FEHR PEERS

MEMORANDUM

To: Rob Lochmiller, City of Spokane Valley
Greg Holder, David Evans and Associates, Inc.

From: Chris Breiland, PE
Patrick Picard, AICP

Subject: Barker Road/BNSF Grade Separation – Consolidated Traffic and Safety Analysis UPDATED July 10, 2018

SE17-0560

INTRODUCTION

As part of a larger effort to remove at-grade rail crossings in the Spokane region, Spokane Valley is working to grade separate the Barker Road/BNSF crossing and also improve traffic and freight operations at the Barker Road/Trent Avenue intersection. In support of this project, Fehr & Peers prepared a series of traffic and safety analyses under year 2040 conditions. This memo presents a summary of findings for six conceptual alternatives being studied as part of the Barker Road/BNSF Grade Separation project.

Problem Statement

An existing conditions analysis demonstrated three primary issues at the Barker Road/BNSF rail crossing that the Grade Separation project is aiming to address. These include:

- Vehicular delays along Barker Road caused by the at-grade BNSF rail crossing, which currently hosts about 55 trains per day
- Reduction in vehicle/train conflicts at this crossing to improve long-term safety
- Poor level of service at the existing Barker Road/Trent Avenue intersection, which currently operates at LOS F, failing both City of Spokane Valley and WSDOT standards

Additionally, both traffic volumes on Barker Road and Trent Avenue as well as train volumes on the BNSF mainline are forecast to increase substantially by 2040. Thus, delays from the at-grade rail crossing and the Barker Road/Trent Avenue intersection are forecast to get worse in the future without improvements. The forecast growth in traffic volumes and train volumes also increases the probability of a crash occurring with a train at the at-grade rail crossing as well as an increase in average annual crashes at the Barker Road/Trent

Avenue intersection (based on the Highway Safety Manual Predictive analysis method[1]). Lastly, the delays to vehicular traffic observed and forecast at the Barker Road/BNSF rail crossing negatively impact emergency vehicle access and response times to the area as well as the ability for the City to attract and permit industrial development in the area that is desired to meet the City's economic development goals.

Background/Context

The City of Spokane Valley is leading the effort to secure funding and study alternatives for the Barker Road/BNSF Grade Separation project, which is included in the Department of Public Work's 2016 Six-Year Transportation Improvement Program (TIP). The goals of the project include:

- Improve emergency vehicle access
- Improve safety and reduce delay caused by train/vehicle conflict
- Reduce noise from train whistles
- Improve the level of service (LOS) of the Barker Road/Trent Avenue intersection, which currently operates at LOS F
- Allow for development of the Northeast Industrial Area

This project is part of a larger effort known as Bridging the Valley, which is a regional program to separate vehicle traffic from major train crossings in the Spokane area. While Bridging the Valley has not received much in the way of State or Federal funding in recent years, it remains a major priority for Spokane Valley to improve safety, provide reliable traffic and freight routes, and spur economic development. This project also strongly supports an ongoing economic development effort to foster development and job creation in the Northeast Industrial Area. Spokane Valley is currently in the process of completing an Environmental Impact Study and Planned Action Ordinance for the Northeast Industrial Area and there is strong developer interest in the area.

EXISTING CONDITIONS

The existing conditions analysis includes an analysis of existing traffic operations and crash history in the area. Traffic analysis was performed for the Barker Road/Trent Avenue intersection and Barker Road/BNSF at-grade crossing as well as at the Del Rey Drive/Trent Avenue intersection and Flora Road/Trent Avenue intersections. These latter two intersections were included as they would be impacted by some or all of the alternatives being considered. Crash history was documented at the Barker Road/BNSF rail crossing and Barker Road/Flora Road rail crossing as well as at the Barker Road/Trent Avenue intersection.

[1] Safety Analysis Guide. Washington State Department of Transportation, September 2017. Pg 16.

BNSF Rail Operations and Crash History

The Burlington Northern Santa Fe (BNSF) Railroad crosses Barker Road and Flora Road just south of Trent Avenue. The BNSF route is one of the company's main transcontinental lines between west coast ports and the interior of the country and hosts Amtrak's twice daily Empire Builder between Chicago and Seattle/Portland. **Figure 1** illustrates some basic operating characteristics for each of these at-grade crossings. Federal Railroad Administration (FRA) data indicates that the BNSF line hosts about 54 trains per day, mostly long-haul freight trains passing quickly through the area.

Historic crash data indicates that the grade crossings on Barker and Flora Road have operated with little crash history over the last 40 years. However, a fatal vehicle crash occurred with a train at the Barker Road/BNSF crossing in 1991.

Figure 1: Operating characteristics of at-grade rail crossings in the study area

Street Crossing	Average Trains per Day	Typical Train Frequency	Gates Down Average/Max (minutes)	Typical Train Speed	List of Crashes (1975-2016)
Barker Road	54	10-90 mins	3:00/4:30	1 - 79 mph	• 1991 - Fatality
Flora Road	54	10-90 mins	No data	1 - 79 mph	• 1975 – no injury • 1990 - no injury

Source: Fehr & Peers; Federal Railroad Administration, 2017

Traffic Operations at Barker Road/BNSF Crossing

The impacts of queuing vehicles at the Barker Road/BNSF at-grade railroad crossings were analyzed using Synchro. The analysis was based on peak hour traffic data and daily railroad gate down times collected on February 14, 2017. Observations showed the crossing gates at the Barker Road/BNSF crossing were down for an average of about 3 minutes per train crossing, but ranged anywhere from 30 seconds to 4.5 minutes.

The queuing analysis looked at the queue length and associated traffic impacts under two scenarios in which the gates are down during both the AM and PM peak hour:

- **Average queue length** – This was measured by the 50th percentile queue length during an average gate down time and represents the typical queue that would occur when a train crosses Barker Road during the peak commuting period.
- **Worst case scenario queue length** – This was measured by the 95th percentile queue length

during the longest observed gate down time[2] and represents a queue during the worst case scenario: a particularly high surge in peak hour traffic combined with a long gate down time. Note: based on the observed frequency of long gate down times the worst case scenario is likely to occur 9-10 times per year.

The results of the queuing analysis are shown in **Figure 2**, including the estimated vehicle queue length in feet along Barker Road during the AM and PM peak when the gates are down. Because of the proximity of Trent Avenue to the Barker Road/BNSF rail crossing a more detailed analysis was performed to see if there would be any impacts to traffic on Trent Avenue.

Figure 2: Vehicle queue length on Barker Road at BNSF rail crossings when gates are down

Condition	Trains per Day	Gate Down Time	Vehicle Queue Length (feet)			
			AM Peak		PM Peak	
			NB	SB	NB	SB
Average (50th percentile)	54	3 minutes	150	250	275	275
Worst Case (95th percentile)	54	4.5 minutes	275	425	475	475

Results shows that queues are typically longer during the PM peak (when traffic volumes are greater), about 275 feet long on either side the BNSF crossing. During the worst case scenario, queues can be as long as 475 feet on either side of the BNSF crossing. It should be noted that in the southbound direction there is only about 100 feet between the railroad crossing stop bar and the Trent Avenue intersection, which is enough space for about 4 cars (or 1 truck and 1 car). This means the queue typically extends about 175 feet along Trent Avenue (and can be as long as 375 feet during the worst case scenario). Vehicles queued on Trent would be in either the westbound left turn pocket, which is about 200 feet long or the eastbound right-turn lane, which is about 300 feet long. Currently these lanes are predicted to be just long enough to store vehicles queued on Trent during the worst case scenario without spilling into the through lanes. However, traffic volumes on Barker Road are forecast to increase by an average of 3.7% per year through 2040 and BNSF is planning to increase train volumes, both of which will increase the likelihood and frequency that the southbound vehicle queue will spill onto the through lanes along Trent Avenue in the future without improvements.

Lastly, in addition to the BNSF crossing, Barker road crosses the Union Pacific (UP) railroad at Euclid

[2] Duration and frequency of gate down times was recorded at the BNSF rail crossings along Barker Road between 7 AM and 6 PM Tuesday, February 14, 2017

Avenue, about one mile south of Trent Avenue. The UP hosts an average of about 9 trains per day. Because there are no grade-separated rail crossings in the study area, there are times that the gates are down on both the UP and BNSF line at the same time. This could delay access into or out of the site for emergency vehicles by as much as 4 minutes. The nearest alternative route would be via Sullivan Road (2 miles west of Barker Road) and Euclid Avenue. Sullivan Road is grade-separated from both railroads.

Level of Service Standards

The City of Spokane Valley uses level of service (LOS) to describe and evaluate traffic operations along major arterial corridors and intersections within the City. Levels range from LOS A to LOS F, which encompass a range of congestion types from uninterrupted traffic (LOS A) to highly-congested conditions (LOS F). The description and intersection delay thresholds of each LOS category are described in **Figure 3.** These are based on the Highway Capacity Manual, which is the methodology used by Spokane Valley. The LOS for signalized intersections is measured by the average delay per vehicle entering the intersection from all approaches, while the LOS for unsignalized intersections is measured by the average delay per vehicle on the approach with the highest average delay.

Figure 3: Level of service description and delay thresholds at intersections

Level of Service	Description	Signalized Intersection Delay (seconds)	Unsignalized Intersection Delay (seconds)
A	Free-flowing conditions.	0-10	0-10
B	Stable operating conditions.	10-20	10-15
C	Stable operating conditions, but individual motorists are affected by the interaction with other motorists.	20-35	15-25
D	High density of motorists, but stable flow.	35-55	25-35
E	Near-capacity operations, with speeds reduced to a low but uniform speed.	55-80	35-50
F	Over-capacity conditions with long delays.	> 80	>50

Source: Highway Capacity Manual 2016, Transportation Research Board

The LOS standards used by Spokane Valley are defined in the Comprehensive Plan as follows:

- LOS D for major arterial corridors:
    - Argonne/Mullan between the town of Millwood and Appleway Boulevard
    - Pines Road between Trent Avenue and 8th Avenue
    - Evergreen Road between Indiana Avenue and 8th Avenue
    - Sullivan Road between Wellesley Avenue and 8th Avenue

    - Sprague Avenue/Appleway Boulevard between Fancher Road and Sullivan Road
- LOS D for signalized intersections not on major arterial corridors
- LOS E for unsignalized intersections (LOS F acceptable if peak hour traffic signal warrant is unmet)

WSDOT also uses LOS thresholds for State Highways. Given that Trent Avenue is a State Route (SR 290), intersections with Trent Avenue would also need to operate at LOS D or better to meet WSDOT LOS standards for urban areas within the Eastern Region.

