hour today to about 55 per hour by year 2040. **Table 8** summarizes the existing pedestrian and bicycle volumes along with the future growth estimates.

9 City of Seattle, July 1, 2016.
10 City of Seattle, Adopted April 2014.
11 Sound Transit, 2016 Service Implement Plan, Draft, October 2015.
12 *Seattle Bicycle Master Plan*, Figure 2-1 Downtown Bicycling Trends in the City.

Table 8. Pedestrian and Bicycle Traffic on S Lander St - Existing and No Build Conditions

	Pedestrians/ Hour		Bicycles / Hour	
	Eastbound	Westbound	Eastbound	Westbound
Existing [a]				
North Side	8	162	1	10
South Side	3	16	5	0
Total	11	178	6	10
2040 No Build				
North Side	10	290	5	35
South Side	10	30	20	0
Total	20	320	20	35

a. *Existing pedestrian and bicycle volumes from SDOT count performed on May 26, 2016. Volumes reflect peak hour conditions during the morning peak hour. Volumes are slightly lower and in the reverse direction during the PM peak hour.*

2.6 Transit Service and Facilities

2.6.1. Link Light Rail

The S Lander St project is located one block west of the SODO Station on the Central Link light rail line that runs from Seattle-Tacoma International Airport, through downtown Seattle, to the University of Washington. On average, 2,400 people per day access Link light rail at the SODO station. By 2040, with the funded extensions to Lynnwood, Redmond, and Angle Lake, 255 daily train trips and 3,900 to 4,300 daily boardings and alightings are expected at the SODO station.[13] Additionally, if voters approve Sound Transit's proposed ST3 System Plan in November 2016, a new West Seattle to Downtown Seattle light rail line would provide a transfer connection at the SODO station and further increase station activity. The light rail line through SODO would connect north to Everett with the ST3 plan.

2.6.2. King County and Sound Transit Buses

King County Metro currently provides bus service along S Lander St. Two all-day bus routes, 21 and 50, provide 14 peak-hour trips and 210 daily bus trips through the corridor; about 6,200 daily boardings were observed on these routes in 2015. Four peak-period bus routes, 37 (northbound), 116X, 118X, and 119X, also operate along S Lander St. These four routes provide six peak hour trips and 28 daily bus trips; about 1,000 daily boardings were observed on these routes in 2015.[14]

S Lander St is also used by buses that may be redirected from other transit corridors due to incidents or construction. This includes buses that serve West Seattle and Burien.

13 Sound Transit, 2016 Service Implement Plan, Draft, October 2015.
14 King County Metro.

2.6.3. Sounder Commuter Rail

Sounder commuter rail service runs on the BNSF main line across S Lander St, providing service between Seattle and Lakewood (40 miles south). Service along this line currently includes 20 daily train trips with 9,400 passengers. By 2040, daily train trips are projected to increase to 26 train trips with an estimated 29,100 to 33,000 passengers.[15] The nearest stop is at King Street Station. The ST3 plan includes track and station improvements that would allow up to 10-car trains for Sounder service. Sound Transit also plans to pursue track agreements that would allow for train service during more hours of the day.[16]

2.6.4. Intercity Passenger Rail

Amtrak provides passenger rail service across S Lander St for the Amtrak Cascades, Empire Builder, and Coast Starlight routes with ten daily train trips in 2015, increasing to 14 daily trips in 2018.

2.7 Safety and Emergency Response

2.7.1. Collision History

Collision reports for S Lander St between 1st Ave S and 4th Ave S were obtained from SDOT. These data reflect the five-year period between January 1, 2011 and December 31, 2015. During that period, the S Lander St segment between 1st Ave S and 4th Ave S was the site of 69 collisions. One of the collisions resulted in a fatality, and involved a pedestrian being struck by a train at the railroad crossing. Table 9 summarizes the collisions by location and type.

Nine out of the ten collisions at the S Lander St/Occidental Ave S intersection were right angle collisions, which involve vehicles turning to or from Occidental Ave S. Two collisions between Occidental Ave S and 3rd Ave S appeared to be related to traffic congestion resulting from train crossings. One collision involved a driver attempting a three-point turn to turn around and one collision involved a bus attempting to maneuver around a car in the queue. In 2015, a driver heading eastbound on Lander St inadvertently turned right onto the train tracks instead of the parking lot directly west of the rail line. The vehicle and oncoming train, which could not stop in time, were both damaged; however, there were no injuries.

Beyond the time period evaluated, there was one additional fatal collision at the railroad tracks in April 2016. As with the prior fatality, it involved a pedestrian crossing the tracks. The railroad signals had been activated and crossing gates were down for both fatal pedestrian/train collisions.

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15 Sound Transit; Ridership values assume ST2 System funding only. Ridership estimates for ST3 are not yet available.

16 Sound Transit, Adopted ST3 Plan for Sounder South Capital Improvements, June 2016.

Table 9. Collision Summary (January 1, 2011 through December 31, 2015)

Intersection	Rear-End	Side-Swipe	Right Turn	Left Turn	Right Angle	Ped / Cycle	Other [a]	Total for 5.0 Years	Average/ Year
S Lander St / 1st Ave S	1	1	0	4	1	6	5	18	3.6
S Lander St / Occidental Ave S	0	0	0	0	9	1	0	10	2.0
S Lander St / 3rd Ave S	0	0	1	0	3	0	0	4	0.8
S Lander St / 4th Ave S	4	0	1	7	5	3	3	23	4.6
Roadway Segment	**Rear-End**	**Side-Swipe**	**Right Turn**	**Left Turn**	**Right Angle**	**Ped / Cycle**	**Other [a]**	**Total for 5.0 Years**	**Average/ Year**
S Lander St between 1st Ave S and Occidental Ave S	0	2	0	0	0	1	2	5	1.0
S Lander St between Occidental Ave S and 3rd Ave S	1	0	0	0	0	0	2	3	0.6
S Lander St between 3rd Ave S and 4th Ave S	1	1	0	0	1	1	2	6	1.2

Source: SDOT, July 2016.

a. 'Other' collision types included insufficient information, driver inattention, and improper movement.

2.7.2. Accident Prediction Report for Public at-Grade Highway-Rail Crossings

The Federal Railroad Administration (FRA) prepares an annual report—the *Web Accident Prediction System (WBAPS)* —that evaluates the safety of railroad grade crossings throughout the United States. The WBAPS system uses data about the each crossing's operational characteristics as well as collision history to determine where and how to improve crossing safety. Based on the *Annual WBAPS 2015,*[17] of all 37,100 BNSF, Union Pacific, and Amtrak crossings in the country, the S Lander St intersection falls within the top 0.5% of rail intersections likely to experience a rail collision. It ranks in the top 10 of the nearly 1,200 crossing in Washington State for rail intersections likely to experience a rail collision.

2.7.3. Emergency Response

S Lander St is a key corridor for emergency response. Fire Station 14 is located at 3224-4th Ave S, just north of S Horton St. The nearest grade-separated crossing of the railroad tracks is located at Edgar Martinez Drive (SR 519) to the north; the Spokane Street Viaduct to the south has no ramps that allow westbound traffic to avoid the railroad tracks. Emergency responders can cross the tracks at S Horton St or a S Lander St. If a train is blocking these crossings, emergency responders must make a real-time routing decision—they can wait for the crossing to clear, attempt to reroute to an unobstructed crossing, or call for another firehouse to dispatch from an unobstructed route. All of these choices increase response time and risk exposure.

2.8 Parking

On-street parking is currently allowed along both sides of S Lander St. There are approximately 25 spaces along the north curb and 26 spaces dispersed along the south curb between driveways and intersections. Most of the parking is unrestricted, meaning it has no time limits. Near 1st Ave S, however, parking along the north side of the street is limited to two hours between 7 AM and 6 PM, and parking on the south side is limited to

[17] Federal Railroad Administration, Office of Safety Analysis Highway-Rail Crossing Safety & Trespass Prevention, February 2016.

one hour between 7 AM and 6 PM. There is also a 30-minute load zone on the south side of the street just east of 1st Ave S. In total, about 10 on-street spaces are designated for short-term parking.

