Juneau – Egan Dr. & Yandukin Intersection Improvement

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Traffic Analysis and Alternative Concepts Report

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Prepared For:
DOT&PF
Southcoast Region

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Table of Contents

Figures

Tables

Abbreviations

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
CAR	Critical Accident Rate
CDS	Coordinated Data System
CBJ	City and Borough of Juneau
CMF	Crash Modification Factor
CRF	Crash Reduction Factor
DOT&PF	Alaska Department of Transportation and Public Facilities
DHV	Design hour volume
ft	feet
PGDHS	*A Policy on Geometric Design of Highways and Streets*
HCM	*Highway Capacity Manual*
HSIP	*Highway Safety Improvement Program*
HSM	*Highway Safety Manual*
HV%	heavy vehicle percentage
LOS	Level of Service (performance grade)
MEV	Million Entering Vehicles
mph	Miles per Hour
MUTCD	*Manual on Uniform Traffic Control Devices for Streets and Highways*
MVM	Million Vehicle Miles
NPV	Net present value
O-D	Origin-Destination
PHF	Peak Hour Factor
sec	seconds
SPF	Safety Performance Function
TMV	Turning Movement Volume
USDOT	United States Department of Transportation
v/c	Volume to Capacity Ratio
veh	vehicles
vpd	Vehicles per day
VSL	Value of statistical life
WEDCOR	*West Egan Drive Corridor Study*

Definition of Terms

Average Annual Daily Traffic (AADT): A measurement of the number of vehicles traveling on a segment of highway each day, averaged over the year.

Capacity: Value of the maximum flow rate.

Control Delay: Portion of total delay a vehicle experiences at a traffic-controlled intersection, given in seconds per vehicle.

Coordinated Data System (CDS): Database of route numbers used to identify streets.

Crash Modification Factor: Value multiplied by the number of crashes in a certain time period to estimate the number of crashes that would remain in that time period if a crash mitigation were in place.

Crash Rate: Number of crashes per a unit of exposure. Common units of exposure include million vehicle miles traveled for roadway segments and million entering vehicles for intersections.

Crash Reduction Factor: Percentage multiplied by the number of crashes in a certain period to estimate how many crashes would be eliminated if a crash mitigation were in place.

Crash Severity: Scale of bodily harm up to and including death, suffered by the occupants of the vehicle involved in a crash. There are four levels of crash severity used: property damage only (PDO), non-incapacitating/possible injury (minor injury), incapacitating injury (major injury), and fatal.

Critical Accident Rate (CAR): A statistical measure used in crash rate analysis to determine statistical significance. If the crash rate of the location in question is above the CAR for that location, the crash rate is above the average crash rate for similar facilities to a statistically significant level.

Expected Crashes: The number of predicted crashes is modified based on actual crash experience at an intersection or on a roadway. Expected crashes will be unique for each intersection or roadway segment.

Flow Rate: Measurement of the number of vehicles passing a given point within a set amount of time, usually an hour.

Interchange: Set of ramps and intersections used to allow traffic to travel to and from a controlled access freeway facility.

Level of Service (LOS): Performance measure concept used to quantify the operational performance of a facility and present the information to users and operating agencies. The actual performance measure used varies by the type of facility; however, all use a scale of A (best

conditions for individual users) to F (worst conditions). Often, LOS C or D in the most congested hours of the day will provide the optimal societal benefits for the required construction and maintenance costs.

Peak Hour: The hour-long period in which the volume of a given road is the highest for the day or other time period. Morning, midday, and evening peak hours are often used for analysis, although peak hours may occur at other times, such as at school dismissal.

Peak Hour Factor (PHF): Measure of traffic variability over an hour period calculated by dividing the hourly flowrate by the peak 15-minute flowrate. PHF values can vary from 0.25 (all traffic for the hour arrives in the same 15-minute period) to 1.00 (traffic is spread evenly throughout the hour).

Predicted Crashes: An estimate of the number of crashes at an intersection or on a roadway segment based on specific characteristics such as AADT, number of lanes, lighting, etc. All places with these same characteristics are estimated to have the same number of predicted crashes.

Safety Performance Function (SPF): Equation found in the *Highway Safety Manual* (HSM) that can be used to predict crashes in a future time period, based on estimated characteristics of the future roadway, such as future AADT.

Volume to Capacity Ratio (v/c): Measure of how much of the available capacity of a facility is being used, calculated by dividing the demand volume by the capacity of a facility. Values of 0.85 or less are a good design objective so that there is available reserve capacity.

Executive Summary

This October 2019 report updates a 2018 study, adding analysis of crashes for the years 2015 through 2017 to the initial study of crashes from 2005 through 2014.

The Fred Meyer intersection[1] of Egan Drive at Yandukin Drive has been mentioned as needing improvements in several community planning documents. In 2012, the Alaska Department of Transportation and Public Facilities (DOT&PF) reconstructed the Egan Drive left-turn lanes by providing a zero offset of the opposing left-turn lanes, and thereby improving sight lines between vehicles in the left-turn lanes and approaching oncoming vehicles in the through-lane. At the same time, the left-turn lanes were extended to provide more queue storage. Continuous lighting was installed on Egan Drive from the study intersection towards downtown in 2013. Prior to this, only the intersection was lighted. Because crash patterns have not changed significantly since these improvements were installed, DOT&PF believes that additional improvements are needed and is conducting a study looking at crashes and efficiency at the intersection and to propose improvements, as needed.

Egan Drive is a controlled-access principal arterial carrying almost 30,000 vehicles per day. It is an important connection for carrying long-distance high-speed traffic, but must also serve local traffic, as there are limited parallel routes. Egan Drive serves vehicular traffic, transit routes, freight traffic, pedestrians, and bicyclists.

Traffic volumes are heavy heading towards downtown in the morning and towards Mendenhall Valley in the evening. Travel speeds are high along Egan Drive, with the 85th percentile speed at about 5 mph above the posted speed limit of 55 mph.

Pedestrians and bicyclists are generally well accommodated in the study area, but there are few locations for pedestrians to cross Egan Drive and those who desire to cross Egan Drive at the Fred Meyer intersection are projected to experience delays in 2040 of much greater than 45 seconds during peak traffic times. Highway Capacity Manual (HCM) 2010 indicates delays of greater than 45 seconds result in a very high likelihood that pedestrians will not wait for an acceptable gap in traffic and instead attempt to rush through shorter gaps. (Note that there is not a marked crossing at this intersection.)

Transit vehicles serve the area, with stops at the Fred Meyer and at the Nugget Mall.

The analysis identified two main concerns for the intersection:

[1] The study intersection is referred to as the "Fred Meyer" intersection in this report to aid the reader in recognizing its location, as that is how it is often referred to locally, and is not intended to suggest that the intersection is owned by Fred Meyer or that Fred Meyer is responsible for the intersection.

- Left-turning vehicles have difficulty judging gaps in oncoming traffic, resulting in injury crashes. The high speed of oncoming vehicles (85^{th} percentile speeds of around 60 mph) contributes to this condition.
- Pedestrians have difficulty crossing Egan Drive at the Fred Meyer intersection because of the lack of adequate crossing gaps. While a controlled, marked crossing of Egan Drive is provided at the Glacier Highway/Nugget intersection, pedestrians have been observed crossing Egan Drive at the Fred Meyer intersection. Thus, if any changes are proposed, consideration should be given to also accommodate the pedestrian crossing movement.

Some treatments to reduce or eliminate left-turn crashes have been identified:

- **Control left-turn movements with a signal or roundabout.** With a traffic signal, left-turn movements would only be made during a protected left-turn signal, when oncoming traffic is stopped by a red signal. A roundabout would re-direct the left-turn conflict to a low-speed merge maneuver with the roundabout circulation lane. Under both options, left-turn demands from the side streets would be served.
- **Eliminate left-turn movements.** This option would prohibit left turns from Egan Drive towards either the Fred Meyer store or the airport. Drivers would have to take another route to reach their destination. Right-in-right-out access would be maintained. Under one option, Glacier Highway/Lemon Spur would be connected through to the Glacier Highway/Nugget intersection to reduce out-of-direction travel.
- **Provide physical separation of the left-turn and through movements.** This option would involve building an interchange with ramps to serve Yandukin Drive to grade separate conflicting movements.
- **Speed control.** Speeds contribute to the likelihood of an injury crash. By reducing speeds (through enforcement, for example), crash severity should be reduced.
- **Traffic demand management.** If measures are taken that spread the traffic demands over longer periods of the day, crashes that result from driver's impatience due to delay in the heaviest volume periods of the day could be reduced.

From these possible methods of reducing crashes, four alternative concepts were chosen for analysis:

- **Alternative Concept A, No Build.** This alternative concept would provide no improvements and would retain the existing conditions.
- **Alternative Concept B, Signal at the Fred Meyer Intersection of Egan Drive at Yandukin Drive.** This alternative concept would install a signal at the Fred Meyer intersection, allowing all vehicle movements at this intersection and providing infrastructure for a pedestrian crossing of Egan Drive. Construction costs for this alternative concept are around $19 million. Signalization reduces angle and left-turn crash frequency and severity. However, rear-end crashes on the major approaches may

increase. In addition, total intersection delay would increase because Egan Drive traffic, previously uninterrupted traffic flow, would be controlled by the traffic signal.

- **Alternative Concept C1, One-Way Extension of Glacier Highway/Lemon Road to the Glacier Highway/Nugget intersection and Closure of the Median at Yandukin Drive.** This alternative concept would close the median at Yandukin Drive, eliminating all left turns at the intersection. Glacier Highway/Lemon Road would be extended to the Glacier Highway/Nugget intersection; however, the extension would be a one-way roadway allowing traffic to travel from Glacier Highway/Nugget towards the Fred Meyer only. Construction costs for this alternative concept are around $15 million. Crashes would be reduced and vehicle delay would increase.
- **Alternative Concept C2, Extension of Glacier Highway/Lemon Road to the Glacier Highway/Nugget intersection and Closure of the Median at Yandukin Drive.** This alternative concept would close the median at Yandukin Drive, eliminating all left turns at the intersection. Glacier Highway/Lemon Road would be extended to the Glacier Highway/Nugget intersection, creating a 4-leg intersection at that location. This alternative concept would provide an alternate route around the Yandukin Drive intersection at Egan Drive. Construction costs for this alternative concept are around $20 million. Crashes would be reduced; however, vehicle delay would increase significantly.
- **Alternative Concept D, Interchange at the Fred Meyer Intersection of Egan Drive at Yandukin Drive.** This alternative concept would build a grade-separated interchange at the Fred Meyer intersection, allowing all vehicle movements at this intersection and providing a grade-separated crossing for pedestrians. Construction costs for this alternative concept are around $34 million. Both crashes and delay would be reduced.

To aid southbound left-turn drivers from Egan Drive to distinguish between right turn and through vehicles in the oncoming traffic, raised channelization could be installed as a low-cost, short-term improvement.

Alternative Concept D, a grade separated interchange, is recommended to be advanced. Points that support selection of Alternative Concept D are:

- All of the identified concerns are addressed by Concept D (see Table 58 on page 131).
- Alternative Concept D's crash reduction is through the physical separation of the conflicting movements rather than signal control. Therefore, the interchange is the most-effective and the longest-term crash reduction tool.
- Alternative Concept D is the only alternative that effectively reduces travel delay over what is currently experienced by intersection users. All other alternatives have increased delay because traffic entering the intersection under those alternatives is subject to control and potential stopping by the signal, whereas the mainline traffic on Egan Drive continues to be free-flow with an interchange.

- As an uninterrupted flow facility, Alternative Concept D has significant reserve capacity to accommodate future travel demand well beyond this study's design evaluation period.
- Finally, Alternative Concept D is consistent with the planning for this area that was previously developed and accepted by public interests and agencies.

This recommendation is solely based on this Traffic Study which does not provide an analysis or consideration of other factors that may affect any final determinations by the Department. This Traffic Study will be integrated into a Planning and Environmental Linkage (PEL) study that will consider environmental and socio-economic issues through a more comprehensive public and agency involvement process. The PEL study will conclude with a final recommendation that could be advanced for future project development.

1 Introduction

1.1 Project Description

The Alaska Department of Transportation and Public Facilities (DOT&PF) has retained Kinney Engineering, LLC to prepare this Traffic Analysis and Alternative Concepts Report for the Egan Drive and Yandukin Drive Intersection Improvement project. The purpose of the study is to examine how to improve the traffic operations, capacity, and safety of the Fred Meyer[2] intersection of Egan Drive with Yandukin Drive and to provide a recommended solution. The project is located within the city limits of Juneau, Alaska, as depicted in Figure 1.

Egan Drive is a four-lane divided, controlled-access, principal arterial roadway running generally north-south with full access control between major intersections and a mix of at-grade intersections and grade-separated interchanges. It serves both long distance and local trips, carrying about 30,000 vehicles per day (vpd). As part of the National Highway System, Egan Drive connects downtown Juneau with the Mendenhall Valley and Juneau International Airport, as well as with the University of Alaska Southeast and the Auke Bay Ferry Terminal.

Yandukin Drive is a major collector roadway in the Mendenhall Valley west of Egan Drive, carrying about 2,500 vpd to Juneau International Airport and other commercial and residential establishments.

Lemon Road/Glacier Highway is a minor arterial. Volumes on this leg have varied from 7,500 to 12,500 vpd between 2012 to 2015. Lemon Road/Glacier Highway is parallel to Egan Drive between the Sunny Point Interchange and Yandukin Drive and carries about 4,500 vpd.

All inbound and outbound traffic must pass through the intersection of Egan Drive at Yandukin Drive. There are no alternative routes to this intersection. In addition to the intersection of Egan Drive at Yandukin Drive, the study area also includes four nearby intersections. The study area is shown in Figure 2.

Note that for this report, Egan Drive and parallel routes are referred to as north-south roadways and all side streets that intersect with Egan Drive are referred to as east-west roadways.

This Traffic Analysis and Alternative Concepts Report presents the existing conditions of the intersection, as well as the future 2040 no-build condition, and analyzes several alternative concepts under these volume conditions. The design year for this report is 2040.

[2] The study intersection is referred to as the "Fred Meyer" intersection in this report to aid the reader in recognizing its location, as that is how it is often referred to locally, and is not intended to suggest that the intersection is owned by Fred Meyer or that Fred Meyer is responsible for the intersection.

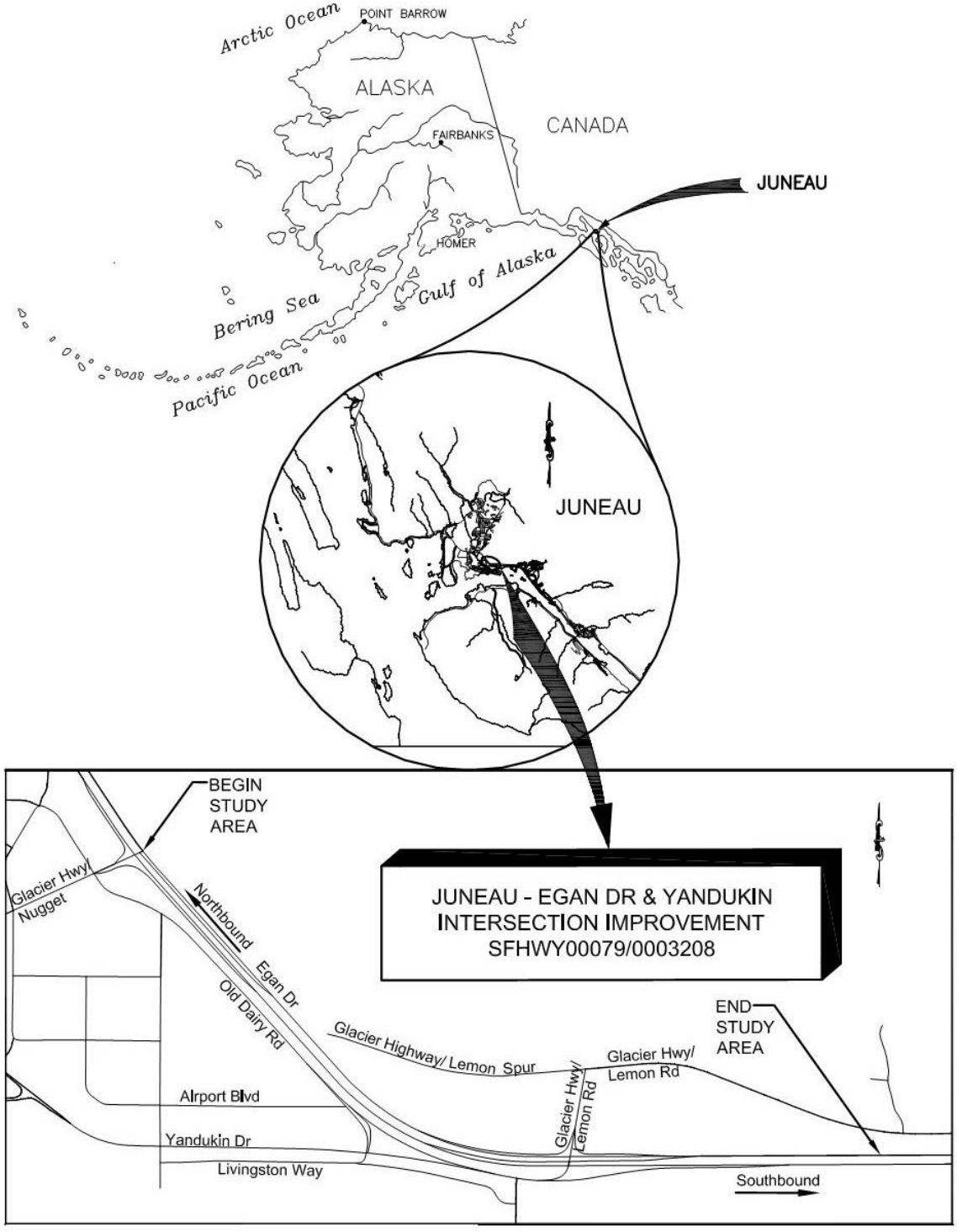


Figure 1. Project Vicinity Map

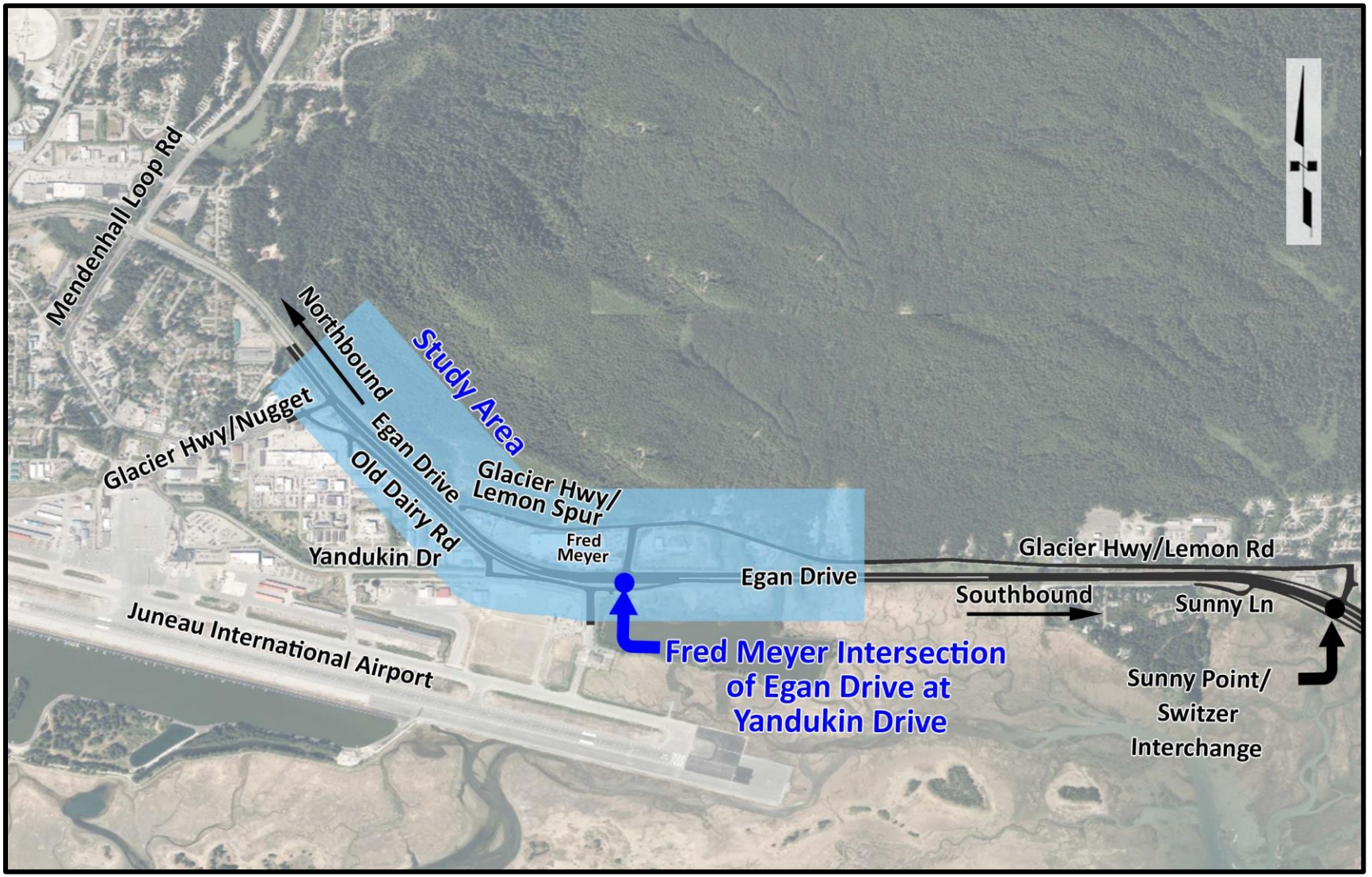


Figure 2. Study Area

1.2 Functional Classification

DOT&PF uses the functional classification of a roadway to select Level of Service (LOS) and operational performance, design speed, and other geometric criteria.