Existing Intersection Traffic Operations

Existing traffic conditions, including average vehicle delay and LOS, at the study area intersections are shown in **Figure 4**. The existing (2017) lane configurations and AM/PM peak hour turn movements for each intersection are shown in **Figure 5**.

Figure 4: Existing (year 2017) intersection LOS results

Intersection	Control	AM Peak		PM Peak		Approach
		Delay	LOS	Delay	LOS	
Barker Rd/ Trent Ave	Side Street Stop Control	**59**	**F**[1]	**41**	**E**[2]	NB
Del Rey Dr/ Trent Ave	Side Street Stop Control	23	C	18	C	SB
Flora Rd/ Trent Ave	Side Street Stop Control	**129**	**F**[1]	**124**	**F**[1]	SB/NB

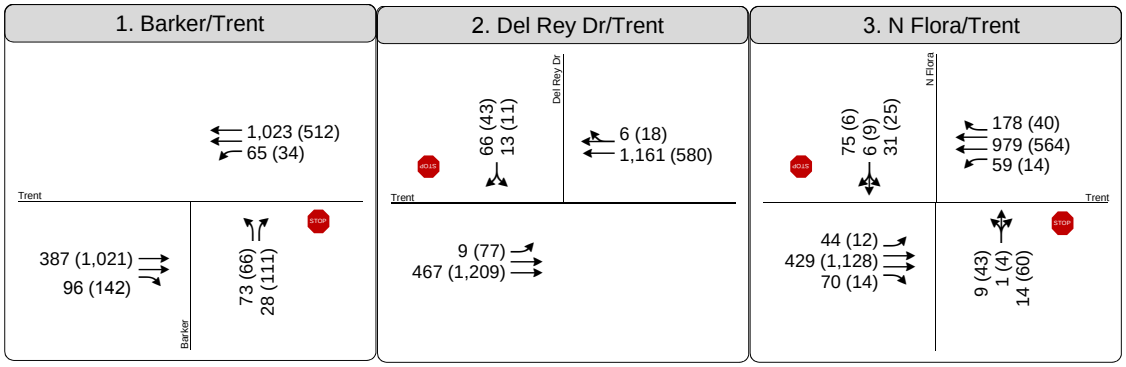
1. Does not meet WSDOT or City of Spokane Valley LOS standards. Intersection operates at LOS F and volumes satisfy the peak hour signal warrant per MUTCD criteria.
2. Does not meet WSDOT LOS standards.

Under existing conditions, the following intersections do not currently meet the City of Spokane Valley or WSDOT LOS standards:

- Barker Road/Trent Avenue (AM peak northbound approach, PM peak northbound approach per WSDOT standards)
- Flora Road/Trent Avenue (AM peak southbound approach, PM peak northbound approach)

Both the Barker Road/Trent Avenue intersection and Flora Road/Trent Avenue intersection currently operate at LOS F during the peak hour and peak hour traffic volumes are sufficient to meet the peak hour signal warrant using MUTCD[3] criteria.

[3] *Manual on Uniform Traffic Control Devices* (MUTCD), Federal Highway Administration, https://mutcd.fhwa.dot.gov



Legend

Traffic Signal Stop Sign **AM(PM)** Peak Hour Traffic Volume

Figure 5
Peak Hour Traffic Volumes and Lane Configurations
Existing Conditions (2017)

Barker Road/Trent Avenue Intersection Crash History

Vehicle collision history was analyzed over a five year period from January 2012 to December 2016 at the Barker Road/Trent Avenue intersection in northeast Spokane Valley, WA. **Figure 6** provides a summary of the crash history at in the vicitinty of the Barker Road/Trent Avenue intersection by severity and whether the cause was related to intersection operations. There were 17 reported crashes at or near the Barker Road/Trent Avenue intersection over the five year period from 2012 to 2016. Of these, four resulted in an injury and zero resulted in a fatality. This equates to an average of 3.4 crashes per year at this location including 0.8 injury crashes per year. Of the 17 reported crashes over the five year period, ten were directly at the intersection and the cause of the crash was found to be related to the intersection, while seven were within 0.1 miles of the intersection, but the cause was not found to be related to the intersection. Three of the four injury crashes were from crashes where the crash was related to intersection operations.

Figure 6: 2012-2016 Crashes by severity in the vicinity of the Barker Road/Trent Avenue intersection

Summary Type	All Crashes	Fatal Crashes	Injury Crashes	Intersection Related
5 year total	17	0	4	10
Average per year	3.4	0	0.8	2.0

Figure 7 provides a summary of crashes from 2012 to 2016 at the Barker Road/Trent Avenue intersection by crash type. Of the 17 total crashes over this period, about 40% were caused by a driver making an improper left-turn or failing to yield, most commonly from a driver entering the intersection from Barker road into oncoming traffic on Trent Avenue. This crash type also made up 50% of injury crashes at this location. The three other crashes related to the intersection include two rear-end crashes (into vehicles waiting at the stop sign or rail crossing at Barker Road) and one where speeding was identified as a factor along Trent Avenue.

Figure 7: 2012-2016 Crashes by type in the vicinity of the Barker Road/Trent Avenue intersection

Severity	Total	Improper turn/ failure to yield	Sideswipe (Trent Avenue)	Rear-end (Barker Road)	Lane deviation (Trent Avenue)	Animal collision	Speeding
All crashes	17	7	2	2	2	2	2
Injury crashes	4	2	0	1	0	0	1

Based on the analysis of recent collisions at this location, it is likely that a roundabout at this location would reduce the "improper left turn" and "failure to yield" collisions.[4] The reduction in these types of crashes is based on the low-speed approach to the roundabouts make it easier to judge gaps in traffic and safely enter the traffic stream. The likelihood of injury crashes is also much lower at a roundabout because of the lower speeds through the roundabout. The grade separation would eliminate the issue of rear-end crashes at the grade crossing.

CONCEPTUAL ALTERNATIVES

The City is evaluating six conceptual alternatives for grade separating the Barker Road/BNSF railroad briefly described below:

- **Alternative 1** – Under this concept Barker Road would be realigned to the west to intersect Trent Avenue at the current Trent Avenue/Del Rey Drive intersection, essentially converting this from a "T" to four-way intersection. Under this alternative the Flora Road/BNSF crossing would close.
- **Alternative 2, 3, and 6** – These alternatives are essentially the same. The only difference is that under Alternatives 2 and 6, Barker Road would go over the BNSF tracks and under Alternative 3 Barker Road would go under the BNSF tracks. Under alternatives 2 and 3 a new north-south grade-separated crossing would be established across the BNSF tracks just east of the current Barker Road alignment. Alternative 6 has the grade crossing and the intersection with Barker/Trent in a similar location to existing conditions. The defining feature of this alternative is that Wellesley Avenue would be realigned to intersect Barker Road at the new Barker Road alignment south of the BNSF track and the existing Wellesley overpass of the BNSF and ramps with Trent Avenue would close. Under this alternative the Flora Road/BNSF crossing would also close.
- **Alternative 4** – Under this concept Wellesley Avenue would be realigned just north of the BNSF tracks to intersect Trent Avenue at a new "T" intersection and Trent Avenue would be four lanes where it intersects Wellesley Avenue (Trent would transition to 2-lanes east of Wellesley Avenue). Barker Road would be realigned to intersect Wellesley Avenue about ½ mile east of the current alignment (just east of the existing approach to the Wellesley Avenue Bridge over the BNSF railroad tracks). Under this alternative the Flora Road/BNSF at-grade crossing would remain open since there would be no new crossing of the BNSF.
- **Alternative 5** – Under this concept Barker Road would maintain its current alignment and intersect Trent Avenue at roughly the current location it does today. Under this alternative the Flora Road/BNSF crossing would close.

[4] Based on WSDOT provided research: https://www.wsdot.wa.gov/Safety/roundabouts/benefits.htm

TRAFFIC ANALYSIS METHODS AND ASSUMPTIONS

This section describes the methodology used to forecast 2040 traffic under the six conceptual alternatives being studied for the Barker Road/BNSF Grade Separation project.

Intersections Analyzed

AM and PM peak hour vehicle delay and level of service (LOS) were analyzed for the year 2040 at the following intersections under each alternative:

- **Alternative 1:**
  - Barker Road/Del Rey Drive/Trent Avenue (NEW)
  - Flora Road/Trent Avenue
- **Alternatives 2/3/6:**
  - Barker Road/Wellesley Avenue (NEW)
  - Barker Road/Trent Avenue (NEW)
  - Del Rey Drive/Trent Avenue
  - Flora Road/Trent Avenue
- **Alternative 4:**
  - Barker Road/Wellesley Avenue (NEW)
  - Wellesley Avenue/Trent Avenue (NEW)
  - Del Rey Drive/Trent Avenue
  - Flora Road/Trent Avenue
- **Alternative 5:**
  - Barker Road/Trent Avenue (NEW)
  - Del Rey Drive/Trent Avenue
  - Flora Road/Trent Avenue

The Flora Road/Trent Avenue and Del Rey Drive/Trent Avenue intersections were included in the analysis as these intersections would be impacted by the various alternatives, particularly by whether or not the south leg of the Flora Road/Trent Avenue intersection across the BNSF tracks remains open.

Regional Travel Demand Model

Traffic volumes at each of the study intersections were estimated in 2040 using the same version of the SRTC approved regional travel demand model that was used for the recent update to the Spokane Valley Comprehensive Plan. It should be noted that the 2040 model used in this analysis is a little different than the current version of the SRTC 2040 model. The SRTC approved Spokane Valley Comprehensive Plan model reflects buildout conditions in Spokane Valley and thus assumes more growth in northeast Spokane Valley than the current SRTC 2040 model, which reflects a slightly lower level of traffic growth. We felt the

model used in this analysis provides a more accurate forecast of growth in the area and if anything would result in more conservative (higher) traffic forecasts than the existing SRTC 2040 Model.

The model assumes several nearby network changes would be made to the area by 2040, including (but not limited to):

- The Barker Road/I-90 interchange would be reconfigured to a standard diamond interchange with two-lane roundabouts plus slip ramps for right-turn movements at both ramps (as reflected in I-90/Barker Rd the Interchange Justification Report)
- Barker Road between I-90 and Appleway Avenue would be widened to five lanes
- The existing partial interchange at I-90/Appleway Avenue would be replaced with a new, full interchange at I-90/Henry Road[5]
- New northbound and southbound left turn lanes on Sullivan Road at the Trent Avenue ramps
- Bigelow Gulch Road would be widened to four lanes and connected to Sullivan Road

Prior to running the model, input was gathered from the Northeast Industrial Area Planned Action Ordinance technical advisory committee (TAC) to identify future land use and transportation network changes that were not already incorporated in the model. The TAC for that project is comprised of representatives from Spokane Valley, Spokane County, Liberty Lake, the Spokane Regional Transportation Council (SRTC), Washington State Department of Transportation (WSDOT), developers, utility providers, and the railroads. The SRTC regional travel model version used for this analysis has land uses within Spokane Valley that are consistent with both the Spokane Valley Comprehensive Plan and the recently completed Mirabeau Subarea Traffic Study.