Parking along Occidental Ave S and 3rd Ave S is unrestricted, and in some places, haphazard. On Occidental Ave S north of S Lander St, there is angle parking along the west side of the street and parallel parking on the east side of the street where a curb exists. Depending on vehicle size, the parking can squeeze the "drivable" space to a single lane of traffic forcing vehicles to wait while an oncoming vehicle passes through the obstructed area. South of S Lander St, there is angle parking on the west side of Occidental Ave S and "No Parking Anytime" signed along the east curb. There is parallel parking on both sides of 3rd Ave S to the north and south of S Lander St, allowing for two-way travel.

2.9 Freight

2.9.1. Major Truck Street

The adopted Major Truck Street network from the 1994 *Comprehensive Plan* does not designate S Lander St as a Major Truck Street.[18] However, the *Draft Freight Master Plan*[19] recommends adopting new freight street classifications that confer a hierarchy of freight functions. The new designations would be Limited Access Facility, Major Truck Street, Minor Truck Street, and First/Last Mile Connector. Within this hierarchy, SDOT recommends that the project segment of S Lander St be designated as a Major Truck Street, defined as "an arterial street serving connections to the regional network, between and through industrial land uses, commercial districts, and urban centers."

2.9.2. Heavy Haul Network

In October 2015, the City Council unanimously adopted legislation to create a Heavy Haul Network on a limited number of city streets to allow for the efficient drayage of sealed, ocean-going containers between the Port of Seattle and nearby intermodal facilities (Ordinance No. 124890). The new maximum allowable tandem drive-axle weight of 43,000 pounds and maximum gross vehicle weight of 98,000 pounds will be administered and enforced under a new permitting system. Although it is not listed as part of the Heavy Haul Network in the 2015 Ordinance, S Lander St could be considered for this network in the future since it connects to several freight transloading facilities where cargo that arrives or departs through the Port is repackaged into containers.[20] Among the conditions of the permit is a requirement for twice-yearly inspections for permitted vehicles. In addition, the legislation establishes a new Commercial Vehicle Enforcement Officer (CVEO) position in SDOT devoted to enforcing truck-related rules and regulations in the Heavy Haul Network area.

Truck trip estimates derived using the Port of Seattle's *Container Terminal Area Traffic Analysis Tool*[21] were used to estimate the potential for heavy truck movements in the event the route is ever added to the Heavy Haul Network. For the high-volume container routes that connect between the Port of Seattle's terminals and the rail yards, heavy trucks were estimated to range up to 50 trucks per day. On inland routes such as S Lander St that connect to local distribution facilities, heavy trucks were estimated to range from 2 to 5 trucks per day. This would represent about 2% of all large trucks that use S Lander St.

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18 SDOT, Map of "Major Truck Streets," 2003. From: http://www.seattle.gov/transportation/Stclassmaps/truckweb.pdf.
19 SDOT, *City of Seattle Freight Master Plan, Public Review Draft,* May 2016.
20 SDOT, *Adopted Heavy Haul Network Legislation,* October 27, 2015, Section 11.61.030 Heavy Haul Network Routes.
21 Transpo Group, Container Terminal Area Traffic Analysis Tool, Model Development and Application, July 2015.

3. Grade Separation Effects

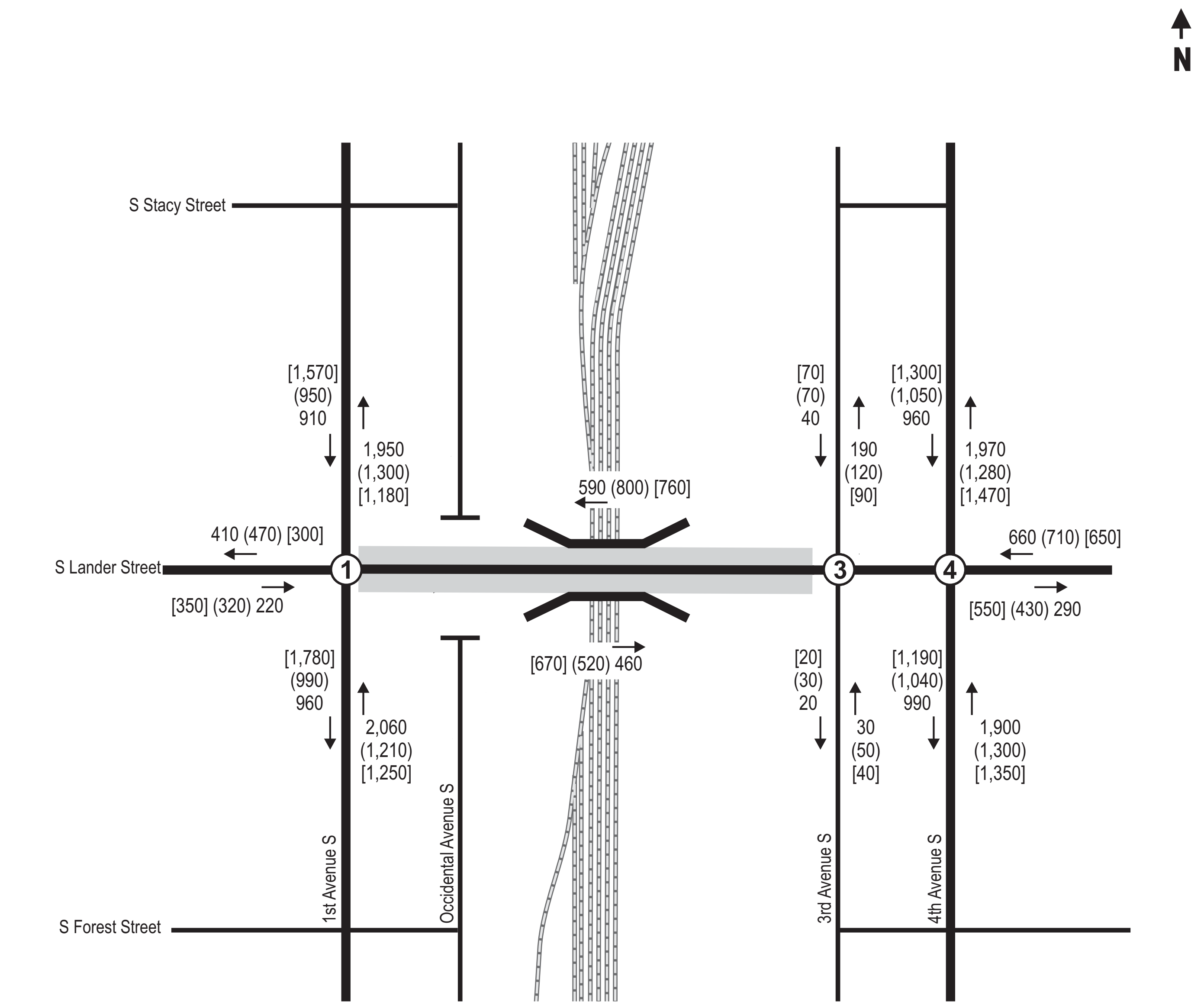
This section describes how the proposed grade separation project would affect traffic operations, local circulation, non-motorized travel, transit, safety and along S Lander St. The alternative bridge alignments and local access options were previously described in Section 1.3. The key design elements that affect operations include number of travel lanes, structure grade, intersection geometry, traffic control, and width of non-motorized facilities. The effect on local access is also evaluated.