Within the project limits, Egan Drive is classified as a principal arterial and Glacier Highway/Lemon Road is classified as a minor arterial. Arterial roads are intended for high mobility and low access and are designed to carry large volumes at an efficient speed. Yandukin Drive is classified as a major collector. Collector roads balance access and mobility and are designed to gather and distribute trips between local streets and arterials.

The American Association of State Highway and Transportation Official's (AASHTO's) *A Policy on the Geometric Design of Highways and Streets*, 2011 (PGDHS) describes urban areas as "those places within boundaries set by the responsible State and local officials having a population of 5,000 or more" and rural areas as "those areas outside the boundaries of urban areas." The project study area is within the more densely populated area of the City and Borough of Juneau (CBJ) and therefore falls within an urban area.

The PGDHS has guidelines for appropriate LOS thresholds for different functional classifications and area and terrain types. Figure 3 presents these recommendations. Based on the table, all intersections affected by the project are recommended to have no worse than LOS C or D in the design year.

Note that this guideline refers to the intersection as a whole, and not to specific movements. Since the only vehicles that experience any delay at the study intersection are the left-turn movements from Egan Drive, the overall existing intersection delay easily meets this threshold and will continue to meet it in the future.

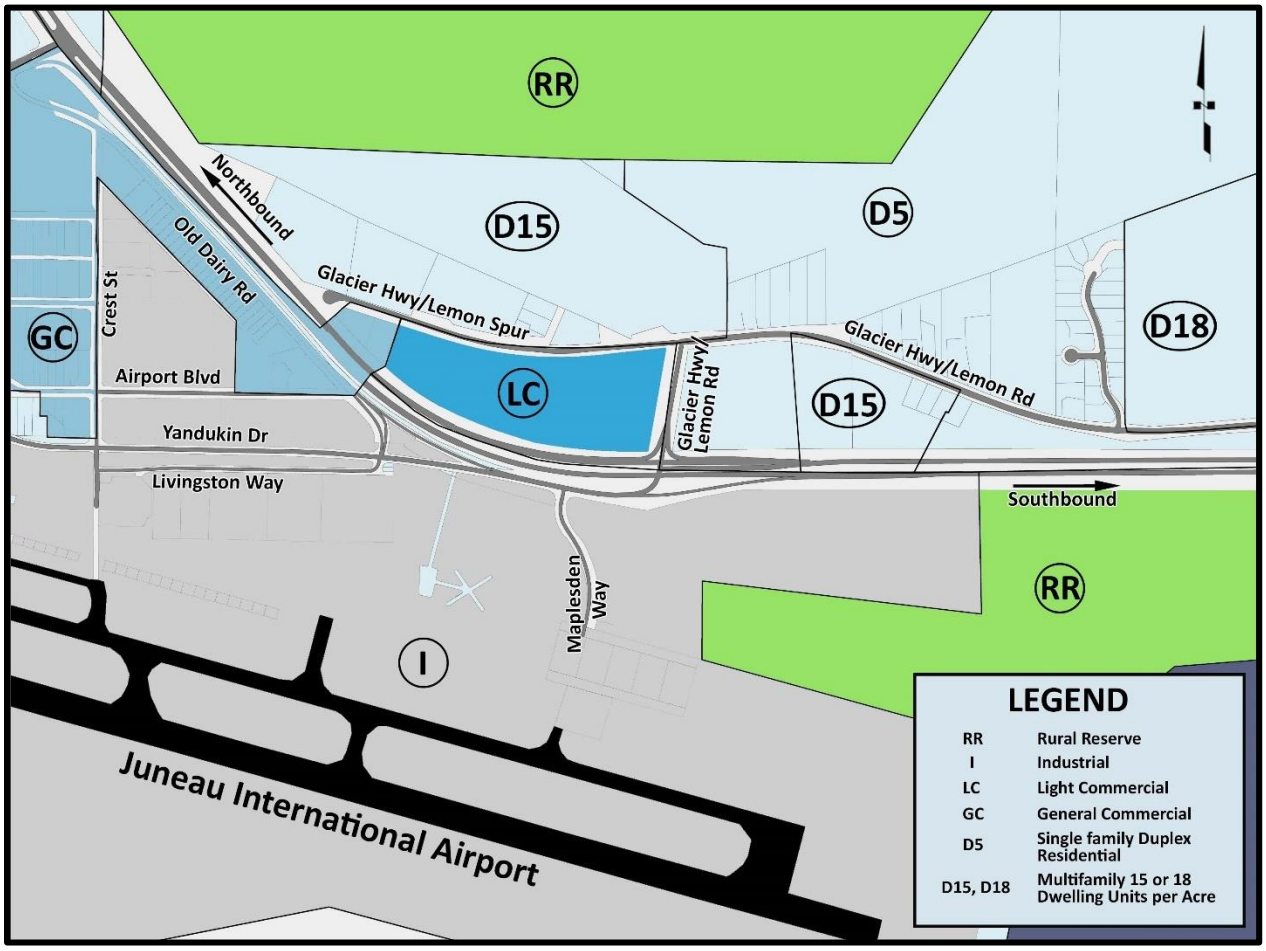
Functional Class	Appropriate Level of Service for Specified Combinations of Area and Terrain Type			
	Rural Level	Rural Rolling	Rural Mountainous	Urban and Suburban
Freeway	B	B	C	C or D
Arterial	B	B	C	C or D
Collector	C	C	D	D
Local	D	D	D	D

Source: Modified from AASHTO PDGHS Table 2-5

Figure 3. Level of Service Recommendations

1.3 Surrounding Land Uses

Within the project area, existing developments include a variety of land uses. Figure 4 presents the land uses in the area. Traffic growth is likely because of the undeveloped lands which are zoned for high-density residential properties within the project area.



SOURCE: City & Borough of Juneau GIS files (obtained November 2017)

Figure 4. Zoning Map in Project Area Vicinity

2 Planning Background

Section Highlights

- Several planning documents describe a need for improved pedestrian and bicycle connectivity, either along or across Egan Drive.
- Many of the studies are in favor of extending Glacier Highway/Lemon Spur to the Glacier Highway/Nugget intersection.

Several planning-level documents, published studies, and concurrent projects related to this intersection were reviewed to ensure that improvements analyzed in this study support the goals of these documents.

2.1.1 Lemon Creek Area Plan (CBJ, 2017)

The Lemon Creek Area Plan is a community-based planning document that develops a series of goals and actions within the Lemon Creek area.

The Lemon Creek Area Plan identified multiple actions to occur within the project area. Most notably, the plan advocates for improvements at the Fred Meyer intersection of Egan Drive at Glacier Highway/Lemon Road and for the extension of Glacier Highway/Lemon Spur to the Egan Drive at Glacier Highway/Nugget intersection.

2.1.2 Comprehensive Plan of the City & Borough of Juneau (CBJ, 2013)

The *Comprehensive Plan of the City & Borough of Juneau (Comprehensive Plan)* provides a guide for the long-range growth, development, and conservation of valued resources.

The *Comprehensive Plan* lists the following improvements within the study area as actions that need implementing:

- **Non-motorized facilities improvements.** Provide sidewalks and bicycle paths/lanes "along existing roads to provide safe and efficient access and recreation and to reduce pedestrian/automobile accidents" and provide a safe pedestrian and bicycle circulation system in the Lemon Creek area.
- **Transportation improvements.** Construction of an extension of Glacier Highway from its current dead-end north of Fred Meyer to the intersection of Glacier Highway and Egan Drive at McDonald's and the Nugget Mall.
- **Parks, trail, community garden, and stream corridor improvements.** Construction of a coastal trail along Egan Drive or along the "inside" or north side of Egan Drive, connecting Sunny Point to neighborhoods to the east and west.

This Traffic Analysis and Alternative Concepts Report considers the impacts of these types of improvements, including improved pedestrian and bicycle connectivity and the extension of Glacier Highway to the Nugget intersection.

2.1.3 Juneau Non-Motorized Transportation Plan (CBJ, November 2009)

The purpose of the *Juneau Non-Motorized Transportation Plan*, published in 2009, is to improve the safety and capacity of the non-motorized transportation network by recommending infrastructure and policy improvements.

The *Juneau Non-Motorized Transportation Plan* identified non-motorized transportation issues along Egan Drive, Yandukin Drive, and Glacier Highway/Lemon Road. [Note: the *Juneau Non-Motorized Transportation Plan* refers to Glacier Highway/Lemon Road as Old Dairy Road.] The *Juneau Non-Motorized Transportation Plan* has recommended the following projects within the study area:

- **High Priority - Crossing between Fred Meyer and Bus Stop.** A crosswalk on Glacier Highway/Lemon Road between Fred Meyer and the bus stop on the east side of the road. **(Completed 2013)**
- **Medium Priority – Bike Lane**. Bike lane on Glacier Highway/Lemon Spur between separated path along Egan Drive and Fred Meyer. **(Partially Completed)**
- **Medium Priority – Coastal Trail.** Paved pathway at least 10 feet wide along the south side of Egan Drive from Yandukin Drive to Twin Lakes Path.

This Traffic Analysis and Alternative Concepts Report considers the impacts of these types of improvements, including improved pedestrian and bicycle connectivity.

2.1.4 West Egan Drive Corridor Study (DOT&PF, 2003)

The *West Egan Drive Corridor Study* (WEDCOR*)* identified possible solutions for the current and expected future transportation problems along and across the Egan Drive corridor between Industrial Boulevard and Yandukin Drive.

WEDCOR identified traffic and safety deficiencies along Egan Drive. The identified concerns within the Egan Drive and Yandukin Drive intersection included:

- **Capacity and Level of Service**
  - Based on the traffic projections of WEDCOR, by the year 2025, unacceptable delay is anticipated at the intersections of Egan Drive at Glacier Highway/Nugget and at Yandukin Drive.
- **System Linkage**
  - By 2025, local trips leaving, entering, and crossing Egan Drive will be delayed unduly. This will be exacerbated by the use of Egan Drive for local trips where other facilities are neither available nor convenient, such as between the Mendenhall Valley and Fred Meyer and between Glacier Highway (North) and Riverside Drive.

- **Airport Access**
  - Due to the importance of Juneau International Airport to the regional economy, access to the airport is critical in the Egan Drive corridor. The study evaluated how well Egan Drive and the surrounding transportation system accommodate the movement of people between and among air, ground, and sea transportation in and around the study area.
  - Travel between Juneau International Airport and other key destinations in the Juneau area (e.g., downtown Juneau, Auke Bay Ferry Terminal) often requires the use of local streets, a factor understood by the residents, but that is not obvious to visitors. The resulting confusion creates unnecessary out-of-direction travel.
- **Safety**
  - The intersection within the study area that has one of the highest accident rates in southeast Alaska is Egan Drive at Glacier Highway/Nugget.
  - Other safety problems identified in WEDCOR include inadequate or marginal sight distance at the Fred Meyer intersection of Egan Drive at Yandukin Drive. **(The sight distance concern was addressed with the 2012 DOT&PF construction project.)**
- **Pedestrian and Bicycle Facilities**
  - The unsignalized intersection at the Fred Meyer intersection on Egan Drive at Yandukin Drive is of particular concern for pedestrians and bicyclists. Additional lanes on Egan Drive to accommodate more vehicles would make access by pedestrians even more difficult unless adequate alternate pedestrian and bicycle facilities are provided.
  - Transit stops at unsignalized intersections like Glacier Highway/Lemon Road at Fred Meyer can be a safety concern for pedestrians.

WEDCOR's proposed action for the Egan Drive and Yandukin Drive intersection was a full interchange that would be located to the east of the existing intersection.

This Traffic Analysis and Alternative Concepts Report updates and refines the capacity, safety, and pedestrian/bicycle analyses presented in the WEDCOR study for future year traffic volumes at the subject intersection,

2.1.5 Juneau Area Wide Transportation Plan (CBJ, 2001)

The *Juneau Area Wide Transportation Plan*, published in 2001, recommends solutions for transportation problems and concerns throughout Juneau. Over the last 16 years, many of the solutions listed in the *Area Wide Transportation Plan* have been implemented. This section describes only the solutions that have not been implemented.

The *Area Wide Transportation Plan* states that the 1998 existing weekday evening peak LOS for the unsignalized intersection at Egan Drive and Yandukin Drive was LOS F.

The *Area Wide Transportation Plan* recommends the following transportation improvements/recommendations within the study area:

- Extending the sidewalk along Egan Drive
- Preserving the median along Egan Drive for a possible mass transit route in the future
- Extending Glacier Highway/Lemon Spur to the Glacier Highway/Nugget intersection
- Widening Glacier Highway from two lanes to three lanes

This Traffic Analysis and Alternative Concepts Report will consider the benefits and costs of these types of improvements, including improved pedestrian and bicycle connectivity and the extension of Glacier Highway to the Nugget intersection.

3 Existing Infrastructure

3.1 Intersections and Traffic Control

The intersection is a 4-leg unsignalized intersection. Figure 5 presents the existing configuration of the study area. Left-turn movements from the side streets are prohibited, and right turns from the side streets have entrance ramps with merge lanes. Therefore, the only movements that experience any delay are the left-turn movements from Egan Drive towards Fred Meyer or towards the airport. A 2012 DOT&PF construction project modified opposing left-turn lane configuration from a negative to a zero offset, thereby improving sight distance.

The existing intersection configuration is presented in Figure 5 on page 11. Auxiliary lane lengths shown are nominal lengths.

Section Highlights

- Egan Drive is a controlled access principal arterial, which means it is an important connection for carrying long-distance high-speed traffic.
- Egan Drive in this area also must serve local traffic, as there are limited parallel routes.
- Pedestrian connections are good for traveling along Egan Drive, but there are few locations for pedestrians to cross.
- Transit vehicles serve the area, with stops at the Fred Meyer and at the Nugget Mall.

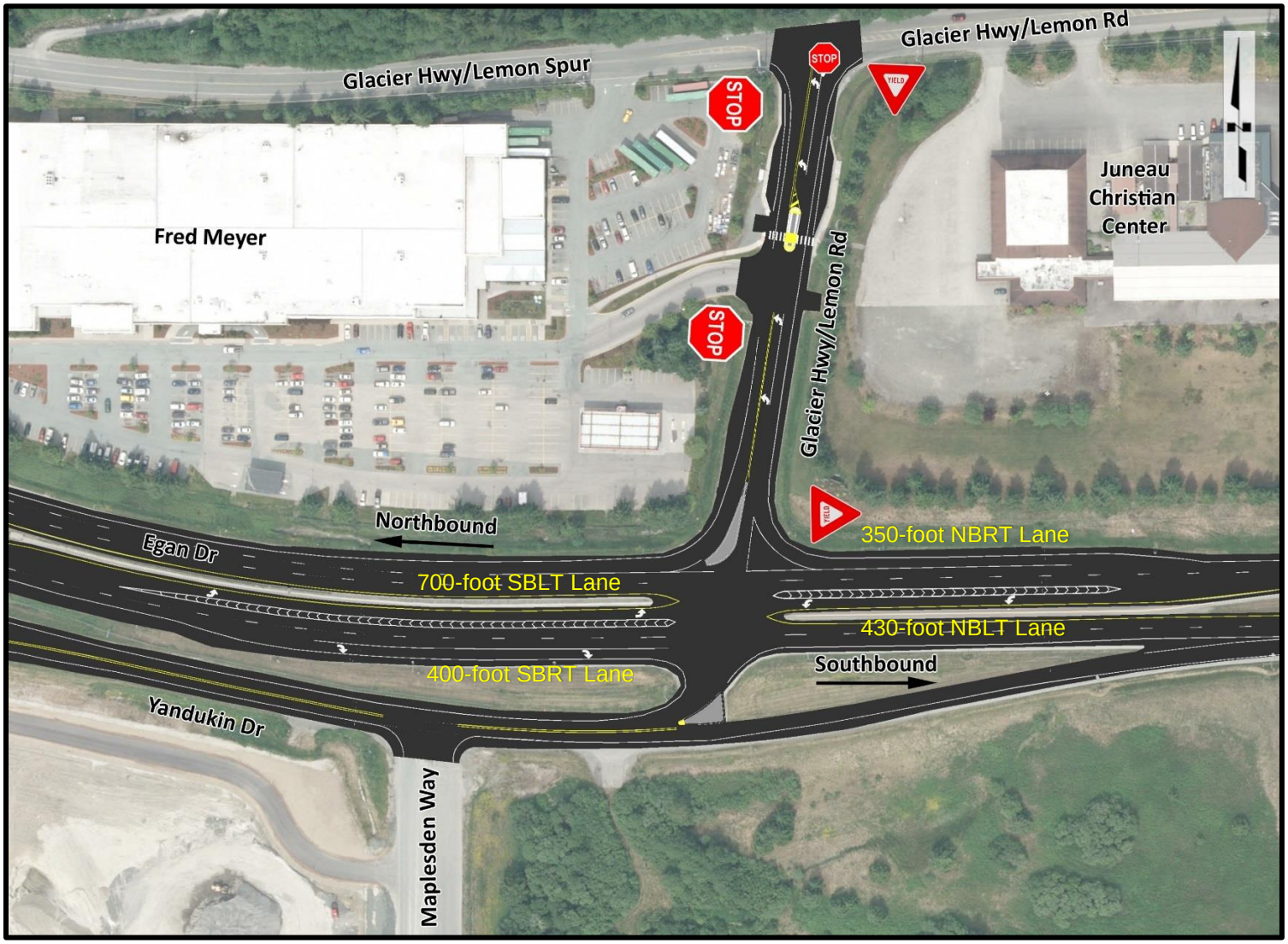


Figure 5. Existing Configuration

3.2 Project Area Roadway Characteristics

Characteristics of the study area roadways related to the geometric design of the roadway are shown in Table 1.

Table 1. Roadway Characteristics

Name	CDS Route #	Functional Classification	Cross Section	Speed Limit (mph)	Sidewalks/ Pathways	Bike lane
Egan Drive/Glacier Highway	296000	Other Principal Arterial	Divided 4-Lane	55	Separated Pathway	No
Glacier Highway/Lemon Road (MP 0.00 to MP 0.12)	296229	Minor Arterial	2-Lane	-	No	Wide shoulders
Glacier Highway/Lemon Road (MP 0.12 to MP 1.26)	296229	Minor Arterial	2-Lane	45	Yes	Yes
Glacier Highway/Lemon Spur	296266	Local	2-Lane	35	No	Not Continuous
Yandukin Drive	296324	Major Collector	2-Lane	40	No	Wide shoulders
Yandukin Drive Wye to Egan Drive	296327	Other Principal Arterial	1-Lane	N/A	No	No
Old Dairy Road	296326	Minor Collector	2-Lane	40	No	Wide shoulders
Glacier Highway Nugget	296331	Minor Arterial	4-Lane	30	Sidewalk	No

3.3 Pedestrian and Bicycle Facilities

Currently, there are no designated pedestrian crossings at the Fred Meyer intersection of Egan Drive and Yandukin Drive. However, there are a variety of sidewalks, separated pathways, and bike lanes within the project area, as shown in Figure 6. While the existing infrastructure provides continuous coverage along the study area roadways, the only pedestrian/bicycle connection across Egan Drive is at the Glacier Highway/Nugget intersection.