After consulting with the TAC, a few changes were made to the regional travel demand model in the vicinity of the Northeast Industrial Area before running the model:

- The 2015 and 2040 land use, including the number of dwelling units and employees, in the seven TAZs within Liberty Lake (442, 445, 446, 447, 448, 449 & 450) were updated based on information provided in the *Liberty Lake Network Analysis Transportation Study* (February, 2017).
- Indiana Avenue was connected between Barker Road and Harvard Road in the 2040 model
- A new east-west connector road between Flora Road and Barker Road was added between Euclid Avenue and Trent Avenue to reflect a planned connection for the area.

In order to account for the observed delay of turning left or crossing Trent Avenue from Flora Road at the

[5] Note: This configuration is consistent with the existing SRTC plan and was assumed when this study was initiated. However, it should be noted that since this study was initiated WSDOT completed their modeling for a new Henry Road interchange and found it did not show purpose and need.

Flora Road/Trent Avenue intersection a 60-second delay was added to all left turning and through movements on Flora Road at this intersection. The added 60-second delay in the model will more accurately reflect actual conditions drivers would experience. This was incorporated specifically at this intersection because it is the only intersection controlled by a side-street stop performing at LOS F in both the AM and PM peak existing conditions that would have the same control device in the future under Alternative 4.

Applying the Difference Method

Instead of using the traffic forecasts directly from the 2040 travel demand model, 2040 volumes were estimated using an industry standard approach known as the difference method. Under the difference method, the difference in traffic volumes between the 2015 and 2040 models were added to observed counts at each of the study area intersections to arrive at a 2040 forecast traffic. This method reduces model error by relying as much as possible on observed data rather than model output data.

Existing traffic data was collected during the AM and PM peak hour on Tuesday, February 14th 2017 at the following intersections:

- Barker Road/Trent Avenue
- Del Rey Drive/Trent Avenue
- Flora Road/Trent Avenue

Estimating AM Peak Volumes

The regional travel demand model forecasts PM peak hour turn movements, but only forecasts 3-hour AM peak turn movements at each intersection. Therefore we developed two methods to estimate 2040 AM peak hour turn movements and looked at the outcomes of both:

- **Inverse of PM peak hour** – One method of estimating traffic growth in the AM peak, was to use 80% of the inverse of growth in traffic in the PM peak, which is consistent with research published in National Cooperative Highway Research Program Report 365[6] and in observed peak hour traffic count data collected in Spokane Valley. For example, 80% of growth in PM peak volumes for southbound right turn movements at each intersection were applied to eastbound left movements to get the AM peak traffic forecast.
- **Factor down 3-hour AM model volumes** – The other method we considered was to factor down the growth in 3-hour AM turn movements by multiplying that growth by 0.365, which is a typical ratio for converting 3-hour AM volumes to 1-hour AM peak hour volumes (based on observing the ratio of 3-hour to 1-hour counts).

[6] Martin, W., N. McGuckin. *Travel Estimating Techniques for Urban Planning*. NCHRP Report 365. National Academy Press, Washington, D.C., 1998.

We looked at 2040 AM peak hour traffic volumes that would result from both methods and decided to use the inverse of the PM peak hour volumes as the resulting volumes were generally slightly higher (and thus would be more conservative) and seemed more reasonable at each intersection.

2040 TRAFFIC ANALYSIS & RECOMMENDED MITIGATIONS

Alternative 1 Results

Two intersections were analyzed under Alternative 1:

- Del Rey Drive/Trent Avenue, which would be converted to a four leg intersection with Barker road rerouted to intersect Trent Avenue at this location; and
- Flora Road/Trent Avenue with the southbound leg closed.

Traffic conditions in 2040 under Alternative 1 at each intersection is shown in **Figure 8** Forecast 2040 lane configurations and AM/PM peak hour turn movements under Alternative 1 for each intersection are shown in **Figure 9**.

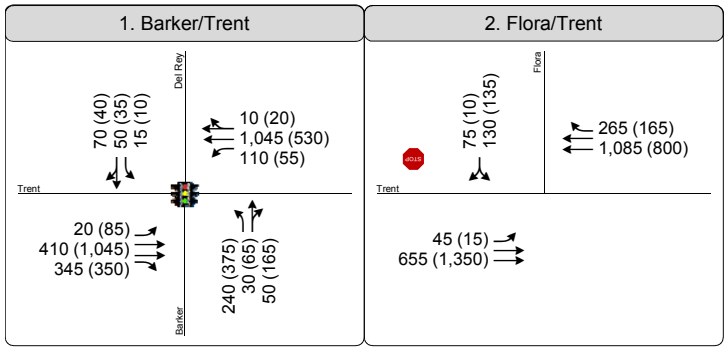
Figure 8: Alternative 1 year 2040 intersection LOS results

Intersection	Control	AM Peak		PM Peak		Approach
		Delay	LOS	Delay	LOS	
Barker Rd/ Trent Ave/ Del Rey Dr	Signal	27	C	30	C	
Flora Rd/ Trent Ave	Side Street Stop Control	**>300**	**F[2]**	**>300**	**F[2]**	SB

1. Does not meet Spokane Valley or WSDOT LOS standards. Intersection operates at LOS F and volumes satisfy the peak hour signal warrant per MUTCD.

Analysis shows that under Alternative 1 the proposed Barker Road/Trent Avenue/Del Rey Drive intersection would operate at an acceptable LOS by 2040 with a signal. However, the Flora Road/Trent Avenue intersection would fail both Spokane Valley's and WSDOT's LOS standard by 2040, as this intersection would operate at LOS F during the AM and PM peak hours as measured by the delay to the southbound approach and traffic volumes would satisfy the peak hour signal warrant per MUTCD[7] criteria.

[7] *Manual on Uniform Traffic Control Devices* (MUTCD), Federal Highway Administration, https://mutcd.fhwa.dot.gov



Legend

Traffic Signal Stop Sign **AM(PM)** Peak Hour Traffic Volume

Figure 9
Peak Hour Traffic Volumes and Lane Configurations
Alternative 1 (Year 2040)

Alternative 1 Recommended Mitigations

Flora Road/Trent Avenue

Under Alternative 1 the southbound leg of the Flora Road/Trent Avenue intersection across the BNSF tracks would be closed. However, the intersection is still forecast to operate at LOS F in both the AM and PM peak as measured by the southbound approach, and would thus fail both the Spokane Valley and WSDOT LOS standards. While this LOS failure is not a result of the Barker Road/Trent Avenue reconfiguration, we still investigated how to provide acceptable operations at this intersection. To address the poor LOS at Flora/Trent, a signal or roundabout could be installed at this intersection. Assuming an actuated, uncoordinated signal with a 110 second cycle length and protected left turn movements on Trent Avenue, traffic would operate at LOS A during the AM and PM Peak by 2040 if these mitigations were applied. A two-lane roundabout would perform as well or better than a signal, and could be a viable option given the low pedestrian and bicycle volumes and the closure of the southern leg of the intersection (and elimination of the associated rail conflicts). Given that Trent Avenue is a State Highway, under WSDOT design criteria an Intersection Control Analysis (ICA) would need to be conducted if Alternative 1 is selected before a signal can be installed. In general, WSDOT prefers roundabouts to signals, where they do not pose significant challenges related to cost, right-of-way acquisition, or environmental impacts since they tend to be safer for vehicles and have lower operating costs.

Barker Road/Trent Avenue/Del Rey Drive

Under Alternative 1 Barker Road would be rerouted west of the current alignment to intersect Trent Avenue at the current Del Rey Drive/Trent Avenue intersection, effectively changing this intersection from a three-way to a four-way intersection. A signal or roundabout at this intersection would be sufficient to accommodate traffic in 2040. However, if the geography of the area were such that Barker Road would need to intersect Trent Avenue some distance east of the Del Rey Drive intersection, the two intersections would need to be spaced sufficiently to allow adequate sight distance from for southbound vehicles at that location to see vehicles that would be turning left from Barker Road onto Trent Avenue. According to the AASHTO Green Book, southbound left turning vehicles would need to be able to see traffic a minimum of 7.5 seconds away to safely cross. Assuming a that vehicles turning left from Barker Road to Trent Avenue make the turn at 20 mph and then accelerate at 9 ft/sec^2 to a maximum speed of 50 mph, the Del Rey intersection would need to be at least 450 feet from the Barker Road intersection in order for vehicles on Del Rey Drive to have adequate sight distance to make the turn onto Trent Avenue. Thus, if the geography of the area prevented Barker Road from intersecting Trent Avenue at the Del Rey Drive/Trent Avenue intersection, Barker Road would need to intersect Trent Avenue at least 450 feet from Del Rey Drive. It should also be noted that if the Barker Road/Trent intersection were offset from Del Rey Drive under Alternative 1, the same mitigations at the Del Rey Drive/Trent Avenue intersection would be needed by 2040 as described in Alternatives 2/3/6.

Alternatives 2/3/6 Results

Four intersections were analyzed under Alternatives 2/3/6, including two existing intersections (Flora Road/ Trent Avenue and Del Rey Drive/Trent Avenue) and two new intersections (Barker Road/Wellesley Avenue and a reconfigured Barker Road/Trent Avenue). Traffic conditions in 2040 under Alternatives 2/3/6 at each intersection is shown in **Figure 10**. Forecast 2040 lane configurations and AM/PM peak hour turn movements under Alternatives 2/3/6 for each intersection are shown in **Figure 11**.