3.1 Traffic Volumes

If S Lander St is grade-separated from the tracks and provides a more reliable trip than other at-grade crossings, it is expected to attract more traffic than it would with the No Build condition. The potential diversion was estimated using the Dynamec model described in Section 2.2.4. The modeling determined that S Lander St could attract 1,600 more vehicles per day, of which 300 would be trucks. These would be diverted from other routes, primarily S Holgate St (~600 vehicles/day), SR 519 (~700 vehicles/day) and S Spokane St (~300 vehicles per day). These potential diversions would include motorists who change their regular travel route away from another grade crossing because S Lander St would be more reliable, or who change their route only when they are confronted with a long train crossing at another location. The diversions from other rail crossings would also affect travel patterns along 1st and 4th Aves S. The changes were accounted for in the 2040-with-project forecasts.

In addition, the project would restrict all side street movements at Occidental Ave S and some movements at 3rd Ave S. These changes would permanently change travel routes to and from these side streets, and traffic would divert to other local access routes (e.g., to parallel arterials via S Stacy St or S Forest St). The diversions associated with the local access restrictions were also accounted for in the 2040-with-project forecasts; the diversion associated with the most restrictive configuration was assumed—west local access Option B (dead end) for Occidental Ave S, and Alternative 2 (shifted bridge alignment, two-way road for east local access)for 3rd Ave S.

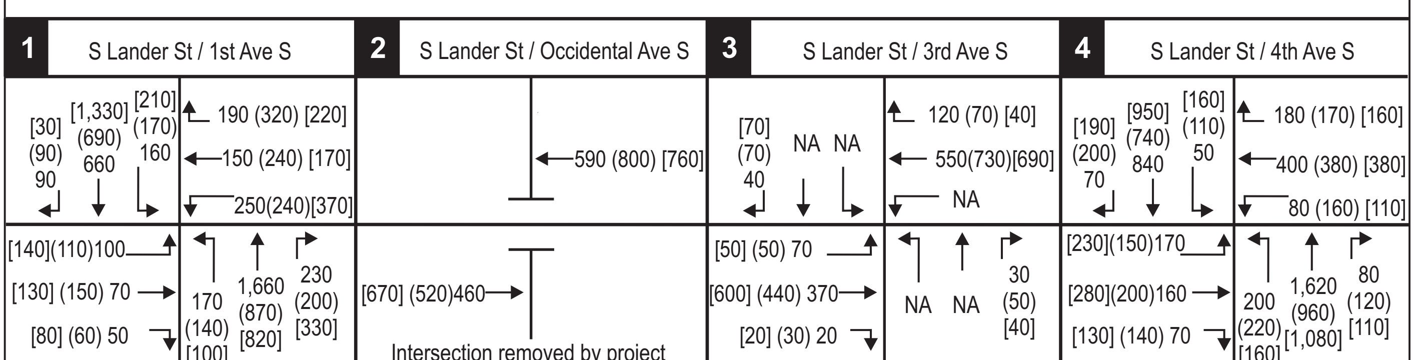
Figure 16 shows the projected 2040 AM, midday, and PM peak hour traffic volumes with the proposed grade separation.



KEY

[##] (##) ## → AM (Midday) [PM] Peak Hour Traffic Volumes

NA Movements restricted due to project



LANDER STREET Grade Separation

Figure 16
Year 2040 Traffic Volumes with Lander Grade Separation AM, Midday, and PM Peak Hours

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06.20.16

3.2 Traffic Operations

3.2.1. Vehicle Delay and Travel Time

Traffic operations with the grade separation were evaluated using the SimTraffic micro-simulation model described in Section 2.4.1. The results, summarized in **Table 10**, show that grade separating vehicular traffic from the railroad tracks would dramatically decrease vehicle delay and travel time in the corridor compared to the No Build conditions. The highest delays and travel times are expected in the westbound direction. Without the grade separation, train blockages and excess congestion following the passing of a train is expected to result in average travel times ranging from 454 seconds (7.6 minutes) during the AM peak hour to over 850 seconds (14.2 minutes) during the PM peak hour. With the grade separation, the average travel times are expected to decrease to about 252 seconds (4.2 minutes) during the AM peak hour and 214 seconds (3.6 minutes) during the PM peak hour. The reductions in delay and travel time range from about 60% during the midday hours to 81% during the PM peak hour.

Table 10. Vehicle Delay and Travel Time - S Lander St with Railroad Grade Crossing

	Future (2040) No Build		Future (2040) With Grade Separation		% Change from No Build to Build	
	Average Vehicle Delay (seconds)	Average Travel Time (seconds)	Average Vehicle Delay (seconds)	Average Travel Time (seconds)	Average Vehicle Delay	Travel Time
AM Peak Hour						
Eastbound (1st Ave S to 4th Ave S)	403.9	454.4	124.3	154.8	-69%	-66%
Westbound (4th Ave S to 1st Ave S)	637.7	724.8	182.6	251.6	-71%	-65%
Midday Peak Hour						
Eastbound (1st Ave S to 4th Ave S)	210.7	257.6	62.6	95.9	-70%	-63%
Westbound (4th Ave S to 1st Ave S)	251.7	330.5	65.7	135.0	-74%	-59%
PM Peak Hour						
Eastbound (1st Ave S to 4th Ave S)	387.0	439.9	131.8	165.0	-66%	-62%
Westbound (4th Ave S to 1st Ave S)	735.2	853.4	142.4	213.6	-81%	-75%

Source: Synchro model developed Heffron Transportation, Inc., June 2016. The No Build condition reflects existing roadway geometry and the 2040-with-grade-separtion project condition assumes the proposed roadway configuration. Signal cycle length and phase splits were optimized for future conditions within the established protocols. Levels of service were calculated using the SimTraffic module with an average of 5 model runs.

3.2.2. Intersection Operations

Levels of service for area intersections were also determined using the SimTraffic micro-simulation model in order to provide a comparison without and with the grade separation. Eliminating the at-grade rail crossing would improve operations at the intersections because they would no longer be affected by queues from the railroad crossing, and would not have to process surges of traffic following a train blockage. As shown in **Table 11**, all intersections along the corridor are expected to operate at LOS E or better in the future with the proposed grade separation and associated lane configurations.

Table 11. Intersection Level of Service - 2040 No Build and 2040 Build Conditions

	Year 2040 No Build Conditions		Year 2040 With Grade Separation	
Time Period / Intersection	LOS [1]	Delay [2]	LOS [1]	Delay [2]
AM Peak Hour				
S Lander St/1st Ave S	E	77.1	E	72.7
S Lander St/4th Ave S	F	114.8	E	61.1
S Lander St/Occidental Ave S [3]	F	501.3	No Intersection	
S Lander St/3rd Ave S [3]	F	439.3	D	33.2
Midday Peak Hour				
S Lander St/1st Ave S	D	41.5	C	25.7
S Lander St/4th Ave S	F	185.1	D	36.9
S Lander St/Occidental Ave S [3]	F	405.4	No Intersection	
S Lander St/3rd Ave S [3]	F	175.8	B	11.5
PM Peak Hour				
S Lander St/1st Ave S	F	90.0	D	53.5
S Lander St/4th Ave S	F	136.3	D	42.0
S Lander St/Occidental Ave S [3]	F	886.7	No Intersection	
S Lander St/3rd Ave S [3]	F	1499.1	C	24.0

Source: Synchro model developed Heffron Transportation, Inc., June 2016. The No Build condition reflects existing roadway geometry and the 2040-with-grade-separtion project condition assumes the proposed roadway configuration. Signal cycle length and phase splits were optimized for future conditions within the established protocols. Levels of service were calculated using the SimTraffic module with an average of 5 model runs.

1. *Level of service.*
2. *Average seconds of delay per vehicle.*
3. *Delay for worst movement from side street stop sign.*

3.2.3. Queue Lengths

Queue lengths that extend back from the traffic signals at 1st Ave S and 4th Ave S were determined to inform project design including lane striping and whether turns would be possible at driveways and intersections. The average and the 95th-percentile queue lengths (which is the queue that would be exceeded 5 percent of the time during the peak hour) were determining using the SimTraffic tool described previously. Table 12 below summarizes the westbound queue lengths approaching 1st Ave S and the eastbound queue lengths approaching 4th Ave S for the 2040 condition with the grade separation project.