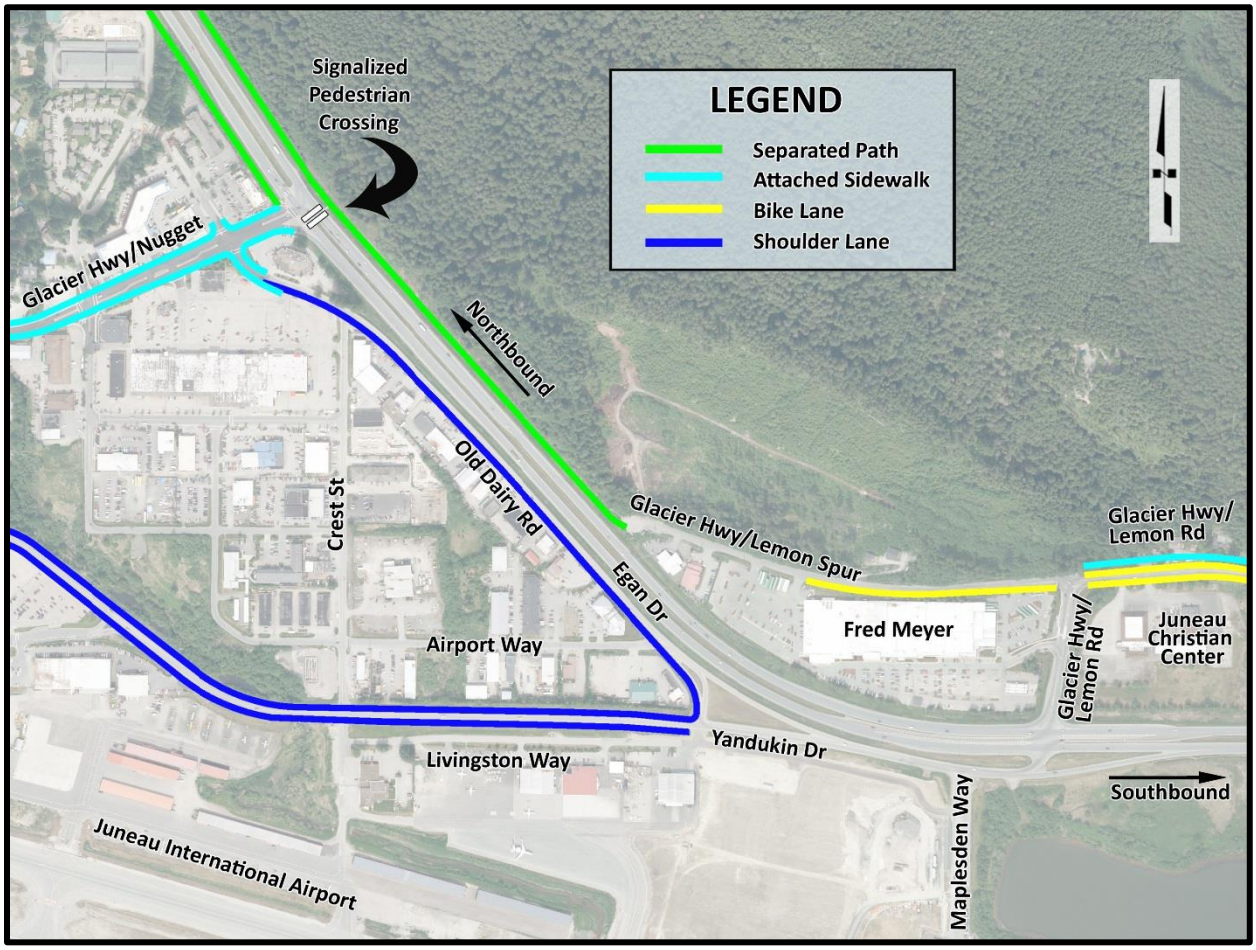


Figure 6. Existing Pedestrian and Bicycle Facilities

3.4 Transit

Figure 7 shows the two bus stops, Stop 427 (West) and 479 (East), on Glacier Highway/Lemon Road near the Fred Meyer intersection of Egan Drive and Yandukin Drive. The area around these bus stops was recently upgraded to connect to the sidewalk from Fred Meyer. Eleven bus routes pass through the study intersection. Five of the routes travel northbound/southbound along Egan Drive between the Nugget Mall and downtown. The other routes traverse Glacier Highway/Lemon Road near Fred Meyer and continue to/from downtown on Glacier Highway/Lemon Road and to/from the Nugget Mall on Egan Drive. At the study intersection, these routes make a westbound right turn when traveling towards the Mendenhall Valley/Nugget Mall and make a southbound left turn when traveling towards the Lemon Creek Area/Downtown.

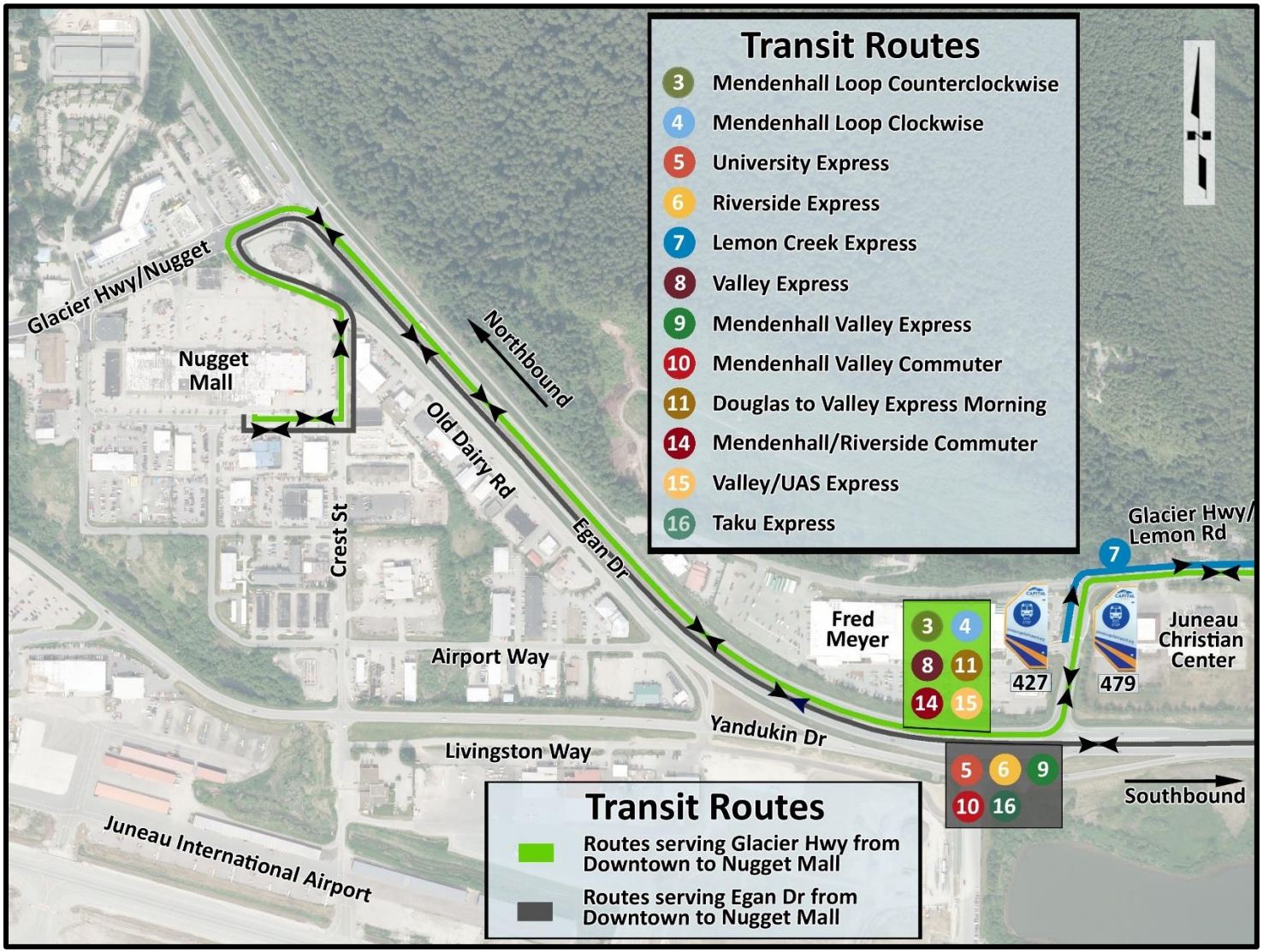


Figure 7. Juneau Capital Transit Route Map

4 Crash Analysis

Section Highlights

- The crash rate at the Fred Meyer intersection on Egan Drive is not statistically above average for similar intersections statewide. However, it has the 5th highest injury rate in Juneau.
- Crash severity at the study intersection is of concern.
- Left turn crashes from Egan are the predominant crash type of concern.
- Crashes are more likely when roads are icy, snowy, or wet, particularly in the months of November through January.
- Crashes are more likely during periods of high traffic volumes and speeds, especially when these conditions occur during periods of darkness.

Crashes are rare and random events. The vast majority of the time, drivers travel safely on the road system. Crashes usually do not occur unless more than one contributing circumstance happens at the same time and in the same space. For example, vehicles stopping when a light turns red rarely experience rear end crashes. Rear end crashes only occur when multiple contributing factors are also present (such as the leading vehicle braking more sharply than expected, the following driver following too closely and or being distracted, icy or wet road conditions that require more time to stop, etc.).

Because crashes are rare and random, a location that has very few crashes most years may unexpectedly have many crashes in the next year. Similarly, a location that consistently has a high number of crashes most years may unexpectedly have a year with few or no crashes. The crash analysis takes this into account be looking at crash trends over several years and by considering factors that are known to contribute to the likelihood of a crash (like traffic volume).

Sometimes, the characteristics of the road design can contribute to the possibility of a crash (such as when the traffic signal is blocked from view due to a horizontal curve and the leading driver doesn't see the red light until they need to brake sharply in order to stop in time). In these cases, changing or mitigating the road design can reduce the number of crashes that occur.

This chapter examines characteristics of crashes that occurred at the Fred Meyer intersection of Egan Drive at Yandukin Drive from 2005 through 2017 to determine what factors contribute to the likelihood of a crash at this intersection and to suggest mitigations that might decrease the likelihood that crashes will occur. The methodologies used for the analysis of crashes comply with the state of the practice. These methodologies provide evidence on whether crash histories are due to safety issues or just randomness, and whether treatments were effective.

4.1 Crash History (2005 to 2017)

For the initial report (October 2018), DOT&PF provided crash data for the roadways and intersections in the study area for a 10-year period from 2005 through 2014. For this update, additional crash data was provided, through 2017.

In 2012, Egan Drive at the study intersection was improved through the *Egan/Yandukin Intersection Safety Enhancements* project. The project implemented a zero offset of the southbound and northbound left-turn lanes on Egan Drive to improve sight distance and safety for left-turning drivers. As a result of this change, sight distance for southbound left-turn drivers was significantly improved. However, southbound vehicles queued up in the southbound left turn lane still partially block the view of oncoming traffic for northbound left turn drivers.

Continuous lighting was installed on Egan Drive from the study intersection towards downtown in 2013. Prior to this construction, only the intersection was lighted.

For each crash listed in the DOT&PF database, the crash type and location were carefully reviewed and adjusted using engineering judgment and crash narratives that were provided for a small subset of the crashes. Figure 8 shows the crashes per year for the study intersection, as well as the Annual Average Daily Traffic (AADT) volumes for each year. The figure illustrates the randomness associated with crash data, with as many as 10 crashes in some years and as few as 2 crashes in others. The number of crashes each year following the reconstruction is consistent with the range of crashes per year before reconstruction, meaning we have no evidence that the construction projects changed the likelihood of a crash occurring.

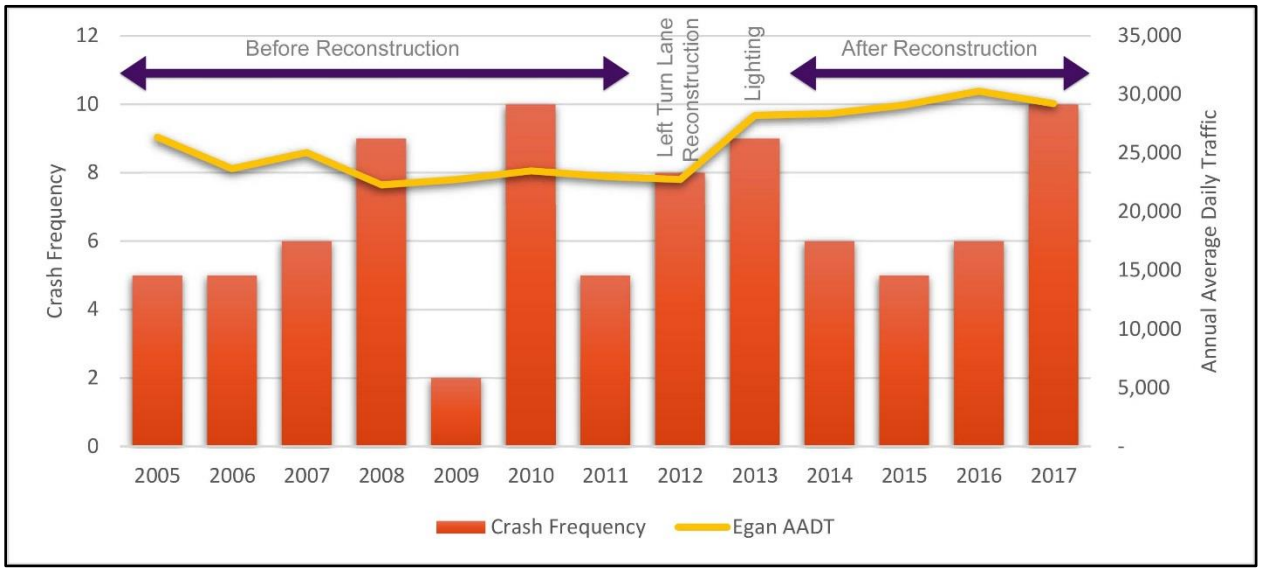


Figure 8. 2005 to 2014 Crash Type by Year for Fred Meyer Intersection of Egan Drive at Yandukin Drive

A statistical analysis, described in Appendix A, was performed to determine whether or not a statistical change could be detected between the periods before and after the reconstruction. This statistical analysis also found no evidence that the construction projects changed the likelihood of a crash occurring.

4.2 Intersection and Segment Crash Rates

Crash rates were calculated based on the number of crashes, the number of years in the study period, and annual average daily traffic (AADT). The crash rates were then compared to statewide averages for similar facilities and the Critical Accident Rate (CAR). The CAR is a threshold above which the observed rate is considered statistically higher than average at a 95% confidence level. When a crash rate exceeds the CAR, there is strong evidence that crashes are caused by underlying contributing factors instead of just random occurrences. Crash rates at intersections are given in terms of crashes per million entering vehicles (MEV). Crash rates on segments are given in terms of crashes per million vehicle miles (MVM). Table 2 presents the intersection crash rates and Table 3 presents the segment crash rates.

Within the study area, one intersection (Glacier Highway/Nugget at Old Dairy Road) and one segment (Old Dairy Road from Glacier Highway/Nugget to Yandukin Drive) have crash rates above the statewide average and the CAR for similar locations. Because this report is focused at the Fred Meyer intersection at Egan Drive, additional detail describing the causes or possible mitigations for crashes at these locations is not described. If alternative concepts for the Fred Meyer intersection impact either of these two locations, however, consideration should be given to improvements that will reduce the number of crashes at these locations, in addition to improvements to the Fred Meyer intersection.

In the most recent DOT&PF *Southcoast Region 2013 Traffic and Safety Report*, the crash rate of the Fred Meyer intersection of Egan Drive at Yandukin Drive was compared to other Southcoast intersections for the years 2009 through 2013. The 5-year weighted crash rate of the study intersection was ranked 13th highest for the entire Southcoast region and ranked 8th highest within Juneau. Using this 5-year data, the study intersection is ranked 5th highest in injury crashes for the entire Southcoast region and ranked 3rd highest in injury crashes within Juneau.

Table 2. Intersection Crash Rates (2005 to 2017)

Intersection	Total Crashes	Average Yearly Entering AADT	Crashes/ MEV	Statewide Averages (Crashes/ MEV)	CAR @ 95.00% Confidence (Crashes/ MEV)	Above Average?	Above CAR?	Safety Index
Egan Dr at Yandukin Dr/Glacier Hwy	86	31,686	0.57	0.55	0.66	**Yes**	No	0.87
Egan Dr at Glacier Hwy/Nugget	110	30,345	0.76	1.57	1.75	No	No	0.44
Glacier Hwy/Nugget at Old Dairy Rd	57	13,232	0.91	0.55	0.72	**Yes**	**Yes**	**1.27**
Glacier Hwy/Lemon Rd at Glacier Hwy/Lemon Spur	3	10,864	0.06	0.52	0.70	No	No	0.08
Yandukin Dr at Old Dairy Rd	9	3,506	0.54	0.52	0.85	**Yes**	No	0.64

Table 3. Segment Crashes (2005 to 2017)

Segment	Total Crashes	Segment Length (Miles)	Average Yearly AADT	Crashes / MVM Traveled	Statewide Averages (Crashes/ MVM)	CAR @ 95.00% Confidence (Crashes/ MVM)	Above Average ?	Above CAR?	Safety Index
Egan Dr/Glacier Hwy: Yandukin Dr to Glacier Hwy/Nugget	15	0.76	25,744	0.16	1.30	1.50	No	No	0.11
Glacier Hwy/Lemon Rd: Egan Dr/Glacier Hwy to Glacier Hwy/Lemon Spur	6	0.12	10,417	1.01	1.60	2.54	No	No	0.40
Glacier Hwy/Lemon Spur: Glacier Hwy/Lemon Rd to Road End	0	0.36	2,293	0.000	1.60	2.78	No	No	0.00
Yandukin Drive: Glacier Hwy/Lemon Rd to Old Dairy Rd	2	0.30	2,670	0.53	1.60	2.80	No	No	0.19
Old Dairy Rd: Glacier Hwy/Nugget to Yandukin Dr	18	0.55	2,157	3.20	1.60	2.57	**Yes**	**Yes**	**1.25**

At the Fred Meyer intersection at Egan Drive, the crash rate of 0.55 crashes per million entering vehicles is slightly higher than the state average and below the CAR for similar intersections. The safety index (calculated as the ratio of the intersection or segment crash rate to CAR) is 0.87. This is lower than DOT&PF's typical cutoff value (0.90, per the Highway Safety Improvement Program Handbook) for considering crash-focused improvements. However, the number of major injuries at the intersection (6 from 2005 to 2017) is the highest of the intersections in the project area and does meet the DOT&PF typical cutoff value for considering improvements focused on reducing injury crashes (2 major injury crashes in a 5-year period, per the Highway Safety Improvement Program Handbook).

4.3 Crash Types

Crash types at the study intersection were examined to determine if there are any contributing factors that could be addressed by this project. Figure 9 presents the crashes at the intersection by crash type. The predominant crash types are left-turn crashes, followed by run off road crashes.

The left-turn crashes were divided evenly among crashes involving vehicles making a southbound left turn and vehicles making a northbound left turn. While some of the contributing factors for left-turn crashes were addressed in 2012 and 2013 (with the zero-offset left turns that improve sight distance and the lighting project), there is no evidence that crash frequency was reduced by these projects.

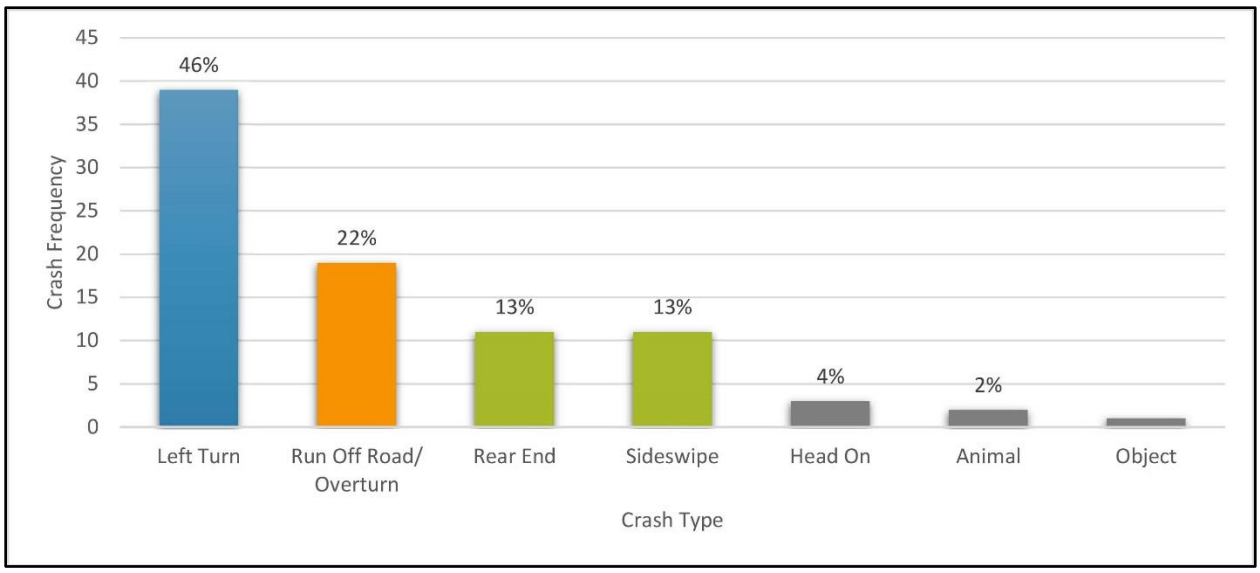


Figure 9. Crash Type Distribution at Fred Meyer Intersection (2005-2017)

4.4 Crash Severity

Figure 10 compares the distribution of crash severity at the study intersection during the periods before reconstruction and after reconstruction with the distribution of crash severity at other

intersections in Juneau. While there were no fatalities at the Fred Meyer intersection of Egan Drive and Yandukin Drive during the entire study period, many crashes resulted in either a minor or major injury. Note that the graph shows a trend of decreasing injury crashes after the left turn realignment and lighting projects (2014 to 2017); however, a comparison of the before and after fatal and injury crashes using the HSM method shows that this change is not statistically significant (Odds Ratio of 0.88 ± 2(0.64), confidence interval of [-0.01 to 2.55]). Because the interval contains "1.0", we cannot conclude that the intersection improvement reduced severity.