Figure 10: Alternatives 2/3/6 year 2040 intersection LOS results

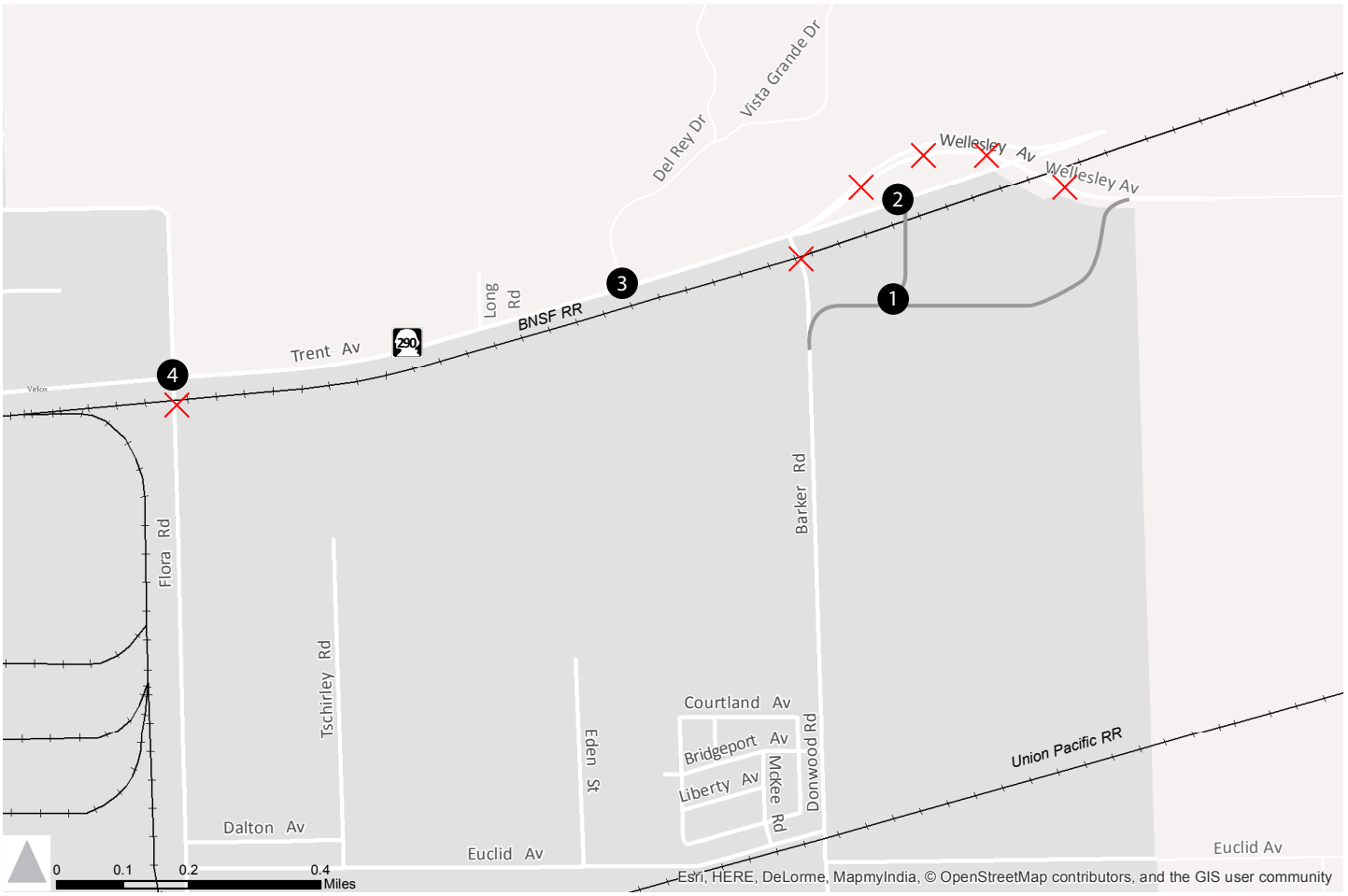
Intersection	Control	AM Peak		PM Peak		Approach
		Delay	LOS	Delay	LOS	
Barker Rd/ Wellesley Ave	Side Street Stop Control[1]	24	C	44	E	WB
Barker Rd/ Trent Ave	Signal	27	C	33	C	
Del Rey Dr/ Trent Ave	Side Street Stop Control	**58**	**F**[2]	**47**	**E**[3]	SB
Flora Rd/ Trent Ave	Side Street Stop Control	**238**	**F**[2]	**>300**	**F**[2]	SB

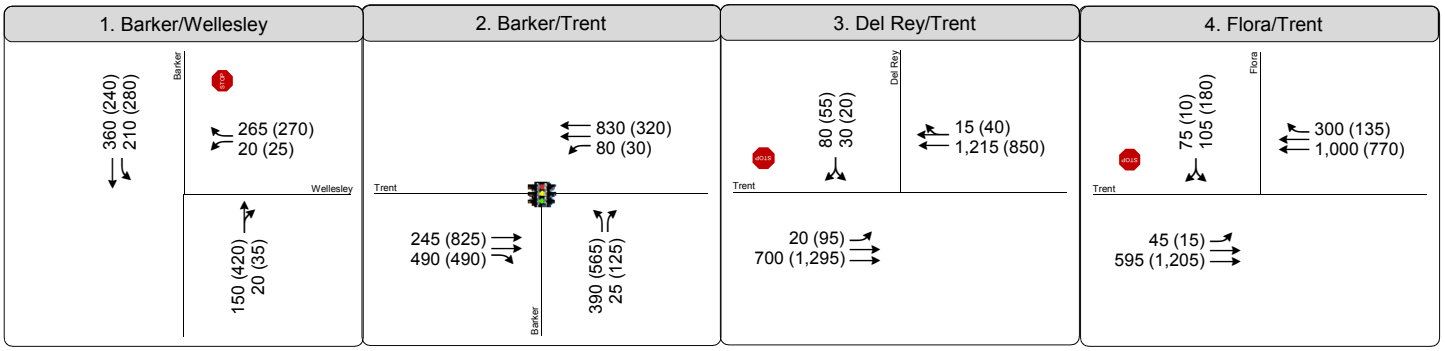
1. LOS for this intersection was analyzed assuming a side-street stop control, but could operate as well or better with a roundabout.
2. Does not meet Spokane Valley or WSDOT LOS standards. Intersection operates at LOS F and volumes satisfy the peak hour signal warrant per MUTCD.
3. Does not meet WSDOT LOS standards.

Analysis shows that under Alternatives 2/3/6 the proposed Barker Road/Wellesley intersection would operate at an acceptable LOS by 2040 with a stop control from the Wellesley Avenue approach. This approach would operate as well or better with a roundabout. In addition, the proposed Barker Road/Trent Avenue intersection would also operate at an acceptable LOS with a signal.

However, under Alternatives 2/3/6 both the Del Rey Drive/Trent Avenue and Flora Road/Trent Avenue would not meet Spokane Valley or WSDOT LOS standards by 2040. The Del Rey Drive/Trent Avenue intersection would operate at LOS F during the AM peak and traffic volumes would satisfy the peak hour signal warrant per MUTCD[8] criteria, thus failing both the Spokane Valley and WSDOT LOS standards. During the PM peak this intersection is forecast to operate at LOS E, which would also fail WSDOT LOS standards. Despite closure of the southbound leg of the Flora Road/Trent Avenue intersection, this intersection would operate at LOS F during the AM and PM peak hours as measured by the delay to the southbound approach and traffic volumes would satisfy the peak hour signal warrant per MUTCD[6] criteria.

[8] *Manual on Uniform Traffic Control Devices* (MUTCD), Federal Highway Administration, https://mutcd.fhwa.dot.gov





Legend

Traffic Signal Stop Sign **AM(PM)** Peak Hour Traffic Volume

Figure 11
Peak Hour Traffic Volumes and Lane Configurations
Alternatives 2/3/6 (Year 2040)

Alternatives 2/3/6 Recommended Mitigations

Flora Road/Trent Avenue

Under Alternatives 2/3/6 the southbound leg of the Flora Road/Trent Avenue intersection across the BNSF tracks would be closed. However, the intersection is still forecast to operate at LOS F in both the AM and PM peak as measured by the southbound approach, and would thus fail both the Spokane Valley and WSDOT LOS standards. While this LOS failure is not a result of the Barker Road/Trent Avenue reconfiguration, we still investigated how to provide acceptable operations at this intersection. The same mitigations recommended at this intersection under Alternative 1 would apply.

Del Rey Drive/Trent Avenue

Under Alternatives 2/3/6 the Del Rey Drive/Trent Avenue intersection would operate at LOS F during the AM peak and LOS E during the PM peak, failing both the Spokane Valley and WSDOT LOS standards. The degradation of LOS in the future will primarily be from background traffic growth unrelated to the project. However, there will be some impact from closing Flora Road at the BNSF rail crossing under Alternative 2/3/6. To address the poor LOS the following mitigation is necessary:

- Stripe the Del Rey Drive approach to include a separate southbound left turn lane. The existing pavement width is sufficient to include the additional turn lane. If striped in this manner the intersection would operate at LOS C/D for several years before exceeding the LOS E and eventually LOS F threshold at some point close to year 2040. Given the inherent uncertainty in long range traffic forecasts (and thus when exactly the intersection would exceed the acceptable threshold), it would be premature to do anything beyond restriping the approach in the near-term.

One of the following recommendations may be applied as a future solution at the point at which the intersection begins to fail the LOS threshold:

Install a traffic signal or roundabout[9] at this intersection;

- Convert Del Rey Drive into a left-in/right-in/right-out configuration – this would require U-turn access either at Flora Road (which could be accommodated by a roundabout or special U-turn movement) or at a separate dedicated intersection located just west of the Del Rey Drive intersection to allow traffic from Del Rey to head east on Trent or south on Barker;
- Install an eastbound acceleration lane for traffic turning left from Del Rey to Trent and widen the Del Rey approach to include separate left and right turn lanes; or,
- Construct a new road from the subdivision north of Trent Avenue to intersect with Trent Avenue opposite of the realigned Barker Road intersection

[9] Given the topography of the area, a roundabout may not be feasible at this location without significant construction costs. This would need to be determined through a WSDOT intersection control analysis (ICA) process.

Any of the single solutions identified above would provide an acceptable LOS at the intersection by 2040. The conversion of Del Rey to left-in/right-in/right-out only configuration would be the least expensive option, but would result in some level of inconvenience for the residents of the subdivision north of Trent Avenue as they would need to either U-turn or use Sullivan Road to travel to destinations to the south/east.

Barker Road/Wellesley Avenue

A side-street stop control is forecast to operate at an acceptable level of service at the new Barker Road/Wellesley intersection under Alternatives 2/3/6. However, given this intersection will require new construction, the City may want to consider a roundabout instead. While a side-street stop control would be an acceptable option, a roundabout will provide more capacity and generally have fewer injury crashes. A one-lane roundabout would be sufficient to accommodate traffic in 2040.