Table 12. Intersection Queue Lengths - 2040 With Grade Separation Project

	AM Peak Hour		Midday Peak Hour		PM Peak Hour	
Intersection/Movement	Average Q [1]	95th-% Q [2]	Average Q	95th-% Q	Average Q	95th-% Q
S Lander St/1st Ave S						
Westbound Left Turn	243	372	127	226	317	408
Westbound Thru	185	425	117	204	230	370
Westbound Right Turn	150	261	139	260	113	357
S Lander St/4th Ave S						
Eastbound Left Turn	138	197	106	172	148	187
Eastbound Thru	105	183	109	183	152	193
Eastbound Right Turn	41	108	68	135	83	162

Source: Synchro model developed Heffron Transportation, Inc., June 2016. Queue lengths were calculated using the SimTraffic module with an average of 5 model runs.

1. *Average queue length in feet.*
2. *95th-percentile queue length in feet.*

3.3 Local Access West of the Railroad Tracks

The new S Lander St bridge approaches would be elevated above S Occidental Ave by 8 to 9 feet, which would eliminate the ability to connect these two streets. Two local access options for S Occidental Ave were previously shown on **Figure 2**. Option A, "Realigned Occidental Ave S," would create a new street under the S Lander St Bridge that could provide a connection for north-south through traffic. Option B, "Dead-end Occidental Ave S," would dead-end Occidental Ave S north and south of the bridge; the street would not cross under the bridge.

The new structure would also alter or eliminate S Lander St access to businesses between Occidental Ave S and the railroad tracks since the roadway would be elevated above these sites. With Option A (Realigned Occidental Ave S), parking for the South Lander Business Park would be provided along the north side of the new surface street. For Frye Lander Station on the south side of S Lander St, the access would need to be moved from S Lander St to Occidental Ave S. For Option B (Dead-end Occidental Ave S), the driveways to both of these buildings would need to be moved to Occidental Ave S.

The number of vehicles that currently cross S Lander St at Occidental Ave S is very low during most hours of the day (fewer than 20 vehicles per hour). However, during the AM peak hour, approximately 90 vehicles cross S Lander St in the northbound direction, and in the PM peak hour, approximately 50 vehicles cross in the southbound direction. At those times, the reverse direction traffic is about 10 vehicles per hour. This peak direction traffic suggests that drivers are using Occidental Ave S as a short-cut to avoid peak congestion on 1st Ave S. Although Option A would provide access for local traffic, it would also make it easier for motorists to use Occidental Ave S for diversion.

The analysis presented previously assumed the worst-case condition that all short-cut and local traffic now using Occidental Ave S would have to divert to 1st Ave S. The additional through-traffic on 1st Ave S would not adversely affect traffic operations at the S Lander St intersection.

For either option, parking restrictions may be needed along Occidental Ave S to provide for unimpeded two-way travel and vehicle turn-around areas. South of S Lander St, parking is already prohibited along the east side of Occidental Ave S, which allows for two-way travel. North of S Lander St, two-way travel could be improved by organizing the angle parking on the west side of the street (to mark a limit beyond which vehicles would block through traffic), and/or by prohibiting parking on the east side of Occidental Ave S between S Lander St and S Stacy St. There are an estimated 12 on-street parking spaces on the east side of Occidental Ave S. For Option B, which would dead-end Occidental Ave S north and south of S Lander St, some additional parking restrictions may be needed to provide for vehicle turn-around at the ends of the streets.

3.4 Local Access East of the Railroad Tracks

3.4.1. Access for Properties West of 3rd Ave S

For the segment between the railroad tracks and 3rd Ave S, different local access configurations have been identified for the two bridge alignment alternatives. **Alternative 1**, which would locate the bridge near the center of the right-of-way, would provide a one-way surface street adjacent to each side of the bridge structure that would loop under the bridge. The westbound surface street would connect from 3rd Ave S on the north side of the structure, and the eastbound surface street would connect to 3rd Ave S on the south side of the structure. **Alternative 2**, which shifts the bridge to the north side of the right-of-way, would provide a two-way surface street connecting from 3rd Ave S south of Lander St to the Seattle Schools Headquarter site. These alternatives were previously shown on **Figure 3**. It is noted that these access options are representative of two distinct concepts. The analysis herein evaluates the worst-case conditions for access to S Lander St as well as alternative routes. Variations may exist within each concept depending on private property access needs; however, such variations would not change the analysis results or conclusions. SDOT will continue to work with the adjacent properties to address access needs..

Both alternatives would require some turn restrictions at the S Lander St/3rd Ave S intersection due to the new configuration of 3rd Ave S and loss of the existing center two-way-left-turn lane on S Lander St. Alternative 1 would likely require that all access to the one-way loop roadway arrive from 3rd Ave S north of S Lander St and depart to 3rd Ave S south of Lander St. Alternative 2 would allow vehicles to access the two-way access road directly from S Lander St. For both alternatives, it is recommended that left turns from 3rd Ave S be prohibited due to the loss of the two-way-left-turn lane and the fact that queues extending from the 4th Ave S intersection could block those left turn movements.

3.4.2. Need for Traffic Signal at S Forest St / 4th Ave S Intersection

For either local access alternative east of the railroad tracks, it may be desirable to signalize the S Forest St/4th Ave S intersection to improve operations for traffic diverted to this route. This section presents signal warrant analysis for the intersection.

Both local access alternatives for businesses east of the railroad tracks would require that all or some of the local traffic enter and exit the area using S Forest St and 3rd Ave S south of S Lander St. The S Forest St/4th Ave S intersection, which is the closest connection point to this local access route, is currently unsignalized. The need for a signal at this intersection was evaluated using signal warrant criteria presented in the *Manual on Uniform Traffic Control Devices (MUTCD).*[22] The manual states, "A traffic control signal should not be installed unless one or more of the factors described in this section are met." Details about the traffic signal warrant analysis are presented in **Appendix B.**

Four warrants were evaluated for this intersection: Warrant 1A and 1B (Eight Hour Volumes), Warrant 2 (Four Hour Volumes), and Warrant 3 (Peak Hour Volumes). The other potential warrants do not apply to this intersection. For all of the volume warrants, traffic in both directions of the main street (4th Ave S) is considered along with just the approach volumes for the highest-volume minor street (eastbound S Forest St). The analysis determined that the intersection volumes are not yet high enough to warrant a traffic signal.

22 US Department of Transportation, Federal Highway Administration, 2003.

With future growth and the proposed S Lander St Grade Separation project, however, volumes on eastbound S Forest St are expected to increase. This would include traffic diverted to S Forest St due to turn restrictions at the S Lander St/3rd Ave S intersection, and traffic that is diverted to the south by the one-way loop with access Alternative 1. Under the worst-case condition for traffic diversions, the intersection at 4th Ave S/S Forest St is expected to meet Warrants 1B (8-hour), 2 (4-hour), and 3 (1-hour). The detailed warrant calculations are in **Appendix B.**

It is recommended that traffic volumes at the S Forest St/4th Ave S intersection continue to be monitored in the future, and a traffic signal should be installed when it is warranted.

3.4.3. S Holgate St Diversion to 3rd Ave S

As detailed in Section 3.1, an estimated 600 vehicles per day could divert from S Holgate St to S Lander St to avoid rail blockages. Some of these diversions would be permanent since S Lander St would provide a more reliable everyday trip. However, some could result from short-term decisions when motorists are blocked by a train crossing on S Holgate St. Most diversions occur for longer blockages associated with long freight trains or switching movements; motorists are not likely to divert for short delays associated with a commuter rail or Amtrak train. Long trains can occur once or twice per hour.