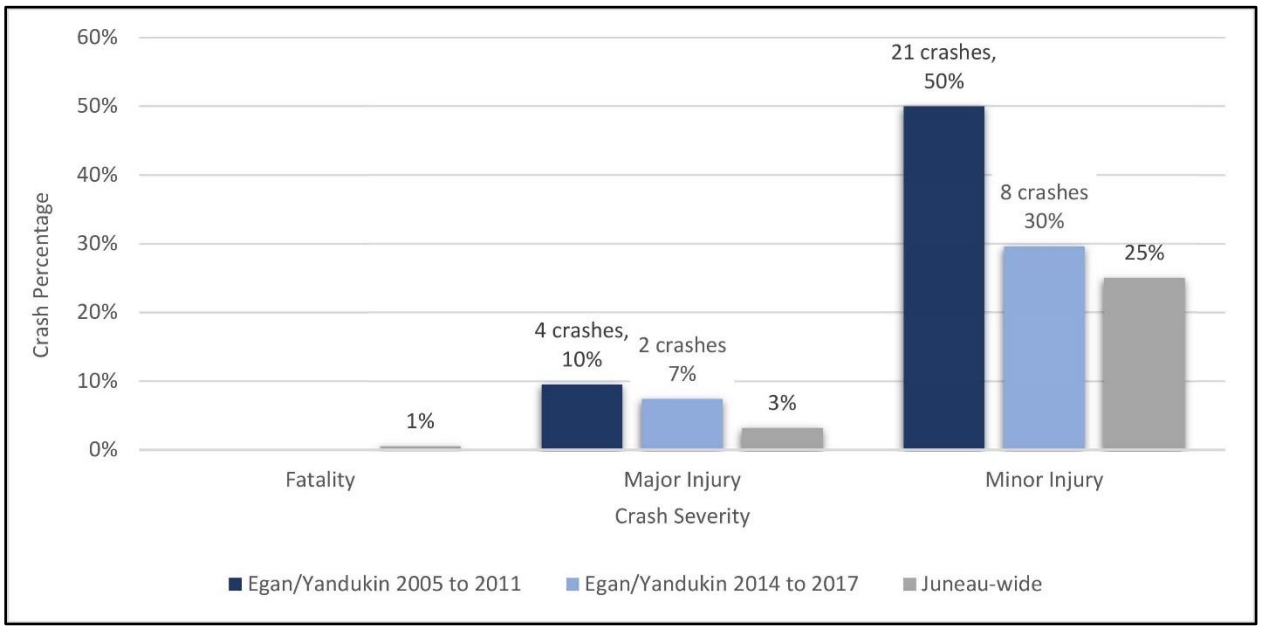


Figure 10. Crash Severity at Intersection Before and After Reconstruction

4.5 Analysis of Factors Contributing to Crashes

4.5.1 Month of Year and Traffic Volumes

As shown in Figure 11, crashes occur most frequently during the winter months, with 52% of the crashes occurring in November, December, and January. By contrast, traffic volumes are lowest in November, December and January, and highest during the summer months.

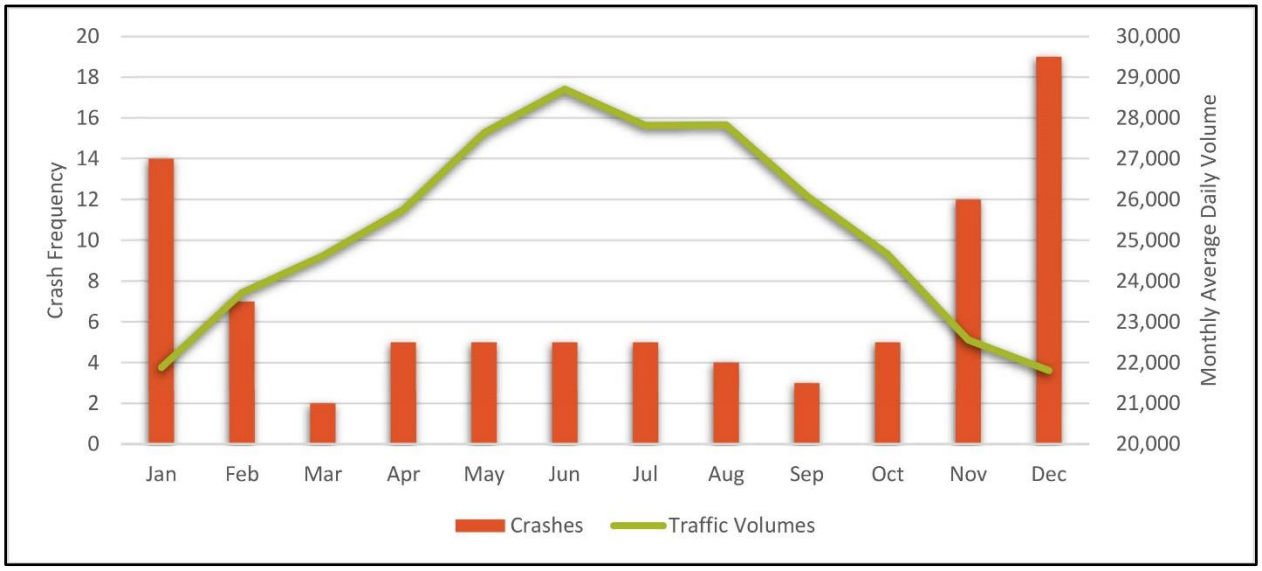


Figure 11. Crashes and Traffic Volumes by Month at Fred Meyer Intersection (2005 to 2017)

4.5.2 Time of Day

As shown in Figure 12, crashes tend to occur in the periods of the day with the highest traffic volumes, with 36% of the crashes occurring between 3 PM and 7 PM, a period with 31% of the daily traffic volume. Crashes in the months of November through January exaggerate this pattern, with 44% of the crashes in November through January occurring between 3 PM and 7 PM.

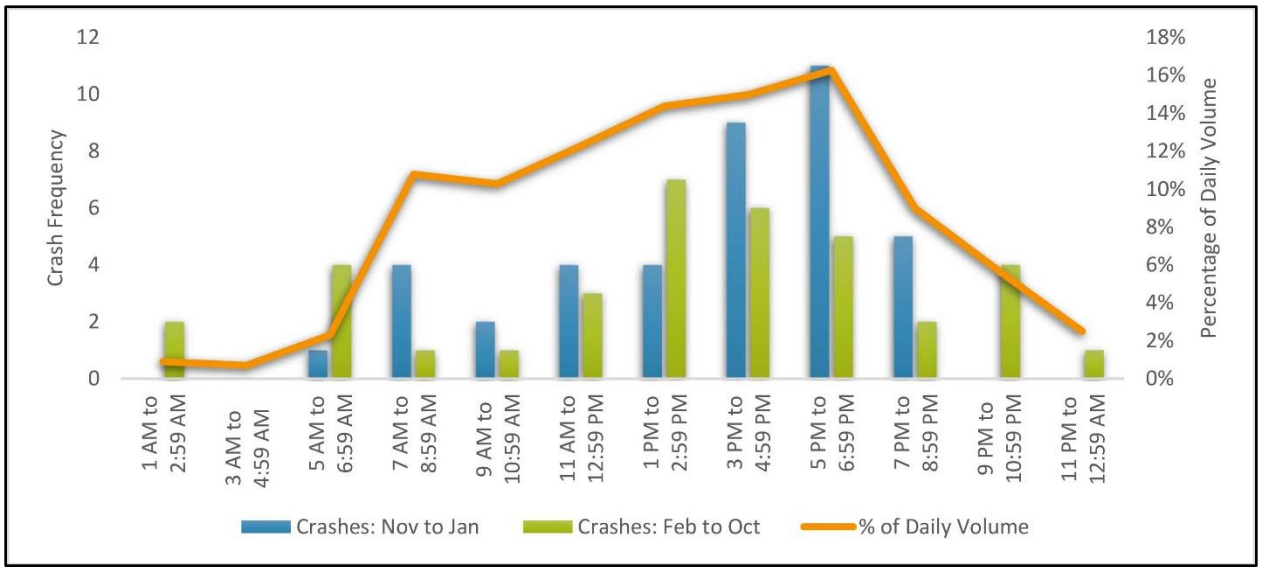


Figure 12. Crashes and Traffic Volume by Time of Day (2005 to 2017)

4.5.3 Road Surface Condition and Weather

One possible reason for the concentration of crashes at the Egan Drive intersection at Fred Meyer during the winter months could be weather or the road surface condition. Figure 13 shows the number of crashes reported in each month by the condition of the road surface reported at the time of the crash. Icy or snowy road surfaces appear to contribute to the peak in crashes in November and December. In January, the increased crash frequency appears to be related to both icy and wet road surface conditions.

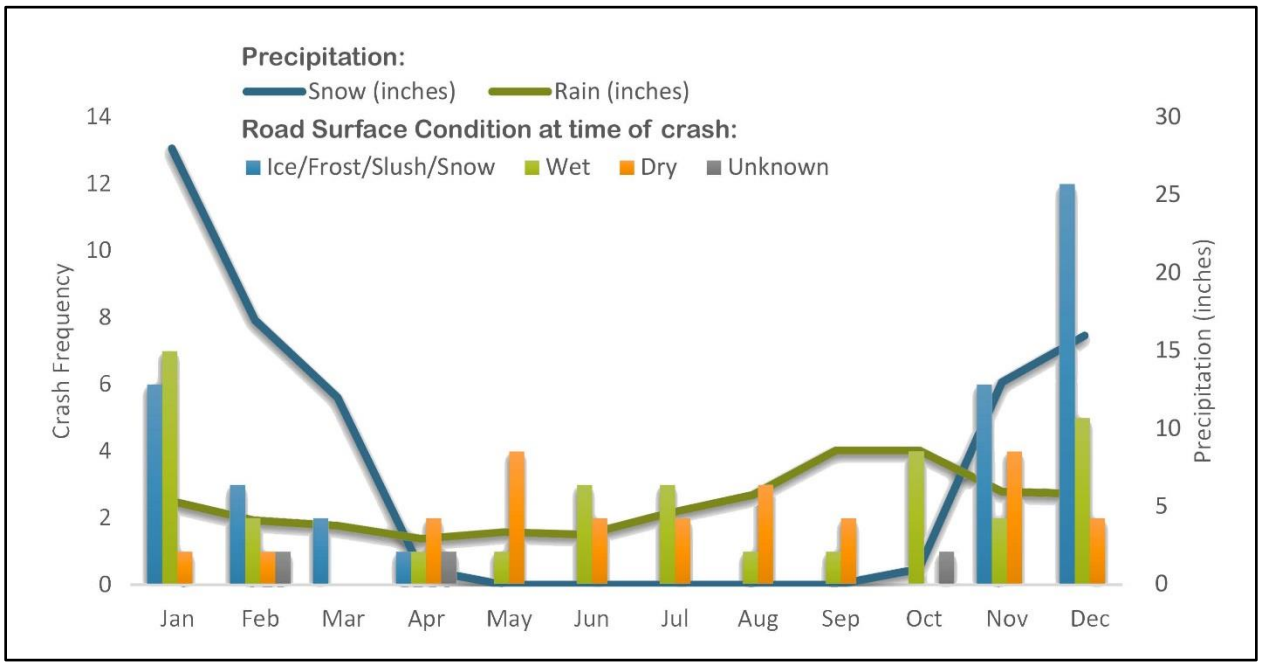


Figure 13. Crashes by Road Condition and Monthly Precipitation (2005 to 2017)

By contrast, the weather condition at the time of the crash (see Figure 14) does not appear to relate as directly to the peak in crash frequency in November through January, since the number of crashes appears to increase for all weather conditions in these months.

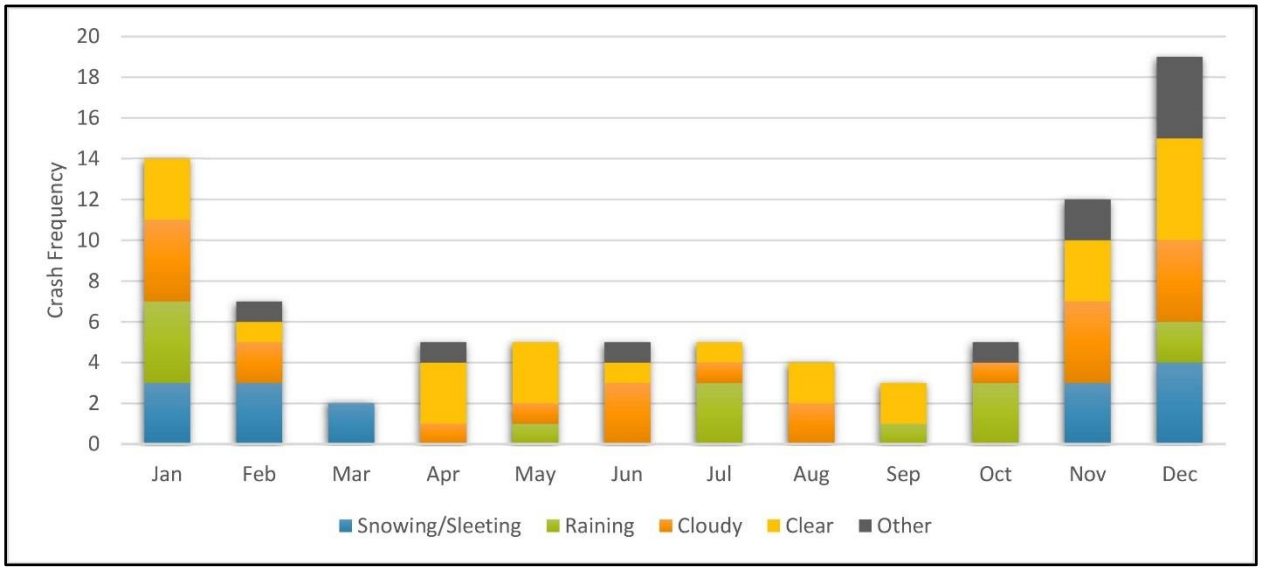


Figure 14. Crashes by Weather at Time of Crash (2005 to 2017)

4.5.4 Light Condition

Another factor that changes seasonally and by time of day is the light condition. For each hour of the day, Figure 15 shows the approximate percentage of time over a year that the sun is above and below the horizon. Figure 16 shows the reported light condition for each crash on Egan Drive and the Fred Meyer intersection by time of day. During the PM peak period (3 PM to 7 PM), crashes appear to be more likely to occur when it is dark outside, as compared to other times of the day when it is more likely to be dark.

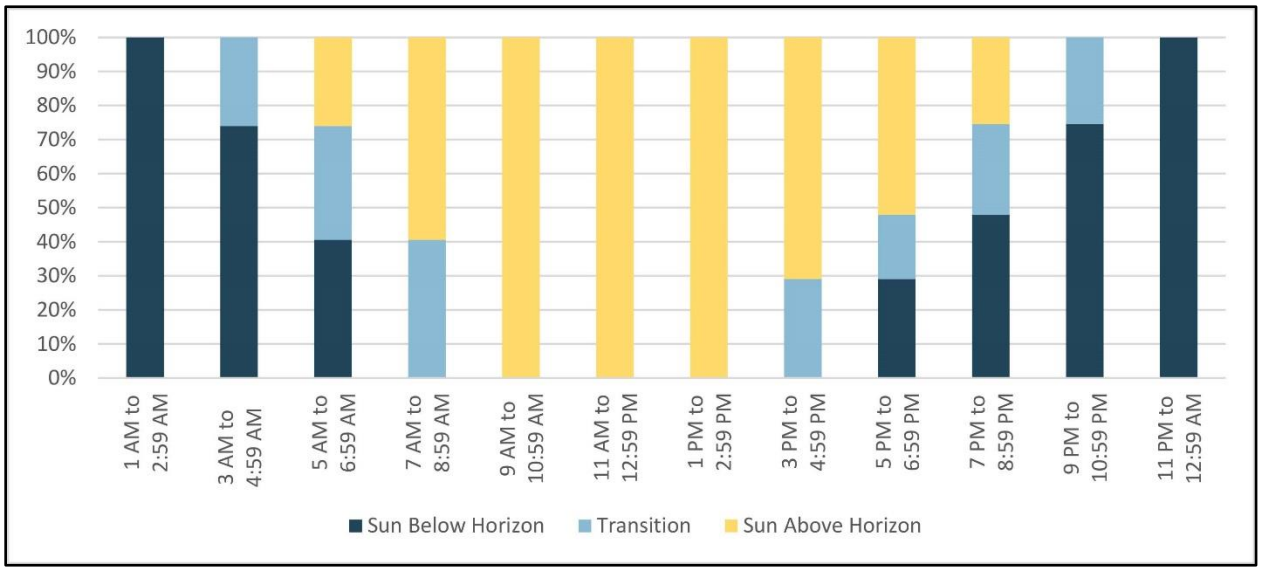


Figure 15. Sun Position Percentages by Time of Day for Juneau

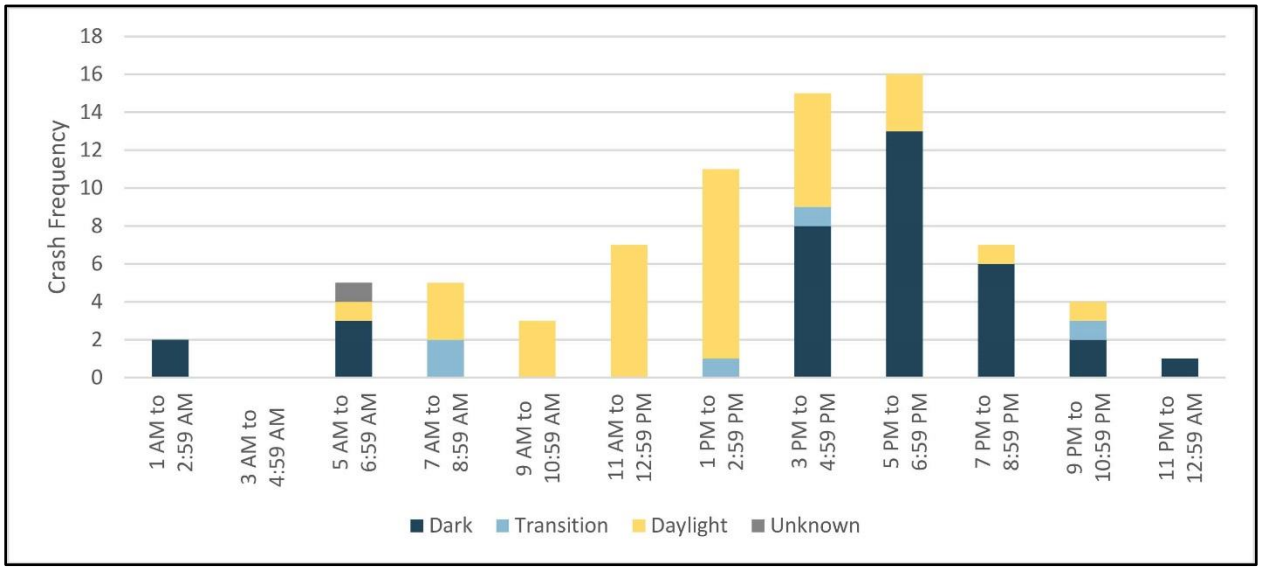


Figure 16. Crashes by Reported Light Condition and Time of Day (2005 to 2017)

4.5.5 Left Turn Crashes by Direction

As discussed in Section 4.3, the predominant crash type at this intersection is left turn crashes. Because of the limited movements at this intersection (vehicles are prohibited from turning left from the side streets onto Egan Drive or from crossing Egan Drive), the left turn movement from Egan Drive turning onto the side streets is the only permitted movement with a crossing conflict. As illustrated in Figure 17, the left turn crashes result in more injuries, with 72% of left turn crashes resulting in major or minor injuries. Additionally, 83% of crashes resulting in major injuries are left turn crashes.