Alternative 4 Results

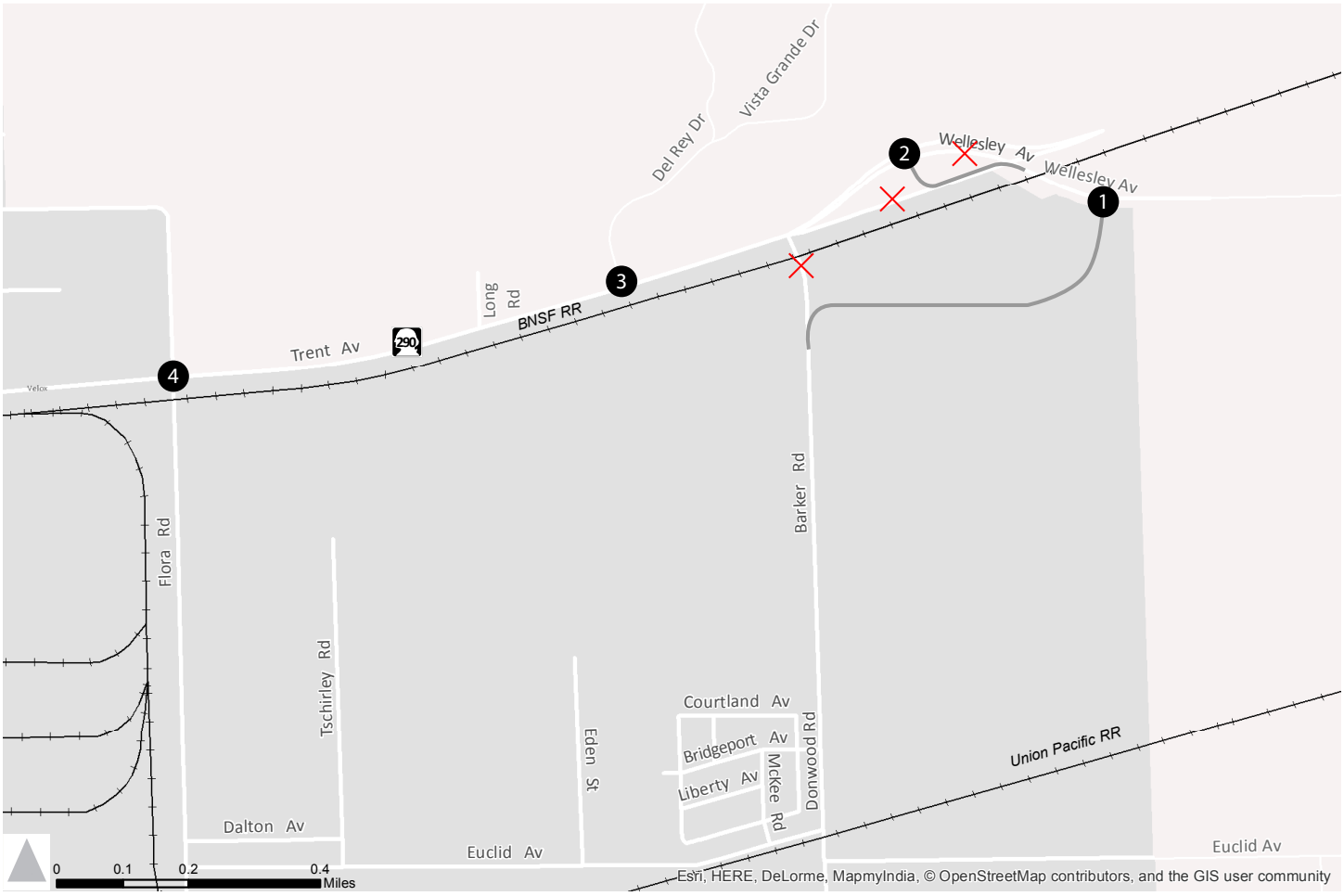
Four intersections were analyzed under Alternative 4, including two existing intersections (Flora Road/ Trent Avenue and Del Rey Drive/Trent Avenue) and two new intersections (Barker Road/Wellesley Avenue and Wellesley Avenue/Trent Avenue). Traffic conditions in 2040 under Alternative 4 at each intersection is shown in **Figure 12**. Forecast 2040 lane configurations and AM/PM peak hour turn movements under Alternative 4 for each intersection are shown in **Figure 13**.

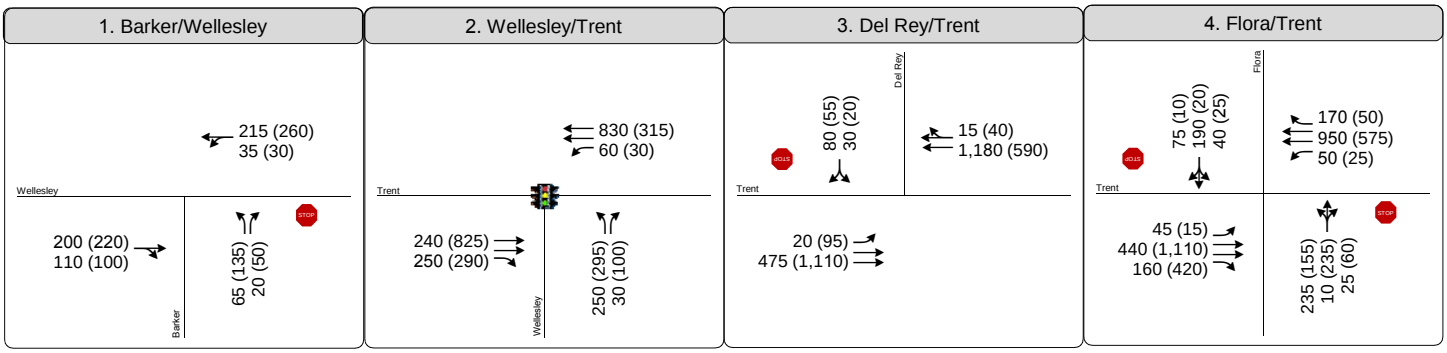
Figure 12: Alternative 4 year 2040 intersection LOS results

Intersection	Control	AM Peak		PM Peak		Approach
		Delay	LOS	Delay	LOS	
Barker Rd/ Wellesley Ave	Side Street Stop Control[1]	14	B	18	C	NB
Wellesley Ave/Trent Ave	Signal	22	C	21	C	
Del Rey Dr/ Trent Ave	Side Street Stop Control	33	D	24	C	SB
Flora Rd/ Trent Ave	Side Street Stop Control	**>300**	**F[2]**	**>300**	**F[2]**	SB/NB

1. LOS for this intersection was measured assuming a side-street stop control, but could operate as well or better with a roundabout.
2. Does not meet Spokane Valley or WSDOT LOS standards. Intersection operates at LOS F and volumes satisfy the peak hour signal warrant per MUTCD.

Analysis shows that under Alternative 4 all intersections studied would perform acceptably by 2040 except Flora Road/Trent Avenue. Delay at this intersection would increase by 2040 and continue to operate at LOS F during the AM and PM peak hours as measured by both the northbound and southbound approaches.





Legend

Traffic Signal Stop Sign **AM(PM)** Peak Hour Traffic Volume

Figure 13
Peak Hour Traffic Volumes and Lane Configurations
Alternative 4 (Year 2040)

Alternative 4 Recommended Mitigations

Flora Road/Trent Avenue

Under Alternative 4 the southbound leg of the Flora Road/Trent Avenue intersection across the BNSF tracks would remain open. Under this concept both the AM and PM peak hour delay is forecast to increase substantially by 2040 causing the intersection to operate at LOS F, thus failing both the Spokane Valley and WSDOT LOS standards. To address the LOS failure, it is recommended that a signal be installed at this intersection along with left turn pockets on Flora Road. Assuming an actuated, uncoordinated signal with a 110 second cycle length and protected left turn movements on Trent Avenue, traffic would operate at LOS C during the AM Peak and LOS B during the PM peak by 2040 if these mitigations were applied. Given that Trent Avenue is a State Highway, under WSDOT design criteria an Intersection Control Analysis (ICA) would need to be conducted to evaluate alternatives before a signal can be installed.

Given that the Flora Road/Trent Avenue intersection would be within 150 feet of the BNSF railroad at-grade crossing under Alternative 4, several additional mitigations strategies will also be needed to signalize this intersection and add left turn lanes on Flora Road:

- First, the existing pavement is 40 feet across at the railroad crossing, which is wide enough to accommodate three lanes instead of two with restriping. However, in order to accommodate a left turn lane, the railroad crossing arms would need to be widened, which would require full replacement of the railroad gate infrastructure.
- Second, given that this intersection is within 200 feet of an at-grade railroad crossing, a signal at this intersection would also need to be interconnected with the railroad crossing. This would require the City to file a petition with the State Utilities and Transportation Commission (UTC). This petition includes an on-site safety assessment with the UTC, WSDOT, and BNSF prior to filing the petition.
- The eastbound right turn lane and westbound left turn lanes may also need to be lengthened to accommodate queuing when the railroad gates are down.

Barker Road/Wellesley Avenue

A side-street stop control is forecast to operate at an acceptable level of service at the new Barker Road/Wellesley intersection under Alternative 4. However, given this intersection will require new construction, the City may want to consider a roundabout instead. While a side-street stop control would be an acceptable option, a roundabout will provide more capacity and generally results in fewer injury crashes. A one-lane roundabout would be sufficient to accommodate traffic in 2040.

Alternative 5 Results

Three intersections were analyzed under Alternative 5, including two existing intersections (Flora Road/ Trent Avenue and Del Rey Drive/Trent Avenue) and one new intersection (a reconfigured Barker Road/Trent Avenue). Traffic conditions in 2040 under Alternative 5 at each intersection is shown in **Figure 14** Forecast 2040 lane configurations and AM/PM peak hour turn movements under Alternative 5 for each intersection are shown in **Figure 15**.