Vehicles on S Holgate St that are stopped by a train crossing west of the tracks would be more likely to turn north onto Occidental Ave S and then use SR 519 to avoid the blockage. They could also U-turn to 1st Ave S to reach the S Lander St crossing since Occidental Ave S would not connect to S Lander St. Vehicles that are stopped east of the tracks could choose to turn either north or south on 3rd Ave S where they could reach the Royal Brougham Way grade-separated structure or S Lander St structure.

The potential diversion to 3rd Ave S between S Holgate St and S Lander St was estimated based on existing traffic volumes on S Holgate St. Westbound traffic across the tracks ranges from 300 to 420 vehicles per hour during the work day. A long train could block up to 70 westbound vehicles. Of those, an estimated 20 to 40 could opt to use 3rd Ave S to reach S Lander St. This volume of traffic could be accommodated by 3rd Avenue S and the proposed traffic control at S Lander St.

Several measures to reduce the potential diversion could be considered if they create traffic congestion along 3rd Avenue S:

- Re-install the dual left turn lane on westbound S Holgate St at 4th Ave S when queues in the single lane exceed 150 feet in length. (The former dual left turn lane was removed in 2015.)
- Install advance-warning signs alerting drivers when a long train may be approaching the S Holgate St crossing.
- Interconnect the traffic signal at S Holgate St/4th Ave S to the train crossing so that additional time is provided for westbound left turns when a train blockage occurs.

3.5 Non-Motorized Facilities

Two options are being considered to serve pedestrians and bicyclists on the bridge. **Option 1** would create a 14-foot shared-use path on the north side of the bridge separated from the vehicle lanes by a 2-foot barrier. **Option 2** would provide 7-foot sidewalks on each side of the bridge, but would have no separate facility for bicycles.

3.5.1. Operations of Share-Use Path (Option 1)

The pedestrian capacity for the shared-use path was estimated using *LOS Criteria for Walkways* in the *Highway Capacity Manual*.[23] Levels of service for pedestrians relate to the density of pedestrian flows, and are affected by whether the flows are constant (such as along a linear path) or platooned (such as what happens downstream from a traffic signal). For this analysis, it was assumed that the capacity of the sidewalk would be 18 pedestrians per minute per foot of sidewalk width, which reflects platooned pedestrian flows.[24] The effective walking width must account for shy distance to features at the edge of a path such as the railing and barrier that would separate the path from the vehicle traffic. A shy distance of 1.5 feet on each side of the path was assumed leaving an effective path width of 11 feet. That width results in an estimated capacity of nearly 200 pedestrians per minute or about 11,800 pedestrians per hour. As previously detailed in Table 8, pedestrian volumes along S Lander St are expected to increase in the future due to improvements to Link light rail service at the SODO Station. Peak pedestrian volumes in 2040 are estimated at fewer than 500 per hour. This volume would be easily accommodated by the 14-foot multi-use path.

Some bicycles are also expected to use the path, and would have to share the space with pedestrians. Level of service for the shared-use path option was evaluated using the Federal Highway Administration's (FHWA) *Shared-Use Path Level of Service Calculator (SUPLOS).*[25] This tool was designed specifically to assess shared-use paths from a cyclist's perspective based on potential conflicts with other cyclists or pedestrians. The level of service is based on path width, number of active passes (overtaking other users going the same direction), number of opposing users, and presence of a striped centerline. The User's Perception LOS, which is based on surveys of other trails and calibrated to the features such as volume and width, would be LOS D during the peak hour. These results indicate that no centerline strip on the path would be needed.

3.5.2. Operations of Sidewalks on Both Sides (Option 2)

A configuration that retains 7-foot sidewalks on both sides of the grade-separated structure is also being considered. The capacity of the sidewalk was determined using the pedestrian flow methodology presented in the *Highway Capacity Manual.* Each sidewalk would have a railing on the outside and a curb to separate the sidewalk from the vehicle travel lanes. The effective width of the sidewalk should account for 1.5-feet of shy distance on each side, which results in an effective width of 4 feet. The capacity of each sidewalk is estimated at about 4,300 pedestrians per hour, which would be adequate to accommodate the expected demand. This option would not have separate facilities for bicycles, and bicyclists would either need to ride in the street or share the sidewalk space with pedestrians. If they share the sidewalk, bicyclists would have little to no room to pass pedestrians, and may have to walk their bikes on the sidewalk.

Because of the limitations described above and the fact that the vast majority of the pedestrians walk along the north side of the street (now and in the future), the shared-use path is recommended. In addition to the shared-use path, surface sidewalks should be provided on both sides of S Lander St, to accommodate local access between 1st Ave S and properties east of Occidental Ave S, and between 4th Ave S and 3rd Ave S. On the south side of S Lander St, a sidewalk should also be located along the south side of the local access street to provide pedestrian access to the Pacific Galleries site. The new structure would eliminate the existing at-grade pedestrian crossing of S Lander St at Occidental Ave S. Pedestrians would need to walk to 1st Ave S to cross the street.

23 Transportation Research Board, 2010.
24 *Highway Capacity Manual,* Exhibit 23-2. Capacity value relates to flow rate for LOS E condition.
25 US Department of Transportation, July 2006.

3.6 Transit

There is an existing westbound bus stop located in front of the Seattle Schools Headquarters building. With the proposed structure, this bus stop should be relocated east—either to S Lander St just west of 4th Ave S, or to 4th Ave S just north of S Lander St. Either location would require that one driveway to the Shell gas station be closed to accommodate the coach length. The Shell station currently has five access driveways: two on 4th Ave S, two on S Lander St and one wide driveway on 3rd Ave S. The driveway that would need to be closed would be closest to the intersection and would not affect access for fuel trucks or the exit from the carwash.

There are currently no bus stops for eastbound service on S Lander St in the project area. Buses that do use eastbound S Lander St turn left onto 4th Ave S and stop on the far side of the intersection adjacent to the US Post Office garage or proceed further east and turn onto the E-3 Busway. The proposed project would not affect those transit operations, and the bus stops should remain at their current locations.

Grade-separating S Lander St would increase the opportunities for east-west transit in SODO by improving service reliability. As described later in Section 4 related to Project Resilience, there would be capacity on the corridor to accommodate more pedestrians generated by increased transit service.

3.7 Safety

The grade separation would eliminate potential train conflicts with vehicles and pedestrians. As previously described in Section 2.3.3, many motorists, bicyclists and pedestrians have been observed crossing the tracks when the railroad gates are in the down position. Of particular concern are pedestrians who crossed the tracks immediately after one train had cleared, but in advance of another oncoming train. Given that there are four tracks at this crossing, sight lines to the oncoming train can be impaired by a train on a nearer track. The potential for crossing violations such as these would be eliminated with the grade separation, substantially improving safety of the corridor, which is one of the highest collision locations in the nation's rail system.

In addition, the project would eliminate direct connections between Occidental Ave S and the mainline section of S Lander St, as well as driveway connections. These changes are expected to reduce the potential for collisions on the corridor.

3.8 Parking

The grade-separated structure would eliminate all on-street parking along S Lander St between 1st Ave S and 4th Ave S. There are approximately 50 on-street spaces that would be removed. Most of the spaces are unrestricted spaces that provide all-day parking for area employees, but ten spaces located at the west end near 1st Ave S have time limits to serve customers of adjacent businesses—five on the north side of the street and five on the south side, between 1st Ave S and Occidental Ave S. While some parking is available along 1st Ave S, bus stops and curb bulbs prevent parking adjacent to the corner businesses. Therefore, it is recommended that some on-street parking along Occidental Ave S be signed for short-term use, and could range from two to five stalls both north and south of S Lander St.

One of the design options would affect off-street parking for the South Lander Business Park Station. West-side local access Option A (Realigned Occidental Ave S) would encroach onto the adjacent property, eliminating on-site parking. Under this option, the project would construct replacement parking area adjacent to the through street (see Figure 2). Option B, which would dead-end Occidental Ave S on each side of S

Lander St would require that parking lot access to South Lander Business Park and Frye Lander Station be relocated to Occidental Ave S.