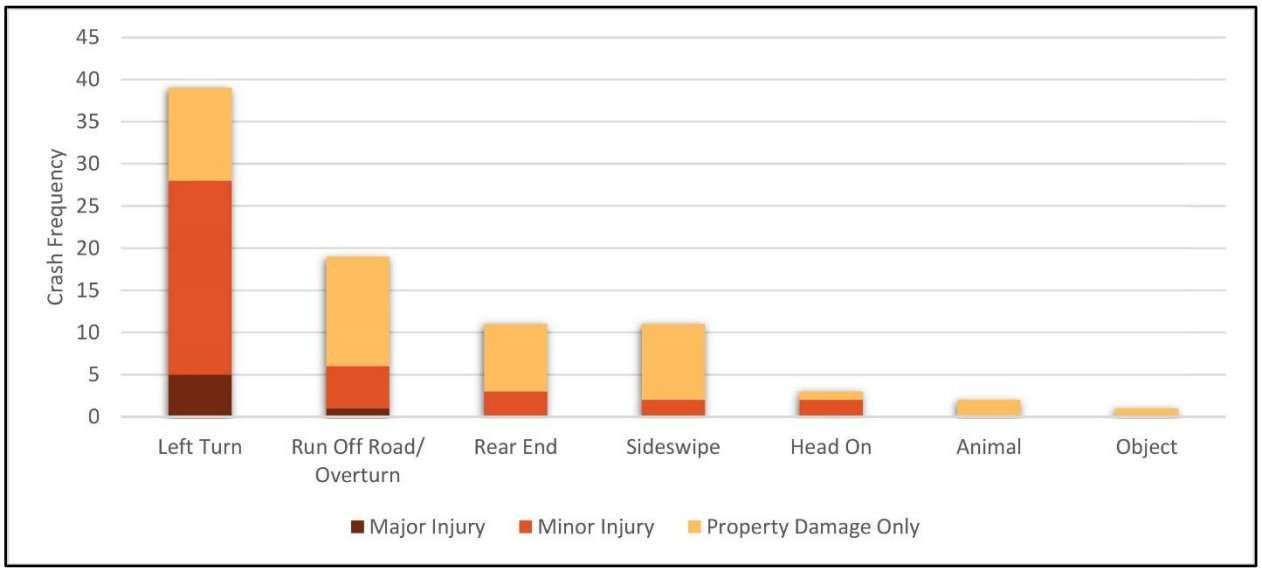
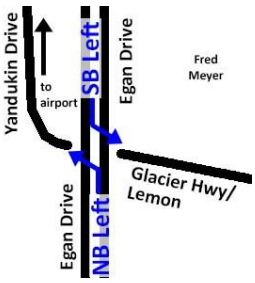


Figure 17. Crashes by Type and Severity (2005 to 2017)

Two directions of left turn crashes are possible: northbound vehicles turning left from Egan Drive to travel towards the airport, and southbound vehicles turning left from Egan Drive to travel towards the Fred Meyer. Table 4 shows that left turn crashes occur at approximately the same rate in both directions.

Table 4. Comparison of Crash Rates for Left Turn Crashes by Direction (2005 to 2017)

Direction of Left Turn	Crash Frequency	Approximate Daily Turning Vehicles	Crash Rate (crashes per million turning vehicles)
Northbound	15	2,400	1.31
Southbound	24	3,500	1.43



4.6 Crash Summary

Figure 18 provides a visualization of the historical crashes at the Fred Meyer intersection of Egan Drive and Yandukin Drive during the 13-year study period, including the two years the area was under construction. The directional orientation of the crashes was interpreted from the crash data. Approach crash patterns are generalized from crash data and depicted without detail of lane assignment and exact position. This level of detail is adequate to identify problem trends and contributing factors.

Left-turn crashes, which occur at this intersection more frequently than other crash types, are the greatest concern. Moreover, crashes at the study intersection have a higher than expected likelihood of resulting in injuries. In 2012 and 2013, reconstruction projects at this intersection improved sight distance for left turn drivers by shifting the relative position of the left turn lanes and by installing continuous lighting from the subject intersection towards downtown Juneau. However, there is no evidence that the likelihood of a crash changed from before these improvements (2005 to 2011) to after these improvements (2014 to 2017).

The following factors appear to be contributing to the identified crash patterns:

- Time of Year: 52% of the crashes at this intersection occur in November, December, and January, typically months of poor weather (rain, fog, snow, ice, etc.) and increased hours of darkness.
- Road conditions: Icy or snowy roads are associated with crashes in November and December. In January, wet roads also contribute to the increase in crashes. Under these road conditions, acceleration and stopping deceleration are reduced because of lower traction. Also, spray from wet roads can impede sight, resulting in increased difficulty in selecting adequate left-turn gaps.

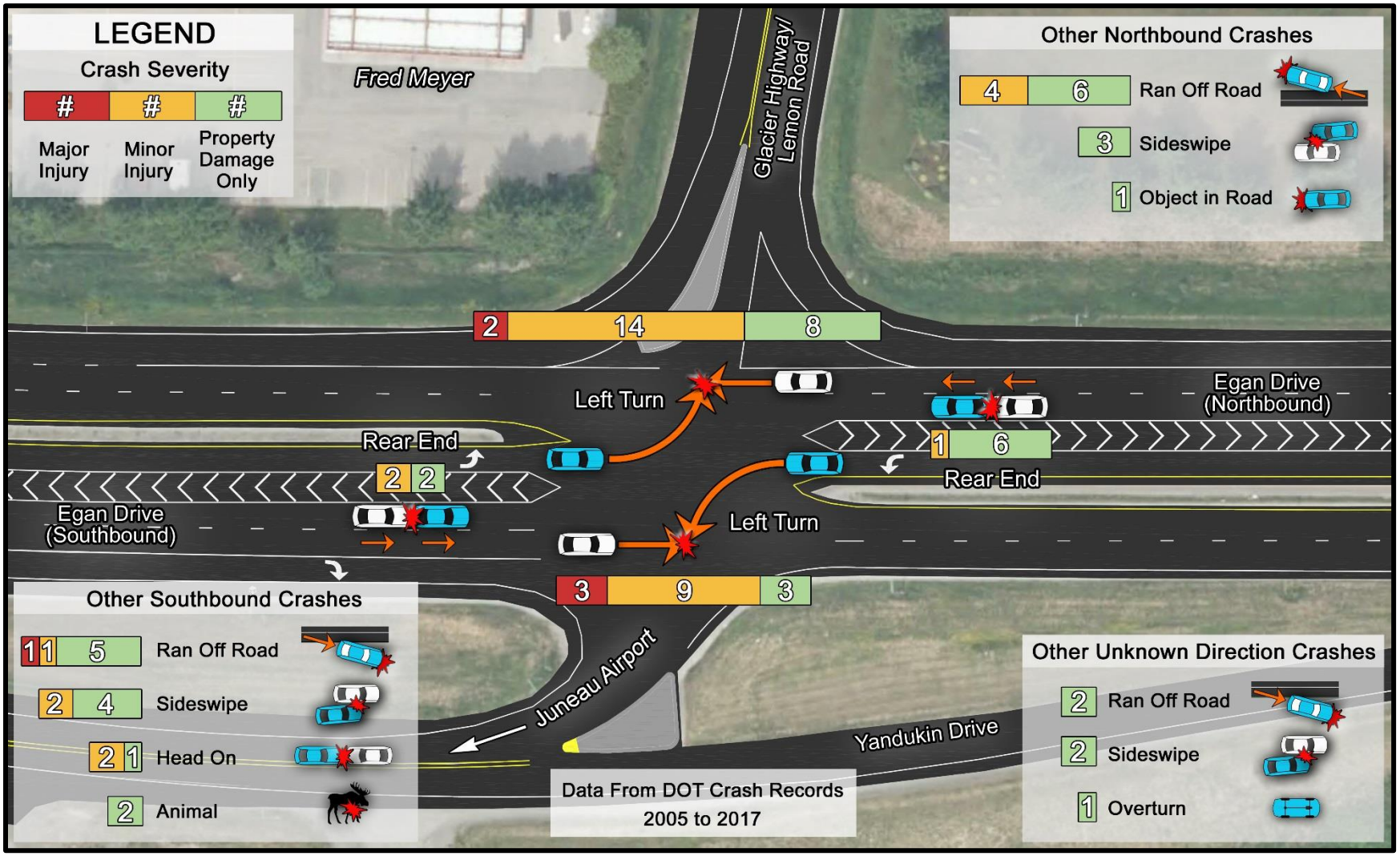


Figure 18. Crash Type and Severity Diagram (2005 to 2017, including two years under construction)

- Time of Day combined with Time of Year: Overall, 36% of the crashes occur during the PM peak period (3 PM to 7 PM); this effect is more pronounced in November through January, when 44% of crashes occur in the PM peak period. Traffic volumes are the highest during this commuting time (31% of daily traffic), and turning gaps of sufficient length are fewer. Moreover, drivers must evaluate three approach lanes with high speed traffic streams to select gaps, which could result in errors, conflicts, and crashes. As such, the elevated crashes during peak commuting times suggests high speed and high volumes contribute to the left-turn crash issues.
- Light conditions: During the PM peak period about 68% of crashes are coded as occurring in darkness even though the sun is at or below the horizon only about 40% of the time in those hours throughout the year. The light conditions as a contributing factor may be confounded by the heavy traffic volumes since these conditions occur simultaneously. However, since crashes are more concentrated in the winter months, it is likely that darkness coupled with high volume traffic and poor road conditions diminishes further the driver's gap selection ability, thus increasing conflicts and crashes.
- Sight distance: For northbound left turn drivers (turning towards the airport), line of sight of oncoming traffic is partially blocked when vehicles are queued up in the opposing left turn lane.

Left turn crashes are considered the most important crash type to address at this intersection, as they occur more frequently than other crashes and tend to be of higher severity (more likely to cause an injury). In addition, other crash types may also be reduced by mitigations that reduce left turn crashes. For example, a left turn conflict may result in a rear end crash when a through vehicle brakes suddenly to avoid a turning vehicle. Or, if one of the vehicles swerves and runs off the road, the conflict could result in a run off road type crash.

Left turn crashes (collisions between left-turning traffic with oncoming through vehicles) are caused by insufficient gaps in the Egan Drive traffic during certain times of the day, as well as the difficulty that left-turn drivers have with gap selection because of high volumes, high speeds, darkness, and environmental conditions. The conflicts between the left-turning vehicle and oncoming through vehicle, and resulting crashes, could be addressed by the following:

- **Control left-turn movements with signalization.** Install a traffic signal so that left-turn movements are only made during a protected left-turn signal when conflicting traffic is held by a red signal. This assigns movement right-of-way and minimizes or eliminates driver's errors in selecting and accepting adequate gaps. However, signals often will create additional conflicts, most notably those that can result in rear-end and sideswipe collisions between through vehicles within the dilemma zone of an approach.

- **Relocate left-turn movements.** Prohibiting left turns at the Yandukin intersection would eliminate conflicts at the intersection and relocate the left turns either to the Glacier Highway/Nugget intersection or to the Sunny Point interchange. Increased traffic demand and therefore conflicts at these other intersections would need to be addressed.
- **Provide physical separation of the left-turn and through movements.** This would involve building a grade separation overpass to grade separate conflicting movements and eliminate left-turn collisions. Left turns would be directed to ramps, and although another set of conflicts is created, the volumes and speeds are much lower and would likely result in less likelihood of crashes.
- **Speed control.** Speeds contribute to the likelihood of an injury crash. By reducing speeds (through enforcement, for example), the likelihood of an injury crash will be reduced.
- **Traffic demand management.** If measures are taken that spread the traffic demands over longer periods of the day, crashes that result from driver's impatience due to delay in the heaviest volume periods of the day could be reduced.

5 Existing Operations

5.1 Traffic

5.1.1 Historical AADT

Average Annual Daily Traffic (AADT) volumes were collected from the DOT&PF Southcoast Region Annual Traffic Volume Report(s). Table 5 summarizes historical AADTs for each road segment in the study area.

To develop 2017 base year AADTs, volume data and turning movement data were collected for the study area in September and October 2017 and compared to historical data. Figure 19 depicts the developed 2017 AADTs.

Section Highlights

- Egan Drive carries almost 30,000 vehicles per day.
- Traffic volumes are heavy heading towards downtown in the morning and towards Mendenhall Valley in the evening.
- Travel speeds are high along Egan Drive, with the 85th percentile speed at about 5 mph above the posted speed limit of 55 mph.
- While most drivers travel through the study area with minimal delay, some turning vehicles experience significant delay.
    - Turning drivers may sit at the Glacier Hwy/Nugget signal for more than one cycle.
    - At the Egan Drive intersection at Fred Meyers, left-turning drivers may choose different routes or choose to turn when the gap in oncoming traffic is insufficient, causing oncoming drivers to brake.
- Pedestrians and bicyclists are generally well accommodated in the study area, but there are few locations for pedestrians to cross Egan Drive and those who desire to cross Egan Drive at the Fred Meyer intersection are projected to experience delays in 2040 that are much greater than 45 seconds during peak traffic times. HCM 2010 indicates that delays greater than 45 seconds result in a very high likelihood that pedestrians will not wait for an acceptable gap in traffic and will instead attempt to rush through shorter gaps.

Table 5. Average Annual Daily Traffic (2005-2015)

Segment Name	Extents	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Egan Dr/ Glacier Hwy	Bridge #2127NB and #2192SB to Yandukin Dr	24,903	23,365	23,667	20,798	21,214	25,802	25,310	25,010	25,254	26,795	27,201
	Yandukin Dr to Glacier Hwy Nugget	26,367	23,667	25,060	22,303	22,749	23,499	23,031	22,760	28,221	28,369	29,122
	Glacier Hwy Nugget to Mendenhall Loop Rd	26,465	25,060	25,152	22,385	22,833	23,586	23,135	22,860	26,195	26,332	26,776
Glacier Hwy/ Lemon Rd	Egan Dr/Glacier Hwy to Glacier Hwy/Lemon Spur	7,491	8,466	*	*	*	*	*	*	*	8,900	7,584
	Glacier Hwy/Lemon Spur to DOT Regional Office	*	4,592	*	*	*	*	*	*	*	-	4,566
Glacier Hwy/ Lemon Spur	Glacier Hwy/Lemon Rd to Rd End	2,936	2,790	*	*	*	*	2,381	2,366	2,443	2,397	2,604
Yandukin Dr	Yandukin Dr Wye to Egan Dr	*	*	*	*	*	*	*	*	*	-	1,997
	Old Dairy Rd to Crest Avenue	-	-	-	-	-	-	*	2,438	2,420	2,686	2,740
Yandukin Dr Wye to Egan Dr	Yandukin Dr to Egan Dr/Glacier Hwy	-	-	-	-	-	-	-	-	-	-	2,500
Old Dairy Rd	Glacier Hwy Nugget to Crest Avenue	1,600	1,632	1,576	1,402	1,682	1,737	1,703	2,765	2,745	2,834	2,834
	Crest Avenue to Yandukin Dr	1,483	1,707	1,613	1,440	1,728	1,785	1,465	1,450	1,440	1,722	1,756
Trout Street	Glacier Hwy Nugget to Jordan Ave	4,169	3,962	3,962	3,526	4,231	4,370	4,286	4,235	5,098	5,125	5,202
Glacier Hwy Nugget	Egan Dr/Glacier Hwy to Jordan Avenue	*	*	*	*	*	*	*	8,126	8,065	8,080	7,567

Note: ***** denotes years with published volumes in DOT&PF Annual Volume Reports that have since been determined to be unreliable by DOT&PF staff and therefore removed from the analysis.

Figure 19. 2017 Average Annual Daily Traffic

5.1.2 Existing Turning Movement Volumes

Turning movement volumes (TMVs) for analyzed intersections within the study area were collected in September and October 2017. PM counts were also taken at the Fred Meyer intersection at Egan Drive and Yandukin Drive in November 2017.

The intersection of Egan Drive and Yandukin Drive experiences an unbalanced directional distribution during the AM and PM peak hours, with 69% of traffic on Egan Drive heading southbound in the AM peak and 69% heading northbound during the PM peak. Total intersection traffic at Egan Drive and Glacier Highway/Nugget is nearly equal in the AM and PM peak hours and is slightly lower at the midday peak hour. At the intersection of Yandukin Drive and Old Dairy Road/Livingston Way, traffic peaks at noon. The other analyzed intersections experience daily traffic peaks during the PM peak hour.

Peak hour factors (PHFs) convert hourly volumes to 15-minute design flow rates for capacity analyses. They represent the uniformity of traffic volumes over an hourly period and range from 0.25 (all traffic arrives in one 15-minute period and no additional traffic arrives for the rest of the hour) to 1.0 (equal number of vehicles arrive during each 15-minute period).

Table 6 shows the intersection PHFs for the morning, midday, and evening peaks for a regular day. These PHFs are representative of locations where traffic is evenly spaced throughout the hour, with some periods being slightly higher volume than others.

Table 6. Existing PHFs for Major Peak Periods

Intersection	AM	Midday	PM
Glacier Highway & Old Dairy Road	0.95	0.95	0.87
Egan Drive & Glacier Hwy/Nugget	0.89	0.92	0.90
Yandukin Drive & Old Dairy Road	0.93	0.89	0.95
Egan Drive & Yandukin Drive	0.86	0.95	0.92
Glacier Hwy/Lemon Spur & Glacier Hwy/Lemon Road	0.89	0.89	0.99

Heavy vehicle percentages (HV%) are also taken into account in analyzing the capacity of intersections. The exact HV% for each movement at each intersection was used for the capacity analysis. HV% on Egan Drive is approximately 4%.

The collected turning movement volumes were balanced to adjust for mathematical inconsistencies and daily variation in traffic. Figure 20 through Figure 22 depict existing TMVs for peak hours.