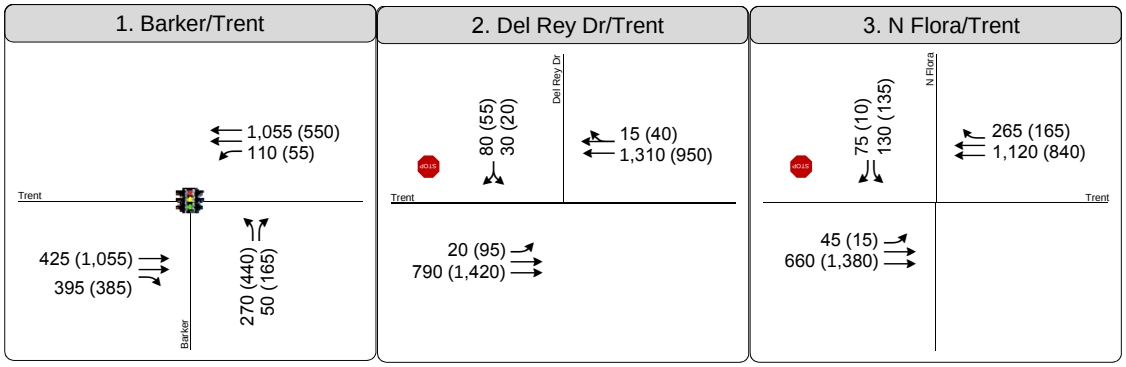
Figure 14: Alternative 5 year 2040 intersection LOS results

Intersection	Control	AM Peak		PM Peak		Approach
		Delay	LOS	Delay	LOS	
Barker Rd/ Trent Ave	Signal	23	C	25	C	
Del Rey Dr/ Trent Ave	Side Street Stop Control	**90**	**F**[1]	**74**	**F**[1]	SB
Flora Rd/ Trent Ave	Side Street Stop Control	**>300**	**F**[1]	**>300**	**F**[1]	SB

1. Does not meet Spokane Valley or WSDOT LOS standards. Intersection operates at LOS F and volumes satisfy the peak hour signal warrant per MUTCD.

Analysis shows that under Alternative 5 the proposed Barker Road/Trent Avenue intersection would operate at an acceptable LOS by 2040 with a signal. However, both the Del Rey Drive/Trent Avenue and Flora Road/Trent Avenue would not meet Spokane Valley or WSDOT LOS standards by 2040. The Del Rey Drive/Trent Avenue intersection would operate at LOS F during the AM and PM peak and traffic volumes would satisfy the peak hour signal warrant per MUTCD[10] criteria, thus failing both the Spokane Valley and WSDOT LOS standards. Despite closure of the southbound leg of the Flora Road/Trent Avenue intersection, this intersection would operate at LOS F during the AM and PM peak hours as measured by the delay to the southbound approach and traffic volumes would satisfy the peak hour signal warrant per MUTCD[8] criteria.

[10] *Manual on Uniform Traffic Control Devices* (MUTCD), Federal Highway Administration, https://mutcd.fhwa.dot.gov



Legend

Traffic Signal Stop Sign **AM(PM)** Peak Hour Traffic Volume

Figure 15
Peak Hour Traffic Volumes and Lane Configurations
Alternative 5 (Year 2040)

Alternative 5 Recommended Mitigations

Flora Road/Trent Avenue

Under Alternative 5 the southbound leg of the Flora Road/Trent Avenue intersection across the BNSF tracks would be closed. However, the intersection is still forecast to operate at LOS F in both the AM and PM peak as measured by the southbound approach, and would thus fail both the Spokane Valley and WSDOT LOS standards. While this LOS failure is not a result of the Barker Road/Trent Avenue reconfiguration, we still investigated how to provide acceptable operations at this intersection. The same mitigations recommended at this intersection under Alternative 1 would apply.

Del Rey Drive/Trent Avenue

Under Alternative 5 the Del Rey Drive/Trent Avenue intersection would operate at LOS F during the AM and PM peak, failing both the Spokane Valley and WSDOT LOS standards. The degradation of LOS in the future will primarily be from background traffic growth unrelated to the project. However, there will be some impact from closing Flora Road at the BNSF rail crossing under Alternative 5. To address the poor LOS the following mitigation is necessary:

- Stripe the Del Rey Drive approach to include a separate southbound left turn lane. The existing pavement width is sufficient to include the additional turn lane. If striped in this manner the intersection would operate at LOS C/D for several years before exceeding the LOS E and eventually LOS F threshold at some point close to year 2040. Given the inherent uncertainty in long range traffic forecasts (and thus when exactly the intersection would exceed the acceptable threshold), it would be premature to do anything beyond restriping the approach in the near-term.

One of the following recommendations may be applied as a future solution at the point at which the intersection begins to fail the LOS threshold:

Install a traffic signal or roundabout[11] at this intersection;

- Convert Del Rey Drive into a left-in/right-in/right-out configuration – this would require U-turn access either at Flora Road (which could be accommodated by a roundabout or special U-turn movement) or at a separate dedicated intersection located just west of the Del Rey Drive intersection to allow traffic from Del Rey to head east on Trent or south on Barker;
- Install an eastbound acceleration lane for traffic turning left from Del Rey to Trent and widen the Del Rey approach to include separate left and right turn lanes; or,
- Construct a new road from the subdivision north of Trent Avenue to intersect with Trent Avenue opposite of the realigned Barker Road intersection

[11] Given the topography of the area, a roundabout may not be feasible at this location without significant construction costs. This would need to be determined through a WSDOT intersection control analysis (ICA) process.

Any of the single solutions identified above would provide an acceptable LOS at the intersection by 2040. The conversion of Del Rey to left-in/right-in/right-out only configuration would be the least expensive option, but would result in some level of inconvenience for the residents of the subdivision north of Trent Avenue as they would need to either U-turn or use Sullivan Road to travel to destinations to the south/east.

Traffic Operations with a Roundabout

Sidra software (version 6.1) was used to analyze the traffic operational performance in 2040 at the Barker Road/Trent Avenue (or Wellesley Avenue/Trent Avenue) intersection with a roundabout configuration under all six alternatives. All settings were consistent with WSDOT's Sidra Policy Settings (WSDOT, November 2015).

On Trent Avenue, the forecasted traffic volumes in 2040 under all alternatives exceed the capacity of a single travel lane and require two eastbound through and two westbound through lanes for each roundabout. The proposed layout of each intersection is shown in the appendix.

Figure 16 shows the operational analysis results for the Barker Road/Trent Avenue intersection under each alternative with the exception of Alternative 4. The Wellesley Avenue/Trent Avenue intersection under Alternative 4 would have the same configuration as Alternatives 2/3/6, but lower volume and thus was assumed to operate as well or better than Alternatives 2/3/6. Figure 16 includes the volume to capacity (v/c) ratio, average control delay per vehicle, and LOS grade. Per WSDOT's recommended guidance, the primary measure of effectiveness (MOE) for roundabout analysis is not LOS, but the overall intersection and approach v/c ratios. WSDOT recommends that v/c ratios not exceed 0.85. The results in the table show that the maximum v/c ratios for each analysis period and intersection are approximately between 0.45 and 0.75. Detailed operational results can be found in the appendix.

Figure 16: Traffic operations at Barker Road/Trent Avenue in year 2040 with a roundabout

Alternative	AM Peak			PM Peak Hour		
	v/c	Delay	LOS	v/c	Delay	LOS
Alternative 1	0.58	8	A	0.69	8	A
Alternatives 2/3/6	0.47	7	A	0.73	9	A
Alternative 5	0.55	7	A	0.65	8	A

2040 SAFETY ANALYSIS

A safety analysis was conducted to predict average intersection crash frequency in year 2040 under each Alternative along Trent Avenue (SR 290) based on the Highway Safety Manual (HSM) predictive method. Given that under each Alternative there were implications for the Flora Road and Del Rey Drive intersections with Trent Avenue (in addition to the Barker Road intersection) those two intersections were also included in the analysis.

The Alternatives and intersections analyzed in this study include the following:

- Barker Road/Del Rey Drive/Trent Avenue under Alternative 1 with a signal
- Barker Road/Del Rey Drive/Trent Avenue under Alternative 1 with a roundabout
- Barker Road/Trent Avenue under Alternatives 2/3/6 & 5 with a roundabout
- Wellesley Avenue/Trent Avenue under Alternative 4 with a roundabout
- Del Rey Drive/Trent Avenue under Alternatives 2/3/6, 4 & 5 with a side-street stop
- Flora Road/Trent Avenue under Alternatives 1, 2/3/6, 4 & 5 with a signal

Both a signal and roundabout were analyzed for the Barker Road/Trent Avenue intersection under Alternative 1 to show a comparison of the two control types. For the other Barker Road intersections a roundabout was analyzed as that is the most likely control type to be carried forward. It is unknown at this time what the intersection control would be at the Del Rey Drive and Flora Road intersections under the various alternatives. For purposes of this analysis under Alternatives 2/3/6, 4 and 5 a side-street stop was assumed for the Del Rey Drive/Trent Avenue intersection and under all Alternatives a signal was assumed at the Flora Road/Trent Avenue intersection. A signal was assumed as the control type for the Flora Road/Trent Avenue intersection under Alternative 4 due to the proximity of the at-grade rail crossing and the ability to coordinate the traffic signal and grade crossing arms to reduce potential vehicle/train conflicts. A signal was also assumed at Flora Road/Trent Avenue under the other Alternatives although a roundabout would be feasible considering the south leg across the railroad tracks would be closed.

Methodology

We used the same spreadsheet tool used by WSDOT for urban and suburban arterials to automate the HSM Predictive analysis[12] (see http://www.wsdot.wa.gov/Design/Support.htm). The WSDOT disclaimer should be noted as it relates to the results when using this tool.[13] The tool, which is based on the HSM

[12] Safety Analysis Guide. Washington State Department of Transportation, September 2017. Pg 16.
[13] Under 23 U.S. Code § 148 and 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous

predictive method, includes several inputs to predict average annual crashes by type, including:

- Intersection control type (signal or stop)
- Number of legs on intersection
- Average Annual Daily Traffic entering intersection
- Presence of lighting
- Calibration factor
- Number of approaches with left-turn and right-turn lanes
- Type of signal phasing for each leg (permissive, protected or permissive/protected)
- Pedestrian crossing volume
- Lanes crossed by a pedestrian
- Crash history (not applicable to multiyear forecasts)

For the above inputs several were assumed to be consistent for all intersections, including:

- Lighting would be present;
- The calibration factor was set to 1 (default);
- Protected signal phasing for all left-turns from Trent Avenue and permissive phasing for all left-turns from the other streets;
- The pedestrian volume was set at 10 pedestrian crossings per day

Intersection Type

The spreadsheet tool includes a stop control and signal control option, but does not include a roundabout option. Therefore, a signal was assumed for all intersections and predicted crashes for intersections with a roundabout were adjusted from the predictions with a signal based countermeasures provided by WSDOT for converting an urban or suburban signal control to a multilane roundabout.

Reduction in Crashes from Roundabouts

WSDOT uses the following crash modification factors for converting a signal control to a multilane roundabout in an urban or suburban setting.