It may be possible to provide parking under the proposed bridge structure depending on the access alternative, overhead clearance, and column layout. Any parking under the structure would need to be available to the public, and could not be designated for a specific business or entity. However, it could be designated with time limits or other restrictions to prevent all-day or overnight parking.

3.9 Freight

The grade separation project would eliminate the rail crossing, which would improve operations and safety of the rail corridor. The project would secure the rail crossing with fencing to prevent vehicular and pedestrian access across the railroad tracks. Trains on the mainline tracks as well as switching tracks that serve Republic Services and other local businesses would have no restrictions on time or duration of crossings or stoppages at S Lander St.

Truck movements would also benefit from the grade separation. Although the new structure would introduce a grade (maximum slope of 7%), trucks would not need to stop on the uphill grade since there would be no traffic control at the top of the ramp (as there is on SR 519 at 4th Ave S), and since queues from the traffic signals at 1st Ave S and 4th Ave S are not expected to extend beyond the crest of the bridge. The slight slowdown that trucks would experience climbing the short grade would be substantially less than the delay associated with train blockages.

Design features on the new roadway, including the corner radii at intersections and pavement depth, would be designed to accommodate large trucks. Turn radii at the arterial-arterial intersections at S Lander St/1st Ave S and S Lander Street/4th Ave S would be designed for a WB-67 truck (a truck that has 67 feet between the rear driving wheels of the cab and rear axle of the chassis). In addition, vertical and horizontal clearances on the new structure would be set to accommodate an oversize load, which is typically defined by a minimum 20-foot height and width. This may require that overhead powerlines that cross S Lander St at Occidental Ave S be raised. The pavement would also be designed to accommodate over-legal loads that are possible on S Lander St as a potential part of the Heavy Haul Network.

4. Project Resilience

The analysis presented in Section 3 reflects typical-day conditions with the grade separation project. Additional analysis was performed to determine how the proposed design would perform if travel demand were to increase due to future projects or events. These could include additional traffic generated by events at the major sports stadia and/or temporary or permanent closure of other grade crossings in the neighborhood. Pedestrian traffic could increase with further expansion of service along the Link light rail line or changes to local transit service. Transit service could increase with improved east-west reliability provided by the grade separation or changes in roadway usage in surrounding neighborhoods.

4.1 Ability to Accommodate Increased Traffic Volumes

Based on the operational analysis previously presented, after the grade-separated structure is built, capacity of the S Lander St corridor would be dictated by the capacity of its intersections with 1st Ave S and 4th Ave S. To test the resilience of those intersections, traffic was added to each direction of S Lander St in 50 vehicle-per-hour increments. These trips were assumed to arrive and depart equally from the north and the south since they could reflect diversions from other grade crossings at S Spokane St or S Holgate St. Traffic simulation analysis (previously described in Section 2.4) was performed to determine how much additional traffic each intersection could accommodate before reaching LOS F conditions. Figure 17 and Figure 18 present the analysis results for the 1st Ave S and 4th Ave S intersections, respectively. Operations during the PM peak hour were evaluated.

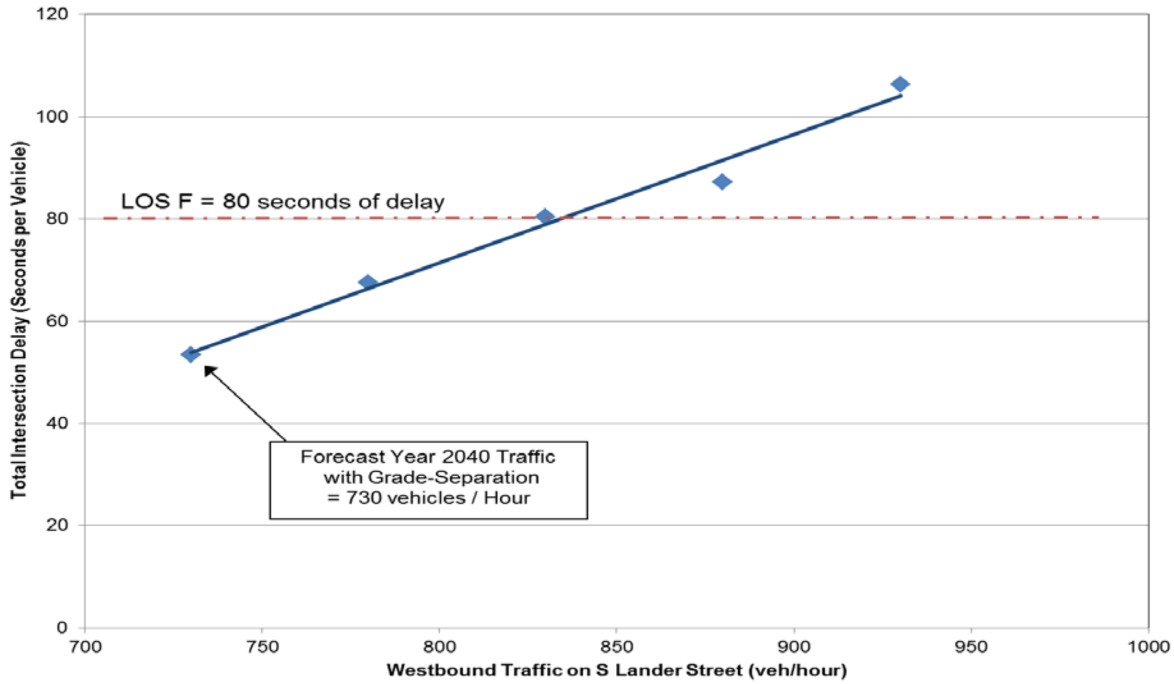
As shown, the S Lander St/1st Ave S intersection could accommodate an increase of about 100 addition vehicles in each direction during the PM peak hour before LOS F conditions are reached at the intersection. For reference, the 100 additional vehicles is equivalent to:

- A 14% increase in traffic over the assumed 2040 Build Volumes; or
- One-third of the peak direction traffic that now uses S Holgate St; or
- Twice the increase in traffic associated with a Mariners game (which was estimated to be 46 westbound vehicles in the 2008 Transportation report);

The S Lander St/4th Ave S intersection would be able accommodate a higher increase in traffic—estimated to be about 150 additional vehicles in each direction during the PM peak hour—before reaching LOS F conditions. For reference comparison, that volume is equivalent to:

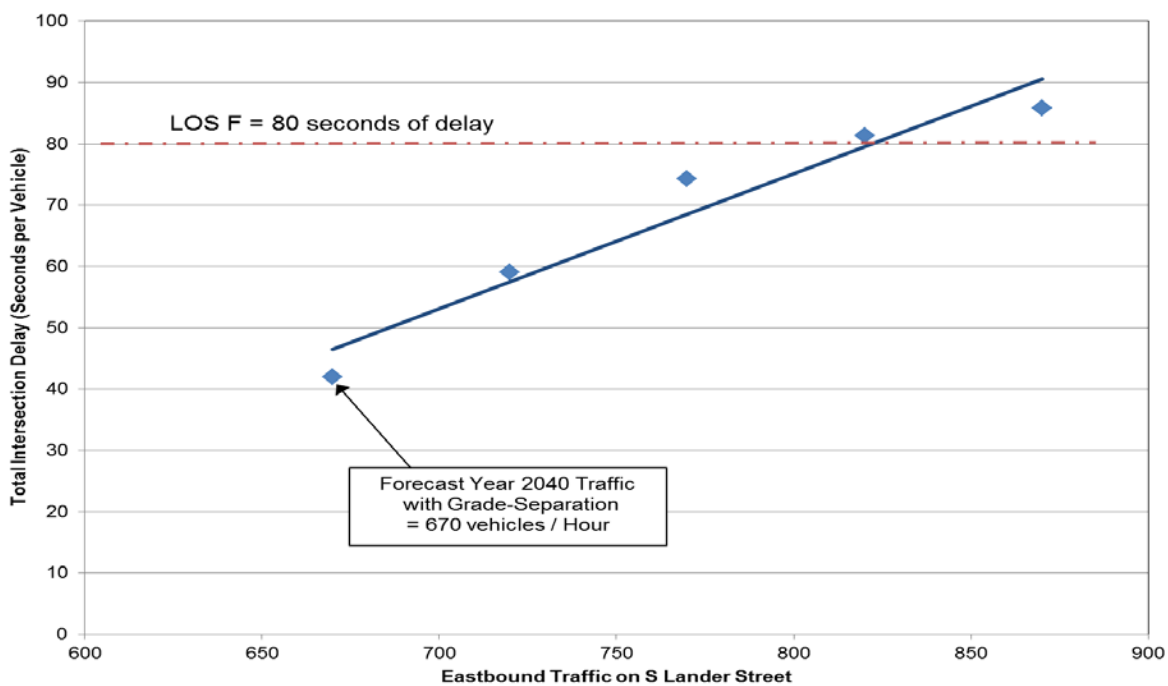
- A 20% increase in traffic over the assumed 2040 Build Volumes; or
- One-half of the peak direction traffic that now uses S Holgate St; or
- Three times the increase in traffic associated with a Mariners game.