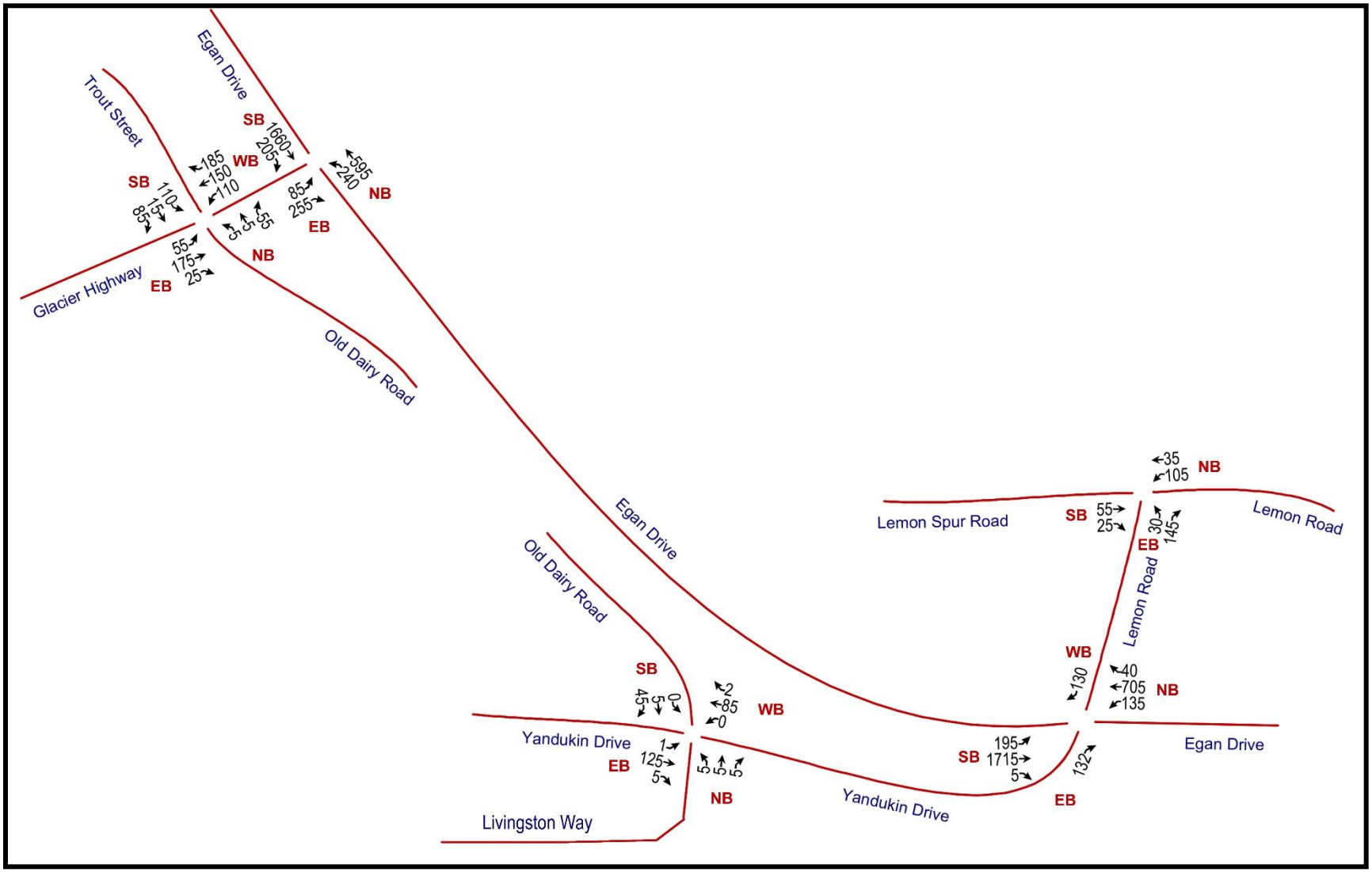


Figure 20. Existing Turning Movement Volumes – AM Peak Hour (7:30 AM to 8:30 AM)

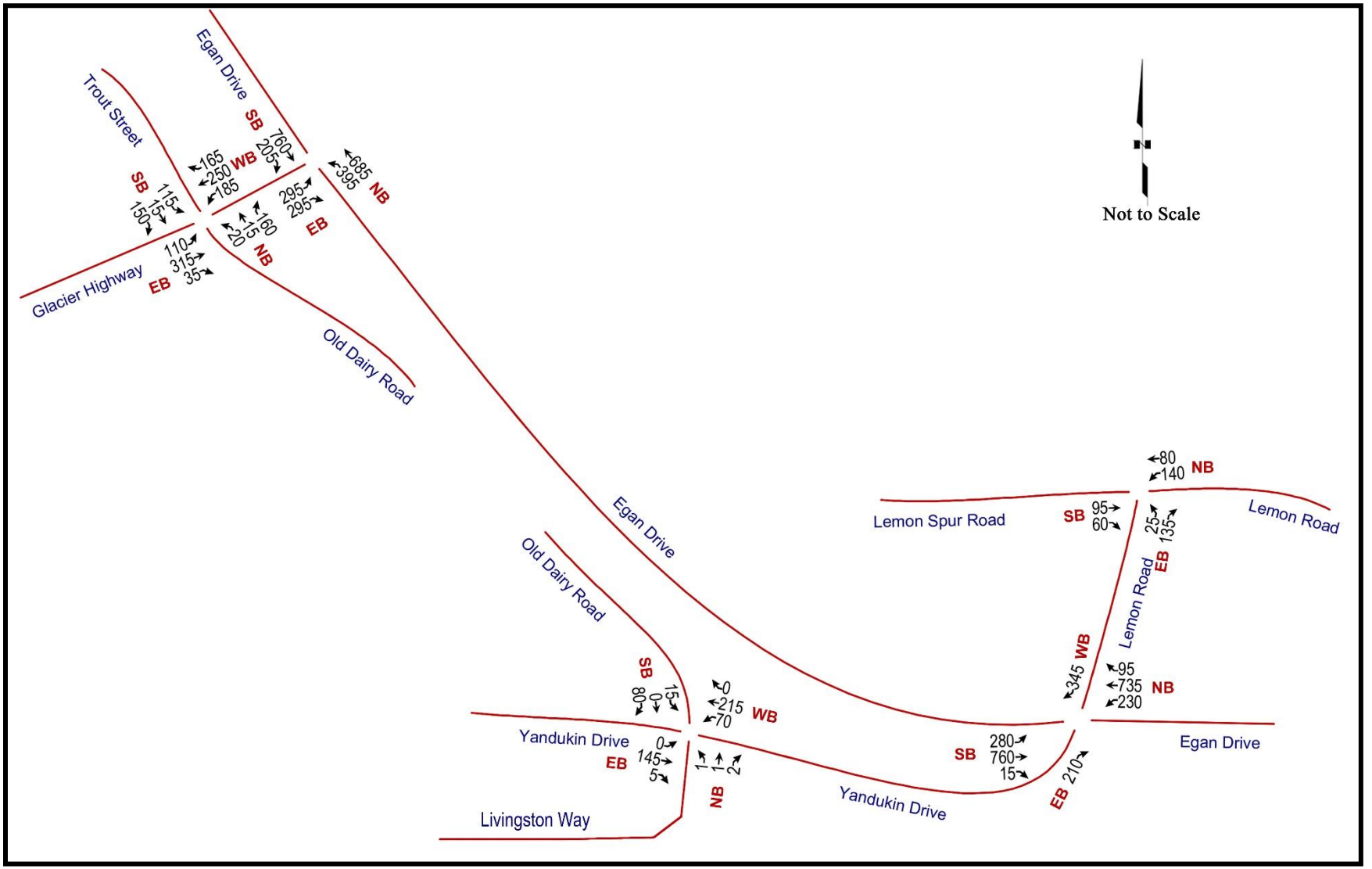


Figure 21. Existing Turning Movement Volumes – Noon Peak Hour (12:00 PM to 1:00 PM)

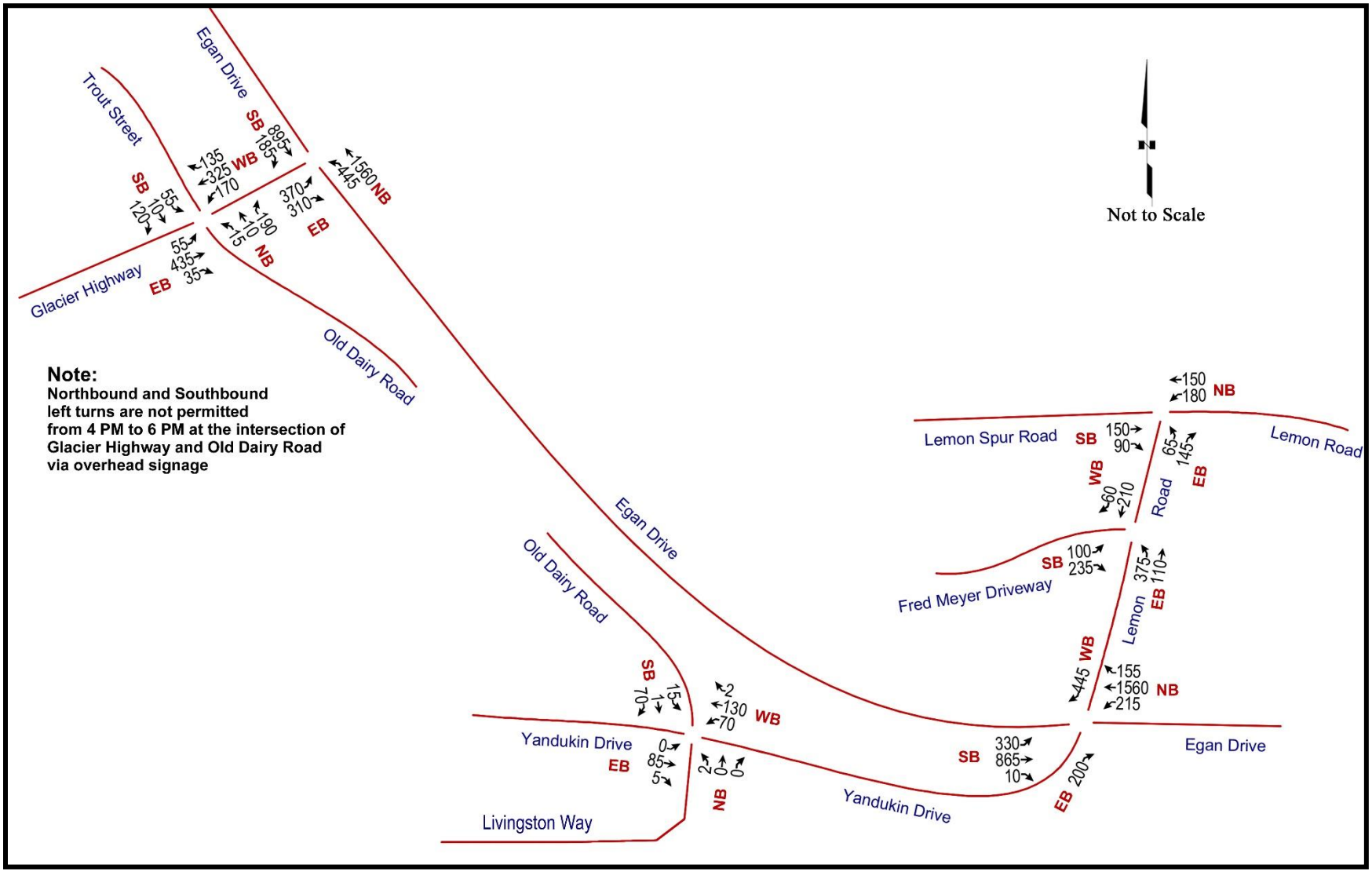


Figure 22. Existing Turning Movement Volumes – PM Peak Hour (4:30 PM to 5:30 PM)

5.2 Existing Intersection Capacity

Capacity analyses were conducted using Synchro Trafficware which applies Highway Capacity Manual (HCM) intersection methodologies. The existing PHFs detailed in Table 6 were used to approximate conditions during the highest 15-minute period of each peak hour.

Capacity analysis at the stop-controlled (unsignalized) intersections considers delay for the stop-controlled approaches only; since the main street through traffic experiences no delay, level of service (LOS) for uncontrolled movements is not reported. In contrast, all approaches experience delay at signalized intersections, so capacity analysis looks at all of the approaches individually, as well as the signalized intersection as a whole.

Table 7 and Table 8 summarize existing intersection LOS at peak hours for Egan Drive and Glacier Highway/Nugget, and Egan Drive and Yandukin Drive, respectively.

The analysis indicates that although the intersections as a whole operate well throughout the day (LOS C), some movements experience a significant delay. Specifically, at the Glacier Highway/Nugget intersection during the morning peak period, the northbound left-turn vehicles (240 vehicles per hour) experience about 75 seconds of delay per vehicle (LOS E) and the eastbound left-turn vehicles (85 vehicles per hour) experience about 60 seconds of delay per vehicle (LOS E). At the Fred Meyer intersection, the northbound left turn (135 vehicles per hour) experiences an average delay of almost 40 seconds (LOS E) in the morning peak hour, and in the PM peak hour the southbound left turn (330 vehicles per hour) experiences an average delay of almost 70 seconds (LOS F).

Table 7 and Table 8 also provide calculated 95th percentile queue lengths for the stopped movements. The calculated left-turn queues at the Fred Meyer intersection of Egan Drive and Yandukin Drive are shorter than the existing left-turn lanes (700-foot lane for the southbound left turn and a 430-foot lane for the northbound left turn); however, anecdotal reports indicate that the southbound left-turn lane length is sometimes exceeded in the PM peak hour. In addition, anecdotal evidence suggests that some people avoid making a southbound left turn in the evening peak hours and instead travel to the Sunny Point/Switzer interchange and travel back along Glacier Highway/Lemon Road to reach their destination. This indicates that the measured turning movement count for the southbound left turn probably does not include all of the demand for that movement.

Table 7. Existing Intersection LOS at Egan Drive & Glacier Highway/Nugget

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	57.2	-	0.0	77.3	1.9	-	-	21.5	0.0	**19.8**
LOS	E	-	Free	E	A	-	-	C	Free	**B**
v/c Ratio	0.6	-	-	0.9	0.2	-	-	0.9	-	-
Queue Length (ft)	75	-	-	350	125	-	-	1000	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	43.8	-	0.0	47.3	3.9	-	-	21.8	0.0	**19.3**
LOS	D	-	Free	D	A	-	-	C	Free	**B**
v/c Ratio	0.8	-	-	0.9	0.3	-	-	0.6	-	-
Queue Length (ft)	150	-	-	325	125	-	-	450	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	45.5	-	0.0	52.7	8.2	-	-	29.1	0.0	**21.0**
LOS	D	-	Free	D	A	-	-	C	Free	**C**
v/c Ratio	0.85	-	-	0.95	0.67	-	-	0.72	-	-
Queue Length (ft)	175	-	-	400	450	-	-	550	-	-

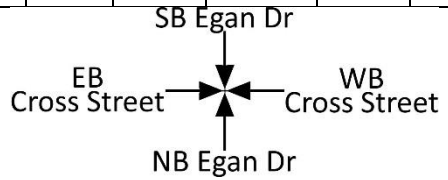
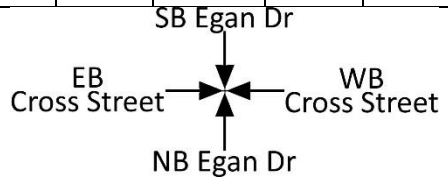


Table 8. Existing Intersection LOS at Egan Drive & Yandukin Drive

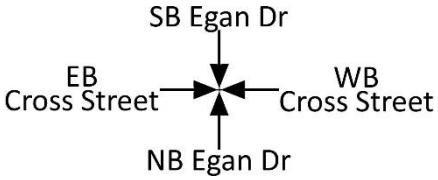
AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**		
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*
Delay (sec/veh)	-	-	0.0	-	-	0.0	**39**	-	-	11	-	-
LOS	-	-	Free	-	-	Free	**E**	-	-	B	-	-
v/c Ratio	-	-	-	-	-	-	0.60	-	-	0.30	-	-
Queue Length (ft)	-	-	-	-	-	-	100	-	-	25	-	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**		
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*
Delay (sec/veh)	-	-	0.0	-	-	0.0	11	-	-	12	-	-
LOS	-	-	Free	-	-	Free	B	-	-	B	-	-
v/c Ratio	-	-	-	-	-	-	0.30	-	-	0.35	-	-
Queue Length (ft)	-	-	-	-	-	-	25	-	-	50	-	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**		
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*
Delay (sec/veh)	-	-	0.0	-	-	0.0	12	-	-	**69**	-	-
LOS	-	-	Free	-	-	Free	B	-	-	**F**	-	-
v/c Ratio	-	-	-	-	-	-	0.30	-	-	0.95	-	-
Queue Length (ft)	-	-	-	-	-	-	25	-	-	275	-	-



Three of the side street right-turn movements at these two intersections have an acceleration lane for merging directly onto Egan Drive, similar to interchange on-ramps. These movements were analyzed with the HCM on-ramp methodology. All of these merging movements have LOS B or better, as shown in Table 9. The ramp free-flow speed and merge length shown in the table were estimated using the HCM methodology. Note that the northbound on-ramp merge was analyzed for two conditions. The HCM methodology suggests the 45-mph free-flow speed and 680-foot merge length; however, observations show that many vehicles turning right from Fred Meyer hesitate and look for gaps in the oncoming through traffic before entering Egan Drive, thus entering at a slower speed and with a smaller merge length. The analysis shows that the merge still operates well (LOS C or better) under this condition.

Table 9. Existing On-Ramp LOS

Intersection	Ramp	Ramp Free Flow Speed (mph)	Merge Length (feet)	AM LOS	Midday LOS	PM LOS
Egan Dr & Glacier Hwy/Nugget	Southbound	30	780	B	A	B
Egan Dr & Yandukin Dr	Southbound	40	720	B	A	A
Egan Dr & Yandukin Dr	Northbound	45	680	A	A	B
		25	200	B	B	C



5.3 Vehicle Speed Study

In September and October 2017, speed studies were conducted near the Fred Meyer intersection of Egan Drive and Yandukin Drive using radar detectors. The locations where 24-hour radar speeds were collected are shown in Figure 23. Figure 23 also presents the 85th percentile speed, pace speed range, and maximum recorded speed during observations. The "pace" is the 10-mph speed range that more vehicles fall into than any other 10 mph range.

Generally, it is expected that 85th percentile speeds should match the posted speed limit of the roadway and that the 85th percentile speed should fall within the pace. All three of the Egan Drive speed study locations have 85th percentile speeds that are 5 mph or more above the speed limit (55 mph), thus drivers are speeding more than expected on Egan Drive. The rest of the speed study locations have 85th percentile speeds that are consistent with their speed limits.

Speed-frequency curves for each location are found in Appendix A.

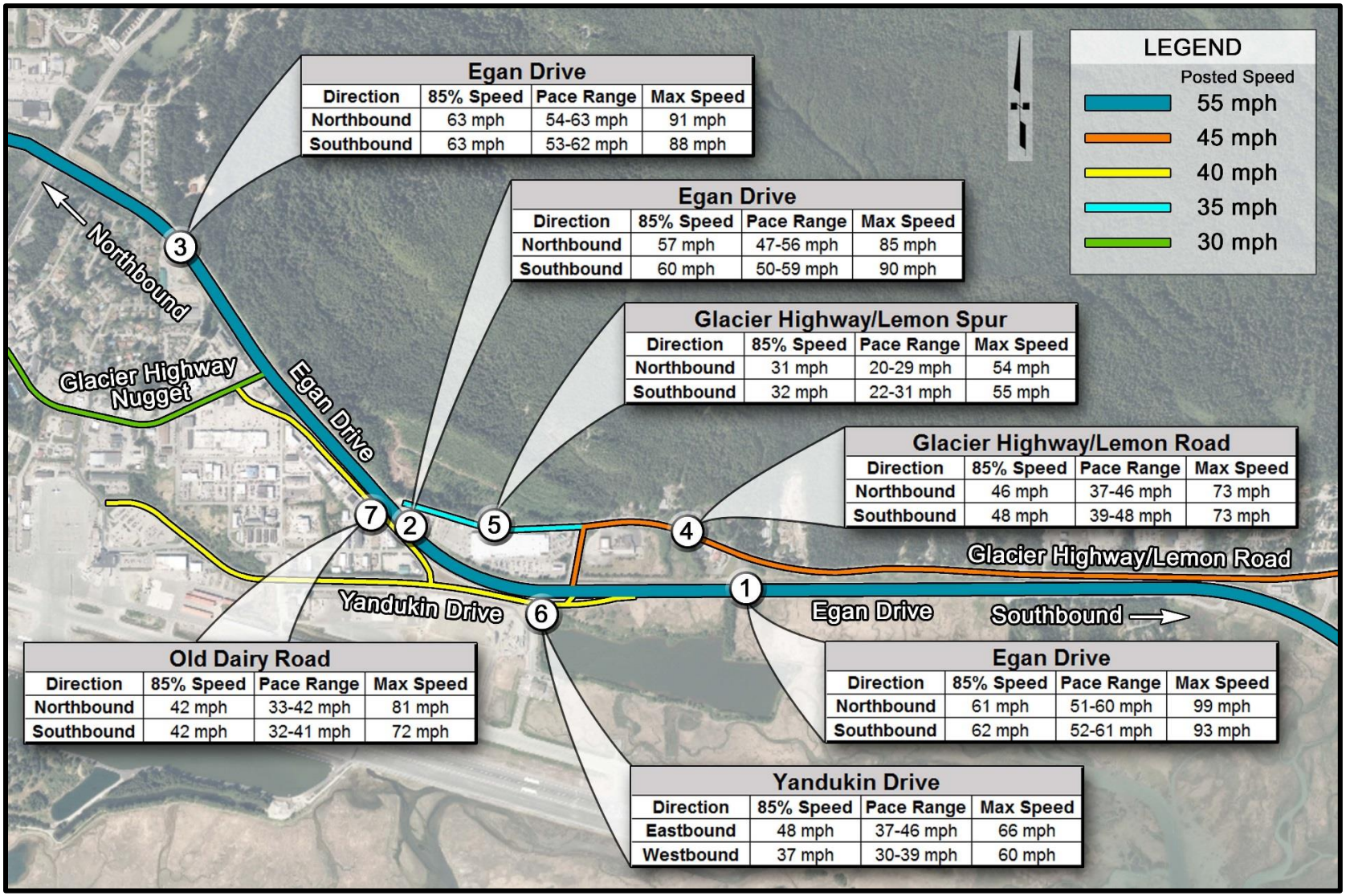


Figure 23. Speed Study Location and Results

5.4 Bluetooth Study and Latent Demands

An origin-destination study was performed to determine where vehicles using Glacier Highway/ Lemon Road near Fred Meyer are going to or coming from. This data can be used if a signal warrant analysis is performed and can also be used to determine how traffic patterns will change under different mitigation concepts.

The origin-destination (O-D) data were collected using Bluetooth detectors which were mounted on poles at three locations: on Glacier Highway/Lemon Road near Fred Meyer, on the access road near the Sunny Point/Switzer interchange, and on Glacier Highway/Nugget near Old Dairy Road.