For volumes equal to or less than 18,000 ADT:

- Collisions of all severities: CMF=0.79
- Fatal & Injury Collisions: CMF=0.34

For volumes greater than 18,000 ADT:

---

roadway conditions, or railway-highway crossings are not subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

- Collisions of all severities: CMF=1.0
- Fatal & Injury Collisions: CMF=0.34

Traffic volumes in 2040 through the Barker/Trent intersection from all approaches would exceed 18,000 ADT under all six Alternatives (see Figure 17). Therefore a CMF of 1.0 for all collision types and CMF of 0.34 for fatal and injury collisions was applied when converting from a signal to a multilane roundabout. This means under each of the Alternatives the intersection is predicted to have the same number of collisions with a roundabout as with a signal, but about 66% fewer fatal and injury collisions. Thus, there would be more property damage only (PDO) crashes with a roundabout as compared to a signal, but fewer fatal and injury crashes.

The reduction in fatal and injury crashes can be attributed to lower travel speeds (typically 15-20 mph) through the intersection, eliminating the temptation to "beat the light" (all drivers must slow down), and the one-way travel pattern which reduces the likelihood of T-bone and head-on collisions, which tend to be the most severe.

Alternative 5 Weaving Area

Alternative 5 is the only concept that retains the ramps between Trent Avenue and Wellesley Avenue. The ramps create a weaving section between the Barker Road/Trent Avenue intersection and the ramps. While this weaving section exists today, the weave could pose a safety concern as traffic volumes grow. Fehr & Peers considered this potential safety concern and do not consider this to be a problem for the following reasons:

- The left turn volume onto southbound Barker Road is forecast to be relatively low. The maximum volume is forecast to be 110 vehicles during the AM peak hour in 2040. This translates into about two vehicles per minute that are making the turn during this highest-volume period.
- Assuming about four times as many vehicles from Trent Avenue as compared to Wellesley Avenue are making a left at Barker Road (based on existing counts and 2040 model outputs), about 90 vehicles per hour from Trent Avenue are expected to make the weave during the peak hour.

Given the relatively low volumes, the weaving movement should not pose a significant operational or safety concern. Under this configuration, the roundabout option at Barker Road/Trent Avenue is still preferred because all drivers have to approach the roundabout at a lower speed, which will give additional time to execute the weaving maneuver. If Alternative 5 is selected as the preferred alternative, it would be desirable for the final design to maximize the weaving distance and consider advanced signage to direct drivers to the appropriate lane. Signage would also be recommended in the eastbound direction to assist drivers in selecting the appropriate lane.

Average Annual Daily Traffic Forecasts

Average annual daily traffic (AADT) was forecast for the year 2040 for each approach to the each intersection using the SRTC travel demand model. A separate model run was conducted to reflect the variation and street configuration under each Alternative, including whether or not Flora Road would be closed across the BNSF tracks. Each 2040 model run also assumed there would be a new-east west connector between Flora Road and Barker Road somewhere south of the BNSF railroad as is consistent with the Infrastructure Plan for the Northeast Industrial Area Planned Action Ordinance recently developed by the City of Spokane Valley.

In order to develop forecasts, the difference method was used whereby the growth in daily traffic for each segment between the 2015 model and 2040 model was added to the existing (most recent) observed daily traffic counts as reported by City of Spokane Valley[14] and Spokane County.[15] This method reduces the likelihood of model error. The 2040 AADT outcomes using this methodology are summarized in **Figure 17**.

Figure 17: 2040 ADT by approach for each Alternative

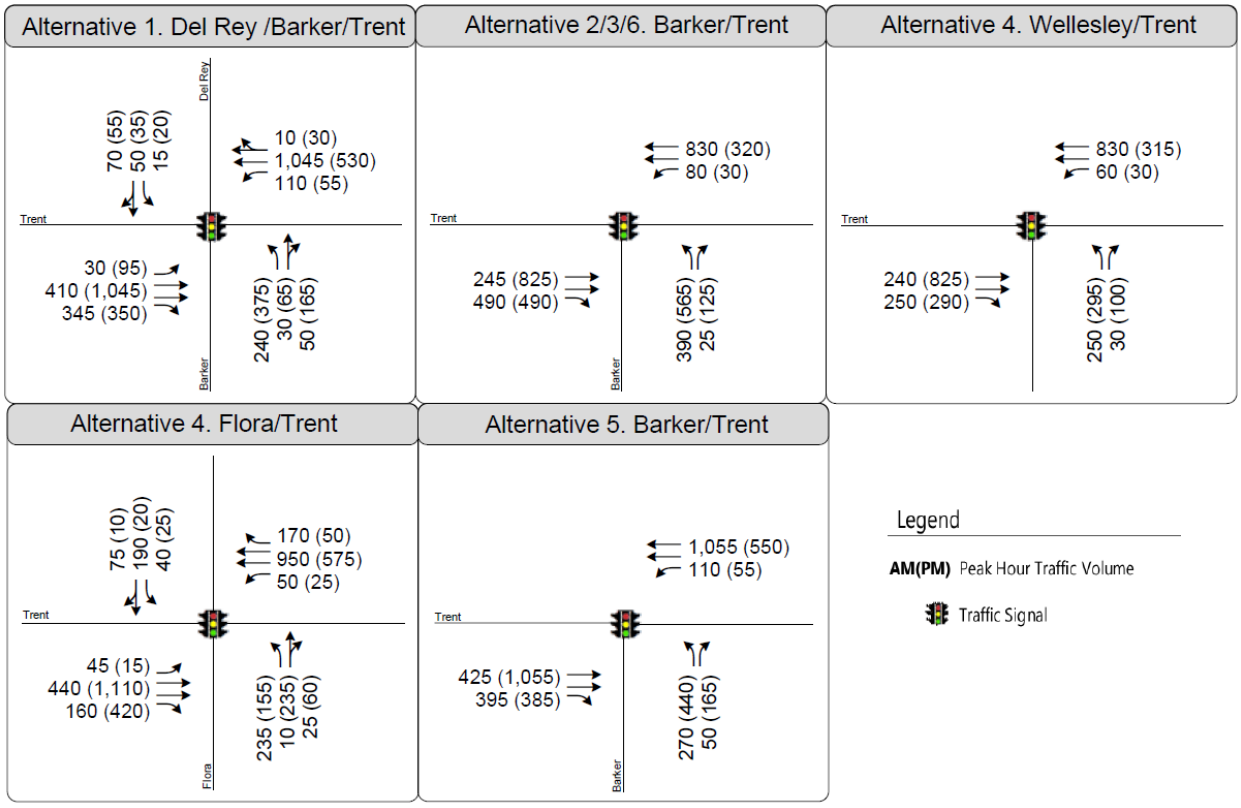
Alternative	Intersection	EB	WB	NB	SB
Barker Road (or Wellesley Avenue) Intersection					
Alternative 1	Barker Road/Del Rey Drive/Trent Avenue	14,500	10,500	6,900	1,300
Alternative 2/3/6	Barker Road/Trent Avenue	13,900	7,900	8,200	n/a
Alternative 4	Wellesley Avenue/Trent Avenue	9,600	7,300	3,700	n/a
Alternative 5	Barker Road/Trent Avenue	14,500	10,500	6,900	n/a
Del Rey Drive Intersection					
Alternative 2/3/6	Del Rey Drive/Trent Avenue	13,900	13,900	n/a	1,300
Alternative 4	Del Rey Drive/Trent Avenue	9,600	9,600	n/a	1,300
Alternative 5	Del Rey Drive/Trent Avenue	14,500	14,500	n/a	1,300
Flora Road Intersection					
Alternative 1/5	Flora Road/Trent Avenue	12,700	14,500	n/a	1,500
Alternative 2/3/6	Flora Road/Trent Avenue	11,300	13,900	n/a	1,600
Alternative 4	Flora Road/Trent Avenue	12,300	9,600	5,300	1,500

[14] http://www.spokanevalley.org/Traffic (see "Most Recent ADT")
[15] https://www.spokanecounty.org/1034/Average-Daily-Traffic-Counts

Lane Configurations

The number of turn lanes at each intersection under each alternative as well as the maximum number of lanes a pedestrian would have to cross was based on findings from the Barker Road/BNSF Grade Separation Traffic Analysis Memo. The lane configurations assumed for most of the intersections under each Alternative are shown in **Figure 18**. In addition to those shown in Figure 18, the Del Rey Drive/Trent Avenue intersection under Alternatives 2/3/6, 4 and 5 would have two eastbound through lanes, two westbound through lanes, an eastbound left turn lane, a southbound right turn land and a southbound left turn lane based on traffic volume. Additionally the Flora Road/Trent Avenue intersection under Alternatives 1, 2/3/6 and 5 would have the same configuration as is shown under Alternative 4 (see Figure), except there would be no southbound leg, and thus no eastbound right turn lane, no westbound left turn lane.

Figure 18: 2040 Peak hour traffic volumes and lane configurations (assuming a signal) by Alternative



In general, left-turn lanes would be available on the Trent Avenue, Del Rey Drive and Flora Road approaches and right-turn lanes would be present on the Barker Road, Wellesley Avenue and Trent Avenue approaches excluding the westbound approach at Del Rey Drive. The maximum number of lanes that a pedestrian would need to cross would be five at the three-leg intersections and six at the four-leg intersections.

Safety Analysis Findings

Using the methodology described in the previous section **Figure 19** shows the average predicted crashes per year by 2040 at the Barker Road/Del Rey Drive/Trent Avenue intersection under Alternative 1, both with a signal and with a roundabout. The findings illustrates that the Barker Road intersection is predicted to have a higher average number of injury crashes per year with a signal than with a roundabout. The results would be predicted to be similarly higher if a signal as oppose to a roundabout were assumed under the other alternatives.

Figure 19: Predicted average crashes per year in 2040 – signal vs. roundabout

Alternative - Intersection	Intersection Control	Predicted average crashes per year	Fatal & injury crashes per year	PDO crashes per year
Alternative 1 - Barker Road/ Del Rey Drive/Trent Avenue	Signal	3.7	1.3	2.5
Alternative 1 - Barker Road/ Del Rey Drive/Trent Avenue	Roundabout	3.7	0.4	3.3

Figure 20 shows the results of the safety analysis under each alternative assuming a roundabout at the Barker Road intersection, a side-street stop at the Del Rey Drive intersection and a signal at the Flora Road intersection. In general, intersections with the highest traffic volumes and highest number of legs are predicted to have a higher number of average crashes. That is why of the Barker Road intersections, the Barker/Del Rey/Trent intersection under Alternative 1 is predicted to have the highest number of crashes per year (3.7) and the Wellesley/Trent intersection under Alternative 4 is predicted to have the least number of crashes per year (1.7). However, the findings also show that the predicted average number of injury crashes per year depends less on the Alternative (including the traffic volume and number of legs) and more on the control type (roundabout versus signal or stop sign) and number of intersections.