Figure 17. Resiliance of S Lander St/1st Ave S Intersection – PM Peak Hour



Source: Heffron Transportation, Inc., June 2016

Figure 18. Resiliance of S Lander St/4th Ave S Intersection – PM Peak Hour



Source: Heffron Transportation, Inc., June 2016

4.2 Ability to Accommodate Increased Non-Motorized Volumes

The 14-foot shared-use path (non-motorized Option 1) has ample available capacity to accommodate many more pedestrians per hour than are forecast to use the corridor. The 14-foot path is estimated to have a capacity for nearly 12,000 pedestrians per hour, and the 2040 volume is forecast to be fewer than 500 pedestrians per hour. Additional pedestrian traffic is expected if Link Light Rail service is extended to West Seattle, Everett and Tacoma, depending on voter approval of ST3. Analysis indicates that the path could adequately accommodate shared use by pedestrians and bicyclists. The two-sided sidewalk (non-motorized Option 2) would have much more limited ability to accommodate increased non-motorized traffic due to the narrow width that would still potentially be shared by pedestrians and bicyclists.

4.3 Ability to Accommodate Increased Transit

The proposed S Lander St Grade-Separation project would increase the travel time reliability of all transit routes that use the street. As such, it could adapt to carrying more transit should future transit routing or frequency change. The project would have capacity for increased vehicle traffic, including transit up to the volumes references in Section 4.1. The westbound stop that is proposed to be located either on S Lander St west of 4th Ave S, or on 4th Ave S north of S Lander St, may need to be extended to accommodate more than one bus at a time. A bus stop extension would likely require closure of a second driveway at the adjacent Shell Station.

5. Recommendations

Overall, no fatal flaws or traffic operational issues have been identified for any of the alternatives or access options. The following sections describe the features that are recommended for incorporation into the project design. Additional measures are also recommended for future consideration to improve local access and protect 3rd Ave S from diversion traffic.

5.1 Recommended Project Features

The following project design features are recommended to accommodate the transportation functions of the corridor.

S Lander St

- Construct four-lane grade-separated structure.
- Provide two westbound lanes that widen to a left-turn, thru-lane, and right-turn lane at 1st Ave S.
- Provide two eastbound lanes that widen to a left-turn, thru-lane, and thru-right-turn lane at 4th Ave S.
- Install signage that alerts drivers approaching a turn lane.

3rd Ave S Access

- Construct Alternative 2, which would locate the bridge to the north side of the right-of-way, and create a two-way surface roadway connecting from 3rd Ave S south of Lander St to the Seattle Schools Headquarter site. This option provides the greatest flexibility in access to meet current and future needs.
- Restrict outbound traffic from both 3rd Ave S approaches to right turns only.
- Add striping and signage to keep S Forest St/3rd Ave S and S Stacy St/3rd Ave S intersections clear from obstructions that may hinder large truck movements (e.g., parking too close to corners, etc.)

Occidental Ave S Access

- Construct Option B, which would dead-end Occidental Ave S north and south of S Lander St.
- Relocate business access driveways from S Lander St to Occidental Ave S.
- Provide the ability to turn-around at the street ends, which may require prohibiting some existing parking, and require multi-point turns for larger vehicles.
- Add striping and signage to keep S Forest St/Occidental Ave S and S Stacy St/Occidental Ave S intersections clear from obstructions that may hinder large truck movements.

Multimodal Facilities

- Construct 14-foot multi-use path on the north side of the structure (non-motorized Option 1).
- Provide surface sidewalks on both sides of S Lander St that link from 1st Ave S to Occidental Ave S to provide for local pedestrian access.
- Provide surface sidewalks on both sides of S Lander St that link from 4th Ave S to 3rd Ave S, and partially along the south side of the two-way surface access road to provide for local pedestrian access.
- Allow for pedestrian crossing of S Lander St on the east side of the 3rd Ave S intersection, which is a legal crossing location. Curb ramps should be provided, but not a striped crosswalk since it would cross a four-lane section that does not have a center refuge area.

Transit Facilities

- Relocate the existing westbound bus stop adjacent to the Seattle Schools Headquarters building to the east—either to S Lander St just west of 4th Ave S, or to 4th Ave S just north of S Lander St. Either location would require that one driveway to the Shell gas station be closed to accommodate the coach length.
- No eastbound transit stops are needed in the corridor. The existing stop on 4th Ave S north of S Lander St would serve eastbound transit routing.

Truck Accommodations

- Design corner radii at arterial-arterial intersections for a WB-67 truck.
- Provide a minimum of 20-feet of vertical and horizontal clearances so the new structure can accommodate an oversized load. This may require that overhead powerlines that cross S Lander St at Occidental Ave S be raised.
- Design pavement to accommodate over-legal loads that are possible on S Lander St if it becomes part of the Heavy Haul Network.

5.2 Additional Measures to Consider

The following describes additional measures for consideration to improve local access, or to protect 3rd Ave S from potential short-cut traffic if S Holgate St is temporarily blocked by a train.

Local Access Improvements

- Install traffic signal at the S Forest St/4th Ave S intersection when warranted.
- Organize parking along the west side of Occidental Ave S north of S Lander St to reduce encroachment into the driving lane. If needed, prohibit parking along the east side of Occidental Ave S between S Lander St and S Stacy St to provide for two-way travel.
- If westbound left turns (to southbound 3rd Ave S) are regularly blocked by the queue of traffic approaching 4th Ave S, then consider additional treatments such as changes to signal phasing (at S Lander St/4th Ave S) or signage/markings to discourage blocking of the intersection.
- If desired by adjacent businesses, designate short-term parking on Occidental Ave S with time limits ranging from 30 minutes to 2 hours depending on the needs of adjacent businesses. The parking should be split between the north and south sides of S Lander St with up to 10 total spaces.

Measures to reduce short-cutting on 3rd Ave S from S Holgate St

Several measures to reduce the potential train-blockage diversions could be considered if they create traffic congestion along 3rd Avenue S:

- Re-install the dual left turn lane on westbound S Holgate St at 4th Ave S when queues in the single lane exceed 150 feet in length.
- Install advance-warning signs alerting drivers when a long train may be approaching the S Holgate St crossing.
- Interconnect the traffic signal at S Holgate St/4th Ave S to the train crossing so that additional time is provided for westbound left turn when a train blockage occurs.