Many devices such as digital cameras, cell phones, and laptop computers communicate with each other using the point-to-point networking protocol known as Bluetooth. Devices identify each other using MAC addresses, which are unique identifiers assigned to each Bluetooth device. The Bluetooth detector records the MAC address for each device it senses. Only devices with Bluetooth enabled are detected. This information can be compared to data collected by other Bluetooth detectors located elsewhere to determine travel time and origin-destination trends.

The detectors were deployed for a 3-week period from September 13 through October 4, 2017. Table 10 shows the number of detections for each origin-destination pair of interest during that time period.

Table 10. Number of Bluetooth Detections for Origin-Destination Pairs from September 13, 2017 to October 4, 2017

	Destination:		
Origin:	**Glacier Highway/ Fred Meyer**	**Glacier Highway/ Nugget**	**Glacier Highway/ Sunny Point**
Glacier Highway/ Fred Meyer	-	2,251 (149)	2,916 (211)
Glacier Highway/ Nugget	2,277 (159)	-	-
Glacier Highway/ Sunny Point	3,328 (248)	-	-

Note: All Detections (PM Peak Hour Detections)

In addition to the Bluetooth detectors, radar detectors were also deployed on several roadways in the study area. These detectors collect volume and speed data for every vehicle that passes. One of the radar detectors was deployed on Glacier Highway/Lemon Road between the Glacier Highway/Fred Meyer Bluetooth detector and the Glacier Highway/Sunny Point Bluetooth detector from September 21 to September 29. Volume data from the radar detector was compared to the paired Bluetooth detections for this area to determine what percentage of the

actual traffic volumes are being discovered by the Bluetooth detectors. Approximately 4% of the traffic was sensed by the Bluetooth detectors. The sample size, while only being approximately 4% of the total traffic on the road was still a statistically-significant total number of readings to determine the routing between Bluetooth recording stations based on the sample data.

The Bluetooth data is used to compare the percentage of vehicles traveling between one O-D pair to the percentage traveling between one or more other O-D pairs. The standard error is calculated using the percentage of vehicles making each movement and the total number of vehicle pairs collected. The maximum standard error is experienced when the percentage using one O-D pair is 50%. Based on the four O-D pairs presented in Table 10, the standard error is less than 0.5% for data considering the entire data collection period and is less than 2% for data considering only data collected during the PM peak hour.

The Bluetooth O-D data and turning movement volumes taken at study area intersections were used to calculate how many vehicles would make a westbound left turn at the Fred Meyer intersection of Egan Drive (leaving the Fred Meyer and turning left to travel towards downtown on Egan Drive) if it were allowed.

Northbound traffic coming to Fred Meyer comes north on either Glacier Highway/Lemon Road or on Egan Drive. Comparing turning movements from 7 AM to 7 PM for Egan Drive northbound right turns and for Glacier Highway/Lemon Road northbound thru and left movements, 30% of the traffic comes from Egan Drive and 70% from Glacier Highway. If it is assumed that southbound traffic would make the same route choices if turning movements were not restricted, then 30% of the traffic headed southbound from the Fred Meyer area would travel directly to Egan Drive (make a westbound left turn) if it could. Table 11 shows the estimated westbound left-turn demand, rounded to the nearest 10, and the approximate range in possible values due to standard error. There is a relatively low demand for this movement.

Table 11. Estimated Westbound Left-Turn Demand from Fred Meyer Towards Downtown on Egan Drive using Bluetooth and Turning Movement Data

Peak Hour	Average Weekday Bluetooth Counts (Fred Meyer to Sunny Point)	Estimated Total Southbound Volume from Fred Meyer Area	Estimated Westbound Left-Turn Demand
7:30 - 8:30 AM	6.1 [5.6 to 6.5]	150 [140 to 160]	50 [40 to 50]
12:00 - 1:00 Midday (Noon)	9.5 [8.8 to 10.2]	240 [220 to 260]	70 [70 to 80]
4:30 - 5:30 PM	10.3 [9.6 to 11.1]	260 [240 to 280]	80 [70 to 80]

5.5 Pedestrian and Cyclist Counts

Manual traffic counts were performed within the study area in September and October 2017. Pedestrian and cyclist counts at five intersections were included in the traffic counts. Data were collected at each intersection for a minimum of 2-hour periods during peak vehicular traffic: 7:00 AM to 9:00 AM, 11:00 AM to 1:00 PM, and 4:00 PM to 6:00 PM or 5:00 PM to 7:00 PM. (The PM peak hour was counted at different times on different days.) The data collected indicates that the most pedestrian and cyclist traffic within the study area occurs at the signalized intersection of Glacier Highway/Nugget and Egan Drive, as well as at the unsignalized intersections of Glacier Highway/Nugget and Old Dairy Road/Trout Street and Glacier Highway/Lemon Spur and Glacier Highway/Lemon Road. Figure 24 shows how pedestrian volumes varied over the day at the Glacier Highway/Nugget intersection. The maximum hourly volume occurred from 11 AM to 12 noon for crossing Egan Drive (south approach). Figure 25 through Figure 27 depict the pedestrian and cyclist movements in the study area for peak vehicle volume hours.

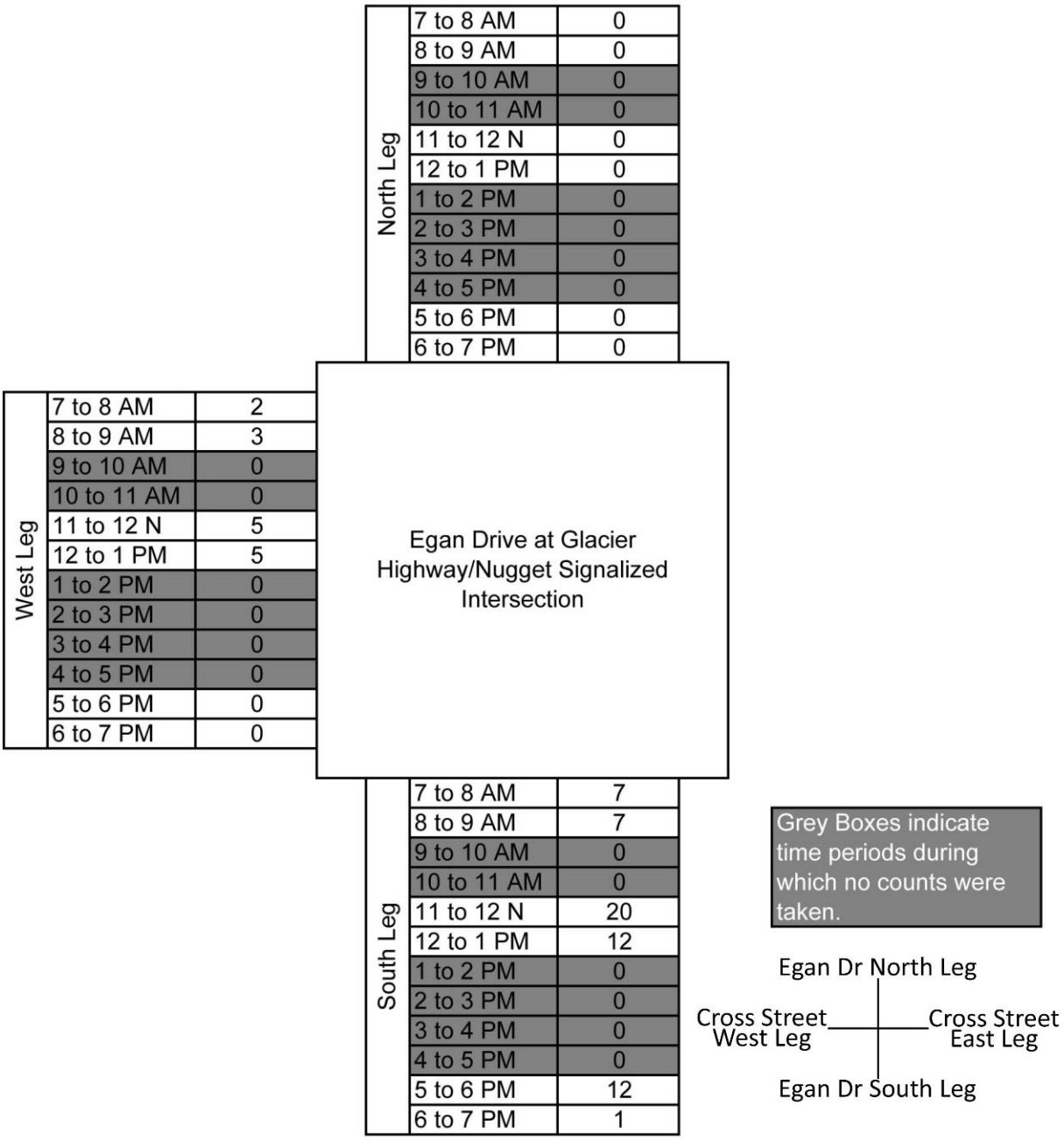


Figure 24. Pedestrian Crossing Volumes at Egan Drive intersection with Glacier Highway/Nugget (September 21 and October 4, 2017)

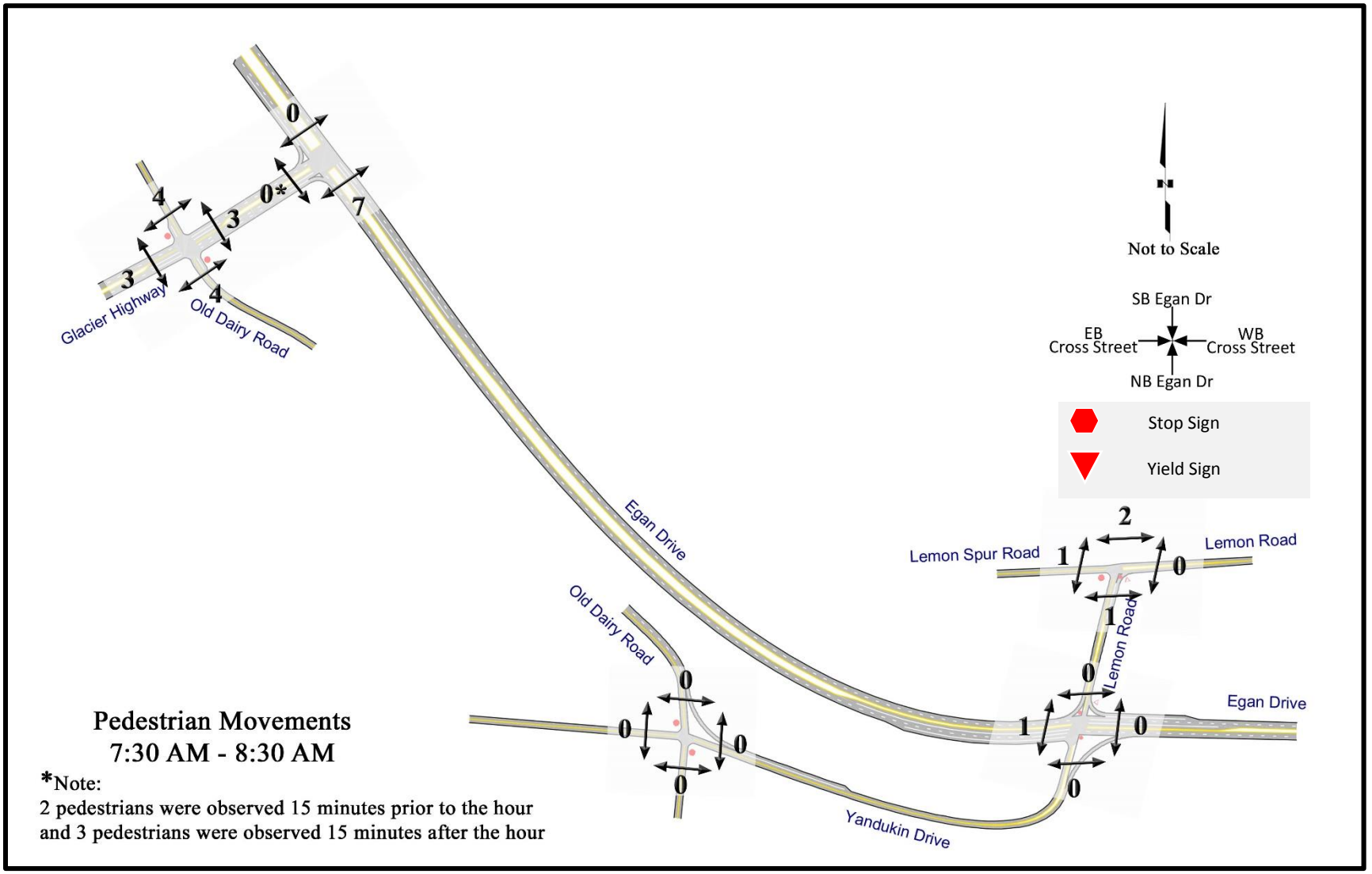


Figure 25. Pedestrian Movements, AM Peak Hour

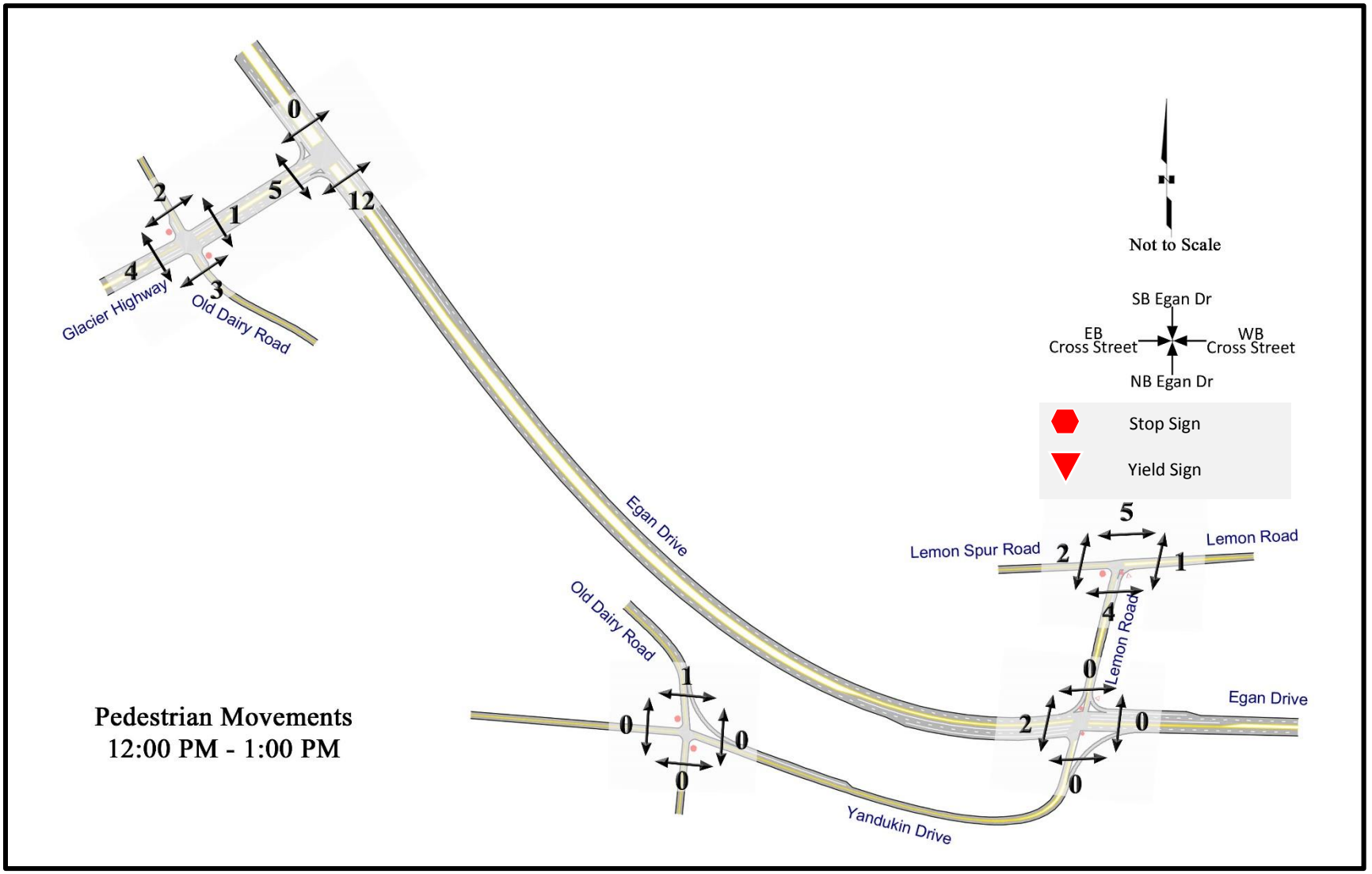


Figure 26. Pedestrian Movements, Midday Peak Hour

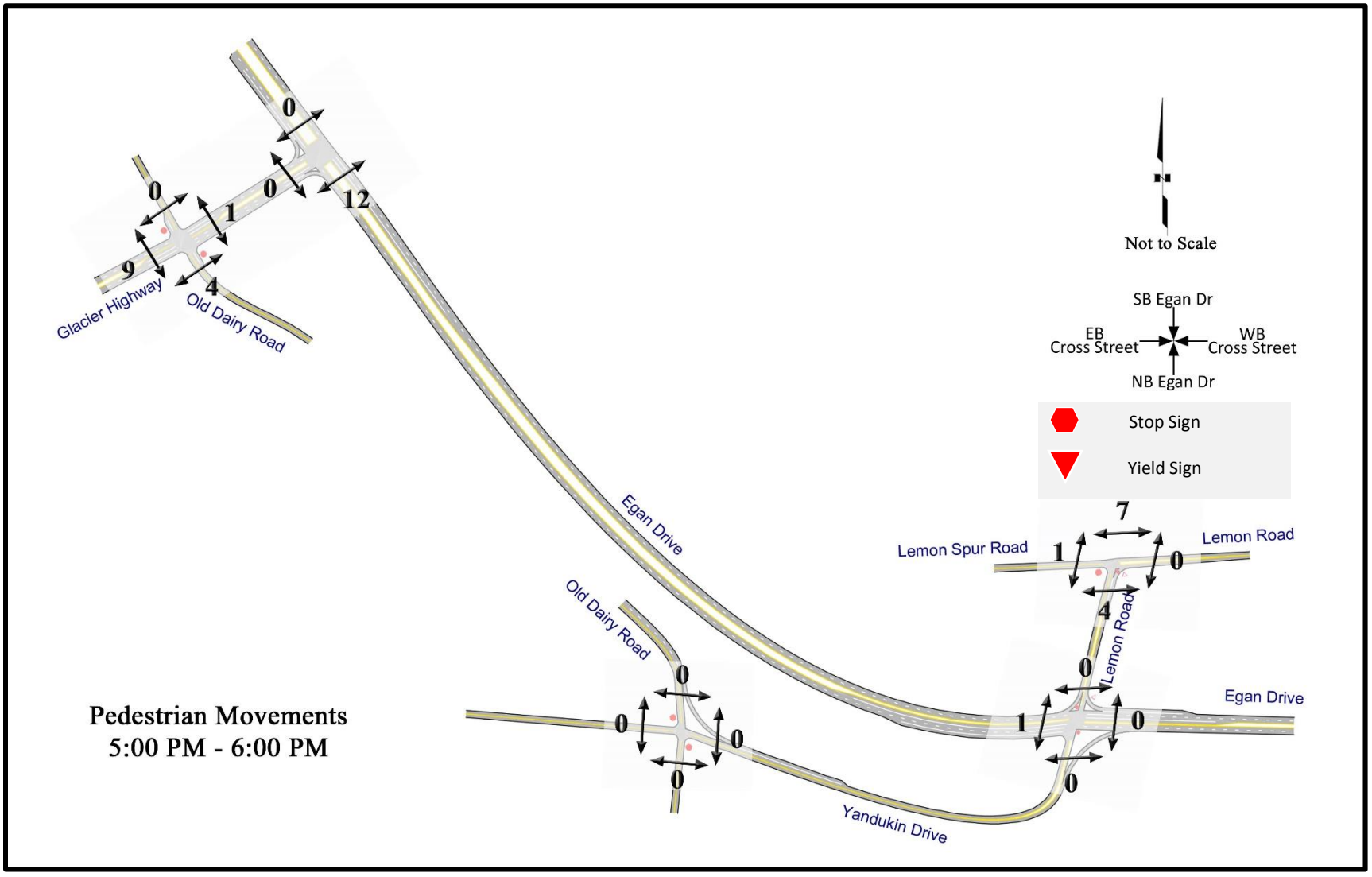


Figure 27. Pedestrian Movements, PM Peak Hour

5.6 Pedestrian and Cyclist Crossing Analyses

Pedestrian delay for intersections within the study area were determined using the HCM 2010 methodology.