The data also shows that there is little variation between alternatives in the predicted number of combined injury crashes. The variation ranges between 1.2 injury crashes per year (under Alternative 1) and 1.8 injury crashes per year (under Alternative 5) when accounting for the intersections with Barker Road, Del Rey Drive and Flora Road. The main reason that Alternative 1 results in a lower predicted number of annual injury crashes is because the Del Rey Drive intersection would be combined into the Barker Road intersection. Even though a fourth leg to the Barker Road intersection would be added under this alternative, because a side-street stop intersection would be effectively removed the net difference would be fewer predicted injury crashes.

Figure 20: Predicted average crashes per year in 2040 by Alternative

Alternative	Intersection	Intersection Control	Predicted average crashes per year	Fatal & injury crashes per year	PDO crashes per year
Alternative 1	Barker/Del Rey/Trent	Roundabout	3.7	0.4	3.3
	Flora/Trent	Signal	2.1	0.8	1.3
Alternative 1 Total			**5.8**	**1.2**	**4.6**
Alternative 2/3/6	Barker/Trent	Roundabout	2.7	0.3	2.4
	Del Rey/Trent	Side Street Stop	1.8	0.7	1.1
	Flora/Trent	Signal	1.9	0.7	1.2
Alternative 2/3/6 Total			**6.4**	**1.7**	**4.7**
Alternative 4	Wellesley/Trent	Roundabout	1.7	0.2	1.5
	Del Rey/Trent	Side Street Stop	1.2	0.5	0.7
	Flora/Trent	Signal	2.7	0.9	1.8
Alternative 4 Total			**5.6**	**1.6**	**4.0**
Alternative 5	Barker/Trent	Roundabout	2.8	0.3	2.4
	Del Rey/Trent	Side Street Stop	1.8	0.7	1.1
	Flora/Trent	Signal	2.1	0.8	1.3
Alternative 5 Total			**6.7**	**1.8**	**4.8**

It should be noted that the safety outcomes predicted in this analysis would change if a second road from the Highland Estates development were connected to Trent Avenue. If this were to happen it would likely increase the predicted injury crashes for Alternative 1 to be similar to Alternative 5. This is because under Alternative 1 an additional intersection to Trent Avenue would be added, while under the other alternatives a fourth leg could be added to the Barker Road or Wellesley Avenue intersection. If another access to Highland Estates were added under Alternatives 2/3/6, 4 or 5, it is recommended to convert the Del Rey intersection into a right-in/right-out to reduce the predicted average annual crashes at this intersection.

It should also be noted that under Alternatives 2/3/6 and 4 an additional intersection would be created at

Barker Road/Wellesley Avenue that would essentially replace the existing Trent Avenue/Wellesley Road ramps that would be preserved under Alternatives 1 and 5. If accounted for this would have a slight impact on total crashes by alternative.

Lastly, Alternative 4 is the only alternative whereby Flora Road would continue to have an at-grade rail crossing. This creates two notable safety issues that could be avoided under the other alternatives. First, there would be more exposure to the railroad and a potential vehicle/rail collision at the Flora Road/BNSF at-grade crossing under Alternative 4 that wouldn't exist under the other alternatives. Second, the predicted average injury crashes would be lower under Alternatives 1, 2/3/6 and 5 if the Flora Road/Trent Avenue intersection were assumed to be a roundabout instead of a signal. However, further evaluation is needed to determine if a roundabout is feasible at the Flora Road/Trent Avenue intersection under Alternative 4 due to the proximity of the at-grade rail crossing.

SUMMARY OF FINDINGS

Based on the analysis of the different alternatives, each concept offers different advantages and disadvantages as they relate to mobility, traffic flow, delay and safety. These are summarized in **Figure 21**. Under all six alternatives, traffic operations at the redesigned Barker Road/Trent Avenue intersection would perform roughly the same and would meet WSDOT LOS standards with both a signal and roundabout. There is also little variation between alternatives in the predicted number of combined injury crashes along the corridor.

One key item to note in the findings presented is that the intersection of Flora Road/Trent Avenue fails to meet the LOS standard regardless of which concept is ultimately selected. In other words, even with the closure of the southern leg of the intersection, additional traffic along Trent Avenue and along Flora Road (largely driven by the Bigelow Gulch Road connection) leads to additional traffic congestion and degraded LOS.

The findings demonstrate that while Alternative 4 would preserve the Wellesley Avenue Bridge and connection between Flora Road and Trent Avenue, a significant amount of traffic would shift from Barker Road to Flora Road under this concept to avoid the lengthy deviation in Barker Road. (This finding is based on the traffic volumes forecast on Barker Road and Flora road under the various alternatives). This will increase delay at the Flora Road/Trent Avenue intersection and may necessitate lengthening the eastbound right and westbound left lanes at this intersection to accommodate queuing when the railroad gates are down. It would also increase the likelihood that vehicles would get delayed at the Flora Road BNSF rail crossing and would increase the chance for vehicle/rail collisions at Flora Road. Further

evaluation is needed to determine if the Flora Road/Trent Avenue intersection could be redesigned with a roundabout due to the proximity of the at-grade crossing.

Alternatives 2/3/6 would result in better travel times for traffic on Barker Road, but would increase travel time for traffic between Wellesley Avenue and Trent Avenue since traffic would have to divert south to Barker before traveling back to Trent. Because of the higher traffic volumes on Trent Avenue under this concept, there would also be some traffic operations impacts to the Del Rey Drive/Trent Avenue intersection, although this report documented how these could be mitigated.

Alternative 1 and 5 would result in the fastest travel time for traffic between Barker Road or Wellesley Avenue and Trent Avenue. While Alternative 1 would improve access to Del Rey Drive from what exists today and offers the best safety benefits, if another connection were desired between the Highland Estates and Trent Avenue this would require an additional intersection with Trent Avenue, which would increase the predicted injury crashes for Alternative 1 to be similar to Alternative 5. This additional connection would make it easier for residents to enter and leave the subdivision and also allow for better emergency vehicle access.

Alternative 5 offers the best network connectivity and the best overall travel times, although it would be similar to Alternative 1. Because of the higher traffic volumes on Trent Avenue under this concept, there would also be some traffic operations impacts to the Del Rey Drive/Trent Avenue intersection, although this report documented how these could be mitigated. Additionally, these impacts would be negated with an additional connection from the Highland Estates that could tie into the redesigned Barker Road/Trent Avenue intersection. This additional connection would make it easier for residents to enter and leave the subdivision and also allow for better emergency vehicle access. Further evaluation is needed to determine the traffic impacts of adding a fourth leg to this intersection. Determination of intersection control will be addressed in the Intersection Control Analysis.

Figure 21: Advantages and disadvantages to traffic flow and safety under each concept

Alternative	Advantages	Disadvantages
Alternative 1	• Along with Alternative 5, fastest travel time between Barker Road and west leg of Trent Avenue (highest volume movements) • Minimal deviation for drivers between Barker Road, Wellesley Avenue and the eastbound leg of Trent Avenue • Would improves access to/from Del Rey Drive • Would eliminate vehicle/rail conflict at Flora Road/Trent Avenue • Flora Road/Trent Avenue could be redesigned with a roundabout, which has safety benefits over a signal • Offers best safety performance assuming no additional connection between Trent Avenue and Highlands Estate development, otherwise would be equivalent to Alternative 5	• Connectivity between Flora Road and Trent Avenue eliminated • If an additional connection is added from Trent Avenue to the Highlands Estates it would require an additional intersection along Trent Avenue • Along with Alternative 5, would result in highest traffic volumes on Barker Road due to the efficiency of the network
Alternative 2/3/6	• Would eliminate vehicle/rail conflict at Flora Road/Trent Avenue • Flora Road/Trent Avenue could be redesigned with a roundabout, which has safety benefits over a signal • A second access to the Highland Estates could tie into the redesigned Barker Road/Trent Avenue intersection • Minimal deviation for drivers between Barker Road and the eastbound leg of Trent Avenue (highest volume movements) • Along with Alternative 5, fastest travel time between Barker Road and east leg of Trent Avenue	• Would increase travel time between Wellesley Avenue and Trent Avenue • Some traffic operations impacts to Del Rey Drive/ Trent Avenue, but these can be mitigated • Connectivity between Flora Road and Trent Avenue eliminated • A new Barker Road/ Wellesley Avenue intersection would be needed

Alternative	Advantages	Disadvantages
Alternative 4	• Connectivity between Flora Road and Trent Avenue would remain in tact • No significant impacts to the Del Rey Drive/Trent Avenue intersection • Would reduce traffic volumes on Barker Road and Trent Avenue east of Flora Road as a result of deviation • Would improve travel time between Wellesley Avenue and Barker Road (although this is forecast to be a relatively low volume movement) • A second access to the Highland Estates could tie into the redesigned Wellesley Avenue/Trent Avenue intersection – improvements for access and emergency vehicles	• Worst overall travel time of any of the alternatives • Would increase travel time between Barker Road and Trent Avenue (particularly to/from the west leg of Trent Avenue which has the highest volumes) • A lot of traffic would divert from Barker Road to Flora Road increasing likelihood of delays at the rail crossing • Flora Road/Trent Avenue could not be redesigned with a roundabout due to the proximity of the at-grade crossing and a signal would be needed, which has a poorer safety record • New crossing gate infrastructure would be needed at the Flora Road/BNSF grade crossing • Eastbound right turn lane and westbound left turn lanes at Flora Road/Trent Avenue may need to be lengthened to accommodate queuing when the railroad gates are down • There would be more exposure to a rail/vehicle conflicts at Flora Road • A new Barker Road/ Wellesley Avenue intersection would be needed

Alternative	Advantages	Disadvantages
Alternative 5	• Offers fewest deviations in the network among any alternative • Along with Alternative 1, fastest travel time between Barker Road and west leg of Trent Avenue (highest volume movements) • Along with Alternatives 2/3/6, fastest travel time between Barker Road and east leg of Trent Avenue • Would eliminate vehicle/rail conflict at Flora Road/Trent Avenue • Flora Road/Trent Avenue could be redesigned with a roundabout, which has safety benefits over a signal • A second access to the Highland Estates could tie into the redesigned Barker Road/Trent Avenue intersection – improvements for access and emergency vehicles	• Greatest traffic impacts to Del Rey Drive/ Trent Avenue, but these can be mitigated • Connectivity between Flora Road and Trent Avenue eliminated • Distance between where Wellesley Avenue and Trent Avenue merge and the proposed Barker Road/Trent Avenue intersection would be relatively short, however, we do not consider this to be a safety concern