APPENDIX A
FUTURE TRAFFIC VOLUME FORECASTS

Future Forecasting Methodology

Future traffic forecasts for the Lander St Corridor without and with the proposed grade separation project were developed by The Transpo Group utilizing the Dynameq software, which is a "mesoscopic" model. Originally created for the Port of Seattle as the *Container Terminal Area Traffic Analysis Tool*, this model was then used by the SDOT to evaluate conditions without and with the Lander St project. The model utilizes a simulation-based dynamic trip assignment method that is more sensitive to congestion and detailed operational characteristics of a network than a traditional (macroscopic) travel demand forecasting model. The software was created by Inro, the same developer of the Emme software utilized by the Puget Sound Regional Council (PSRC) and the City of Seattle (City) for their respective macroscopic travel demand forecasting models, and is designed to utilize trip tables (summarizing the origin and destination zones of all modeled trips) developed in Emme models.

The Dynameq model utilizes transportation analysis zones (TAZs) that are smaller than the PSRC's model TAZs, but nest within them. It provides dynamic traffic assignment that takes into account roadway and intersection congestion, accounts for delays encountered by railroad crossings, bridge closures and ramp metering, and includes detailed roadway network attributes such as lane configurations and signal phasing. The model area included four railroad crossings between 1st Ave S and 4th Ave S, at S Holgate St, S Lander St, S Horton St, and S Spokane St. The model was calibrated to traffic volume and speed data obtained from several City, State, and Port sources.

Future regional non-Port travel demand was based upon trip tables obtained from the PSRC 2035 Emme model, and the Port-generated demand was accounted for separately using Port truck trip forecasts and distribution projections. The major roadway network changes assumed for the future included completion of the Alaskan Way Viaduct Replacement project, the Mercer Corridor project, and Waterfront Seattle project. The model also assumed Port of Seattle throughput growth to 3.5 million twenty-foot equivalent units (TEUs) consistent with the Port's *Century Agenda*, its strategic growth plan.

Table A-1 summarizes the existing and forecast 2025 average daily traffic and truck volumes on key streets in SODO. Results are presented for the "No Build" condition, which assumes no changes on S Lander St and the "Build" condition, which assumes completion of the Lander St Grade Separation project. The annual growth rate reflects the growth between the Existing (2015) and 2025 No Build condition. The column marked "Redistributed Trips" then reflects the net changes in traffic between the 2025 No Build and Build condition, which is an estimate of the trips that would divert to S Lander St once it is a more reliable route without railroad blockages.

Table A-1. Forecast Traffic Volumes for Key SODO Area Streets

St (Extents)	Average Daily Traffic - All Vehicles: Existing (2014)	2025 No Build	2025 Build	Annual Growth Rate (Existing to 2025 No Build)	Redistributed Trips with Lander Grade Separation (Build - No Build)
S Lander St (1st to 4th Ave)	12,900	13,100	14,700	0.1%	1,600
S Holgate St (1st to 4th Ave)	9,700	9,900	9,300	0.2%	-600
S Spokane St (1st to 4th Ave)	15,000	15,500	15,200	0.3%	-300
SR 519 (1st to 4th Ave)	28,600	27,400	26,700	-0.4%	-700
1st Ave S (Holgate to Lander)	28,000	26,900	26,500	-0.4%	-400
1st Ave S (Lander to Horton)	29,200	28,100	28,200	-0.3%	100
4th Ave S (Holgate to Lander)	25,000	25,600	25,400	0.2%	-200
4th Ave S (Lander to Spokane)	22,500	23,300	22,800	0.3%	-500
	Average Daily Trucks: Existing (2014)	**2025 No Build**	**2025 Build**	**Annual Growth Rate (Existing to 2025 No Build)**	**Redistributed Trips with Lander Grade Separation (Build - No Build)**
S Lander St	1,300	1,500	1,800	1.3%	300
S Holgate St	700	900	800	2.3%	-100
S Spokane St	1,650	1,800	1,700	0.8%	-100
SR 519	2,750	3,300	3,200	1.7%	-100
1st Ave S (Holgate to Lander)	2,500	3,100	2,900	2.0%	-200
1st Ave S (Lander to Horton)	2,600	3,000	2,800	1.3%	-200
4th Ave S (Holgate to Lander)	2,600	2,700	2,600	0.3%	-100
4th Ave S (Lander to Spokane)	1,900	2,100	2,000	0.9%	-100

Source: The Transpo Group and SDOT, Model results from Dynamec model, March 2016.

APPENDIX B
SIGNAL WARRANT ANALYSIS FOR 4TH AVE S/S FOREST ST

Summary of Signal Warrants

Both local access alternatives for businesses east of the railroad tracks would require that local traffic enter and/or exit the area using S Forest St and 3rd Ave S south of S Lander St. The intersection at S Forest St/4th Ave S, which is the closest connection point to this local access route, is currently unsignalized. The need for a signal at this intersection was evaluating using signal warrants in the *Manual on Uniform Traffic Control Devices (MUTCD).*[26] The manual states, "A traffic control signal should not be installed unless one or more of the factors described in this section are met." The eight (8) warrants for traffic signal installation are listed below:

- Warrant 1 – Eight-Hour Vehicular Volume (minimum volumes over eight hours)
- Warrant 2 – Four-Hour Vehicular Volume (minimum volumes over four hours)
- Warrant 3 – Peak Hour (minimum volume over one hour period)
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing (adequacy of gaps near school crossing location)
- Warrant 6 – Coordinated Signal System (platooning for one-way or two-way streets)
- Warrant 7 – Crash Experience (number and type of accidents)
- Warrant 8 – Roadway Network (for organized traffic flow networks)

For this intersection, volume Warrants 1 (Eight Hour), 2 (Four Hour), and 3 (Peak Hour) are most relevant. The other warrants do not apply. For all of the volume warrants, traffic on both directions of the main street (4th Ave S) are considered along with just the approach volumes for the highest-volume minor street (S Forest St). The table below presents the signal warrant analysis.

26 US Department of Transportation, Federal Highway Administration, 2003.

Table B1. Signal Warrant Analysis - 4th Avenue S/S Forest Street 2040 Build Conditions

Time Beginning	4th Avenue S Total Both Directions	S Forest Street Eastbound Approach	Warrant 1A 4th Avenue S >600? Met?	Warrant 1A S Forest Street >150? Met?	Warrant 1B 4th Avenue S >900? Met?	Warrant 1B S Forest Street >75? Met?	Warrant 2 Met?	Warrant 3 Met?
12:00 AM	117	0	N	N	N	N	N	N
1:00 AM	110	0	N	N	N	N	N	N
2:00 AM	107	0	N	N	N	N	N	N
3:00 AM	116	0	N	N	N	N	N	N
4:00 AM	264	0	N	N	N	N	N	N
5:00 AM	687	0	Y	N	N	N	N	N
6:00 AM	1,581	0	Y	N	Y	N	N	N
7:00 AM	2,348	86	Y	N	Y	Y	Y	N
8:00 AM	2,401	92	Y	N	Y	Y	Y	N
9:00 AM	2,251	121	Y	N	Y	Y	Y	Y
10:00 AM	2,099	113	Y	N	Y	Y	Y	Y
11:00 AM	2,232	120	Y	N	Y	Y	Y	Y
12:00 PM	2,236	126	Y	N	Y	Y	Y	Y
1:00 PM	2,046	115	Y	N	Y	Y	Y	Y
2:00 PM	2,156	122	Y	N	Y	Y	Y	Y
3:00 PM	2,273	122	Y	N	Y	Y	Y	Y
4:00 PM	2,342	126	Y	N	Y	Y	Y	Y
5:00 PM	2,047	89	Y	N	Y	Y	Y	N
6:00 PM	1,310	57	Y	N	Y	N	N	N
7:00 PM	804	0	Y	N	N	N	N	N
8:00 PM	522	0	N	N	N	N	N	N
9:00 PM	331	0	N	N	N	N	N	N
10:00 PM	254	0	N	N	N	N	N	N
11:00 PM	197	0	N	N	N	N	N	N
Total	30,833	1289						
			0		11		11	8
			8		8		4	1
			NO		YES		YES	YES