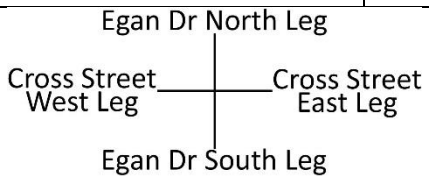
5.6.1 Delay for Pedestrian Crossings at Signalized Intersections

The HCM methodology to determine the delay for pedestrians crossing signalized intersections considers signal timing characteristics.

The only signalized intersection in the study area is the intersection of Egan Drive with Glacier Highway/Nugget. Table 12 summarizes the calculated delay at the intersection. The HCM 2010 states that "In general, pedestrians become impatient when they experience delays in excess of 30 s/p [seconds per pedestrian], and there is a high likelihood of their not complying with the signal indication" (Page 18-69). Thus, pedestrians are likely to feel impatient as they wait at the Nugget signal and may cross against the walk signal.

Table 12. Pedestrian Delay at Egan Drive & Glacier Highway/Nugget, Existing

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)
Midday	South Leg	40-60
	West Leg	40-60
PM	South Leg	40-60
	West Leg	40-60



5.6.2 Pedestrian Crossings at Unsignalized Intersections

The HCM 2010 methodology to determine LOS for pedestrians crossing at unsignalized intersections (two-way stop-controlled) is determined solely based on the length of delay a pedestrian is expected to experience at the crossing. Table 13, modified from HCM 2010, summarizes the relationship between pedestrian delay and the amount of risk a pedestrian is willing to take to cross a roadway after a given amount of delay.

Table 13. Pedestrian Delay at Unsignalized Intersections

Control Delay (sec/pedestrian)	**Comments**
0-5	Usually no conflicting traffic
5-10	Occasionally some delay due to conflicting traffic
10-20	Delay noticeable to pedestrians, but not inconveniencing
20-30	Delay noticeable and irritating, increased likelihood of risk taking
30-45	Delay approaches tolerance level, risk-taking behavior likely
>45	Delay exceeds tolerance level, high likelihood of pedestrian risk-taking

HCM 2010 describes the average time pedestrians must wait before crossing, or the average pedestrian gap delay, as a function of critical headway and vehicular flow rate. Critical headway is the minimum time needed between conflicting vehicles in order for a pedestrian to comfortably cross the street. When the gap between vehicles is below the critical headway, a pedestrian crossing opportunity is not available. Pedestrian delay is also affected by the rate at which vehicular traffic yields to pedestrians. For the analysis of unmarked crossings, the yield rate was assumed to be zero, meaning cars do not yield to pedestrians. Table 14 and Table 15 present pedestrian crossing delay for each analyzed unsignalized crossing location during the midday and PM peaks, respectively. Only the uncontrolled crossings are analyzed. For stop-controlled approaches, pedestrians are assumed to experience no delay, as all vehicles are required to yield to pedestrians at stop-controlled approaches.

Generally, pedestrians attempting to cross uncontrolled approaches at intersections in the study area experience significant delay. In many cases there are nearby controlled crossings that have significantly less delay; however, in some cases, the distance to the next available crossing is very far. For example, pedestrians wanting to cross Glacier Highway/Nugget at Old Dairy Road could travel about 300 feet to the Egan Drive signal for a controlled crossing. Similarly, pedestrians wanting to cross Glacier Highway/Lemon Road at Glacier Highway/Lemon Spur could cross the north leg, which is controlled by a stop sign. However, pedestrians wanting to cross Egan Drive at Yandukin Drive near the Fred Meyer would have to travel the longest distance to reach a controlled crossing (about ¾ mile from the Yandukin Drive intersection to the Glacier Highway/Nugget intersection).

Table 14. Pedestrian Delay at Unsignalized Intersections, Existing, Midday Peak Hour

Intersection	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
Glacier Highway & Old Dairy Road/Trout Street	South Leg	No Pedestrian Delay – Stop-Controlled	
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	29	High
	East Leg	>45	Very High
Yandukin Drive & Old Dairy Road/Livingston Way	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	16	Moderate
	East Leg	16	Moderate
Egan Drive & Yandukin Drive	South Leg	>45	Very High
	North Leg	>45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	
Glacier Hwy/Lemon Spur & Glacier Hwy/Lemon Road	South Leg	35	High
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	No Pedestrian Delay – Stop-Controlled	

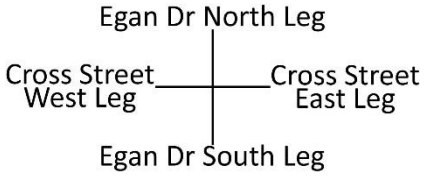
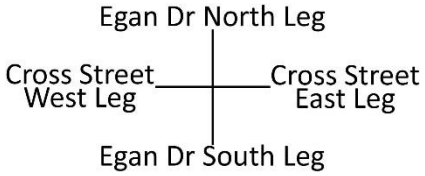


Table 15. Pedestrian Delay at Unsignalized Intersections, Existing, PM Peak Hour

Intersection	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
Glacier Highway & Old Dairy Road/Trout Street	South Leg	No Pedestrian Delay – Stop-Controlled	
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	41	High
	East Leg	>45	Very High
Yandukin Drive & Old Dairy Road/Livingston Way	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	9	Low-Moderate
	East Leg	9	Low-Moderate
Egan Drive & Yandukin Drive	South Leg	>45	Very High
	North Leg	>45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	
Glacier Hwy/Lemon Spur & Glacier Hwy/Lemon Road	South Leg	>45	Very High
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	No Pedestrian Delay – Stop-Controlled	



6 Future "No Build" Operations (Alternative Concept A)

6.1 Projected Traffic

6.1.1 Projected AADT

Southcoast Region DOT&PF has determined that the base annual traffic volume growth rate to be used for all projects in the region is 0.25%. Design year (2040) volumes were projected from the 2017 base year AADTs shown in Section 5.1 starting on page 29 using the 0.25% annual growth rate. Table 16 compares 2017 base year AADTs with projected 2040 design year AADTs, while Figure 28 shows the 2040 AADTs on a map.

Section Highlights

- Fairly minor increases in daily traffic volumes are forecasted (0.25% growth rate over 20 years).
- Movements that experience delay under the existing conditions will experience increased delay under forecasted volumes.
- Average intersection delay during the peak hour periods will remain at a level of service C in the 2040 at the signalized intersection of Egan Drive and Glacier Highway/Nugget
- The level of service of the northbound left-turn movements at Egan Drive and Yandukin Drive would be F in the AM peak and B in all other peaks. The southbound left-turn would be F in the PM peak and B in all other peaks.

Table 16. Average Annual Daily Traffic, 2017 and 2040

Segment Name	Extents	2017	2040
Egan Dr/Glacier Hwy	Bridge #2127NB and #2192SB to Yandukin Dr	27,000	29,000
Egan Dr/Glacier Hwy	Yandukin Dr to Glacier Hwy Nugget	29,000	31,000
Egan Dr/Glacier Hwy	Glacier Hwy Nugget to Mendenhall Loop Rd	27,000	29,000
Glacier Hwy/Lemon Rd	Egan Dr/Glacier Hwy to Glacier Hwy/Lemon Spur	9,300	9,600
Glacier Hwy/Lemon Rd	Glacier Hwy/Lemon Spur to DOT&PF Southeast Regional Office	6,300	6,500
Glacier Hwy/Lemon Spur	Glacier Hwy/Lemon Rd to Rd End	2,600	3,100
Yandukin Dr	Glacier Hwy/Lemon Rd to Yandukin Dr Wye	3,500	3,700
Yandukin Dr	Yandukin Dr Wye to Egan Dr	3,100	3,500
Yandukin Dr	Old Dairy Rd to Crest Avenue	3,200	3,400
Yandukin Dr Wye to Egan Dr	Yandukin Dr to Egan Dr/Glacier Hwy	2,500	2,600
Old Dairy Rd	Glacier Hwy/Nugget to Crest Avenue	5,400	5,600
Old Dairy Rd	Crest Avenue to Yandukin Dr	1,000	1,000
Trout Street	Glacier Hwy/Nugget to Jordan Ave	4,800	5,000
Glacier Hwy/Nugget	Egan Dr/Glacier Hwy to Jordan Avenue	13,100	13,500
Livingston Way	South of Yandukin Dr	-	900

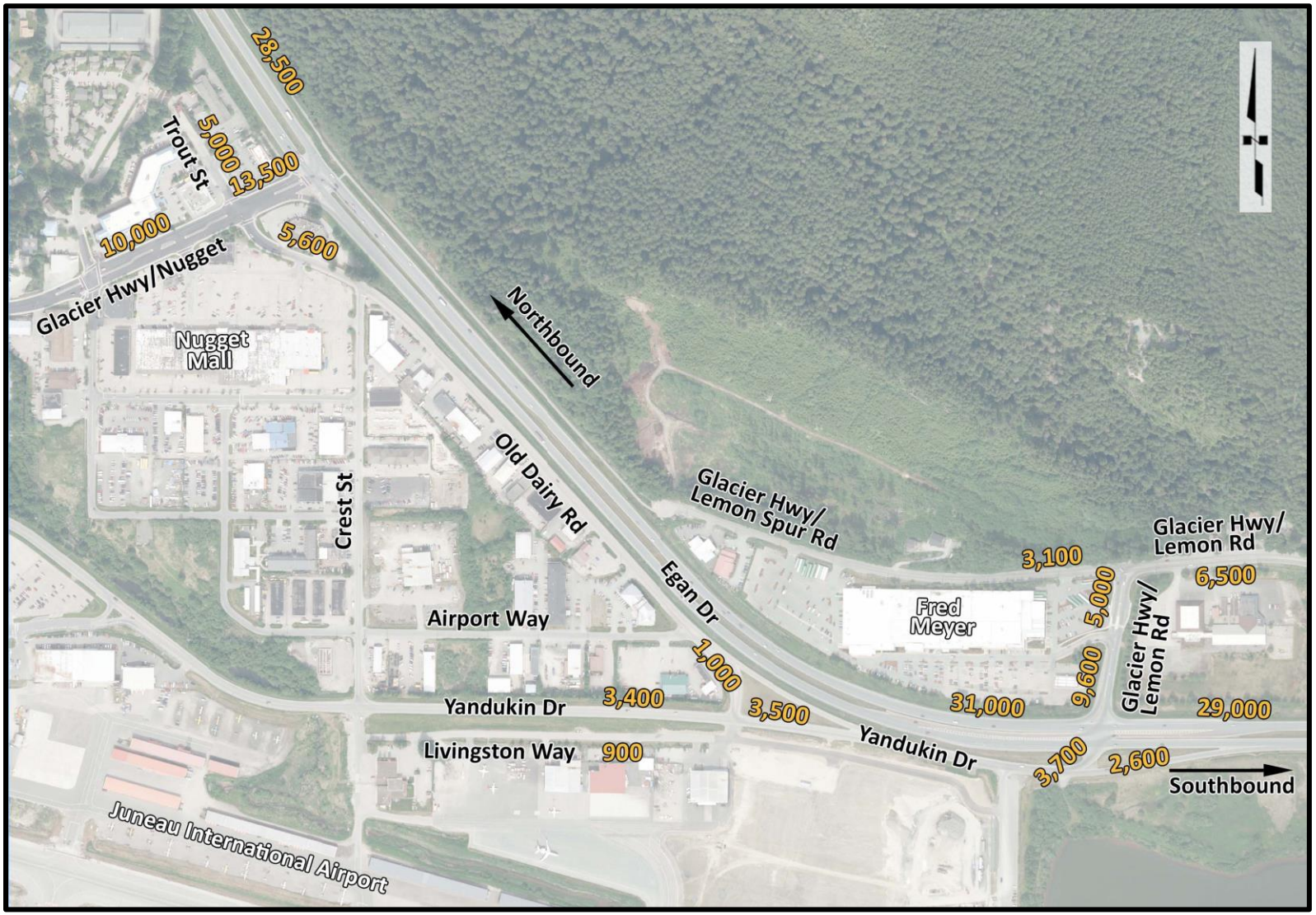


Figure 28. Average Annual Daily Traffic, 2040

6.1.2 2040 Turning Movement Volumes

Future intersection TMVs were calculated based on AADT projections for the approach roads, existing turning movement proportions, and estimated design hour volume (DHV) percentages. The PGDHS indicates that the 30th highest hour percentage for a given highway is generally a good estimate of the DHV. Therefore, the DHV percentage for the PM peak (12%) was taken from the 30th highest hour percentage for Egan Drive between the Fred Meyer and the Sunny Point interchange, as reported in the Southcoast Region *2013 Traffic and Safety Report* (the most recent available). DHVs for the morning peak period and the midday peak period were taken from the volume counts that were collected in fall 2017. Table 17 shows the DHV percentages that were used for each time period on Egan Drive. Slightly different DHVs were used as needed to balance the traffic volumes between intersections. Figure 29 through Figure 31 depict 2040 TMVs for peak hours.

Table 17. Design Hour Percentages, Egan Drive, 2040

Time Period	AM	Midday	PM
Design Hour Volume Percentage	9%	7%	12%

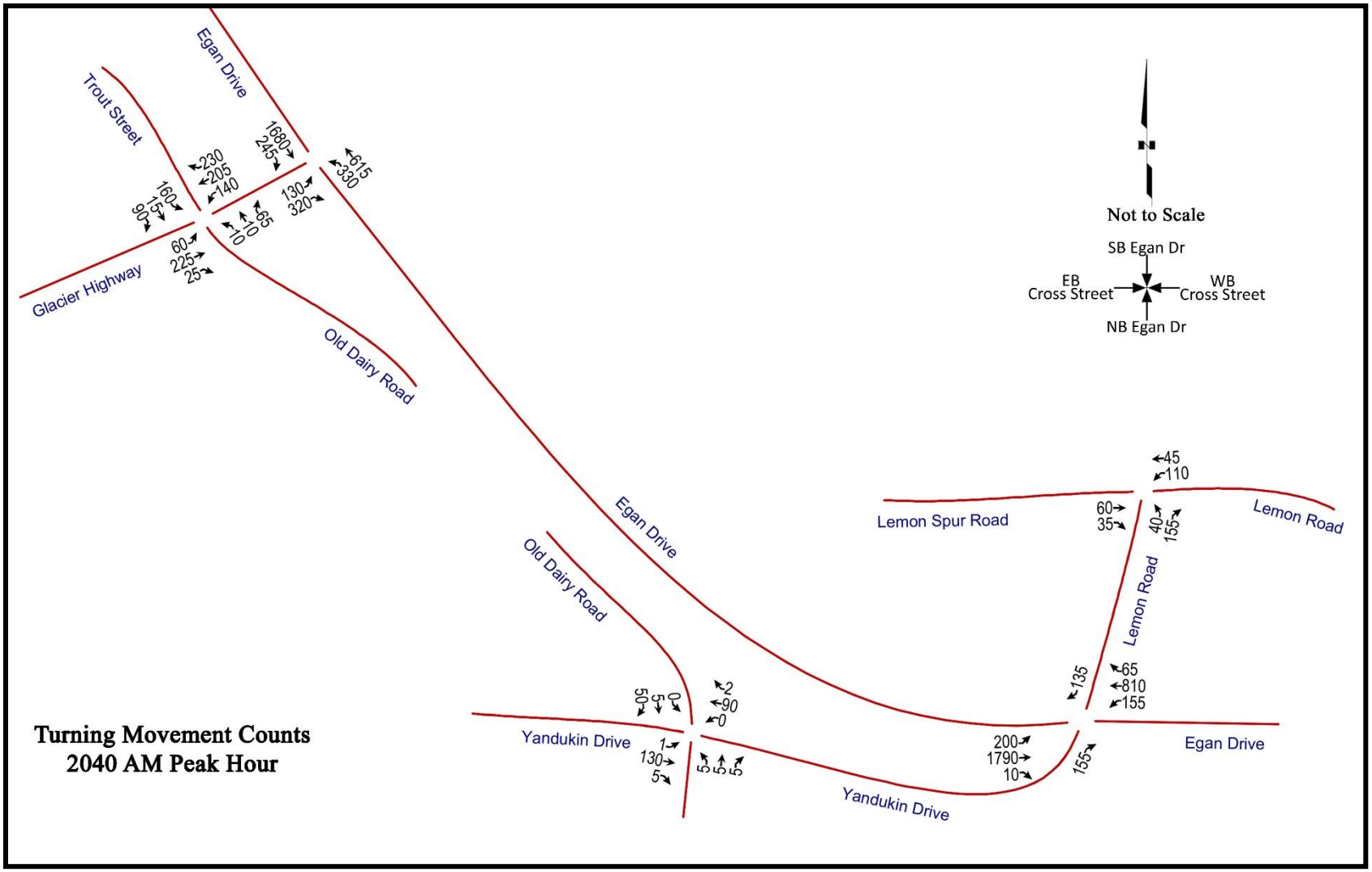


Figure 29. Turning Movement Volumes, 2040, AM Peak Hour

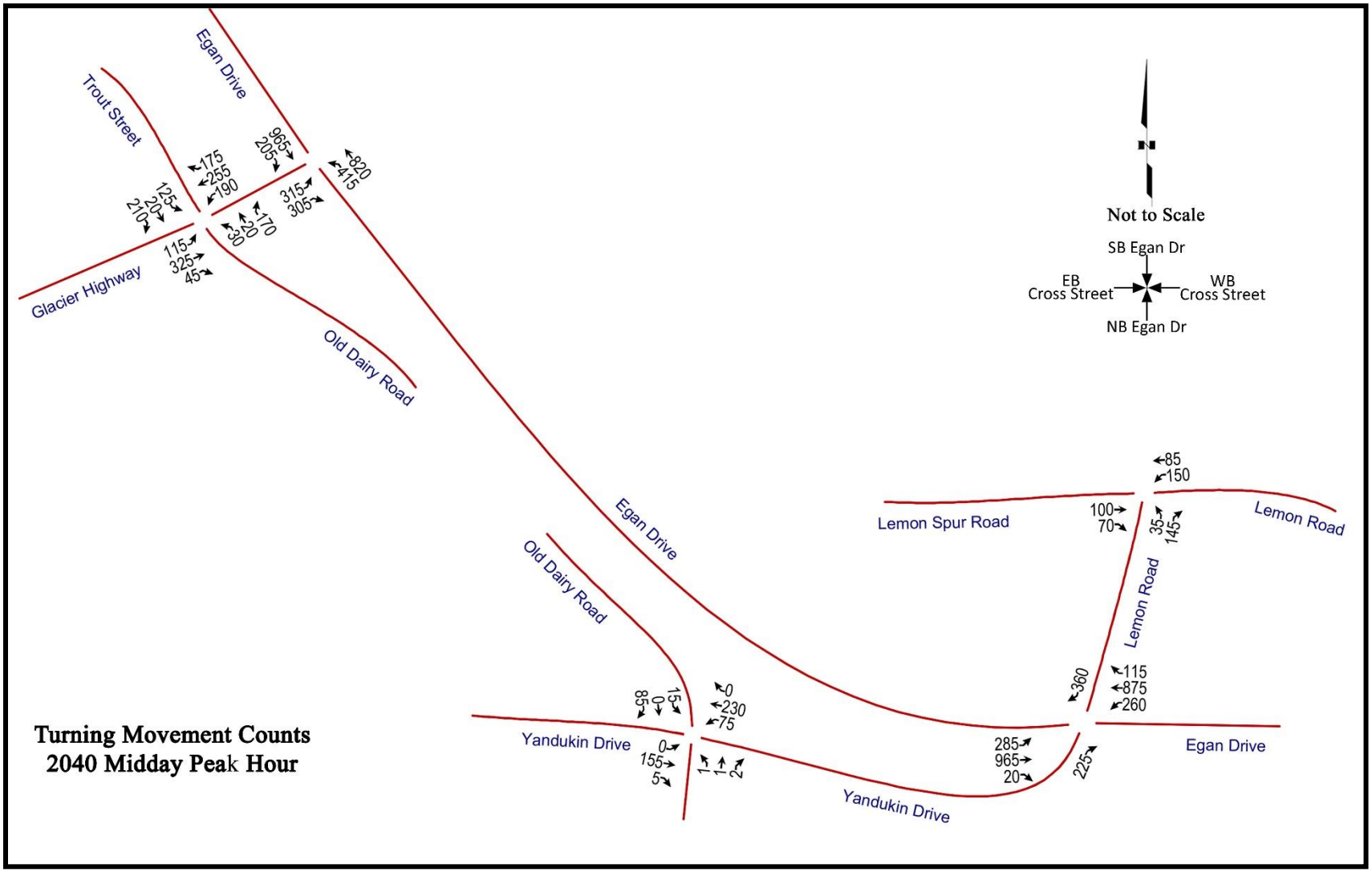


Figure 30. Turning Movement Volumes, 2040, Midday Peak Hour

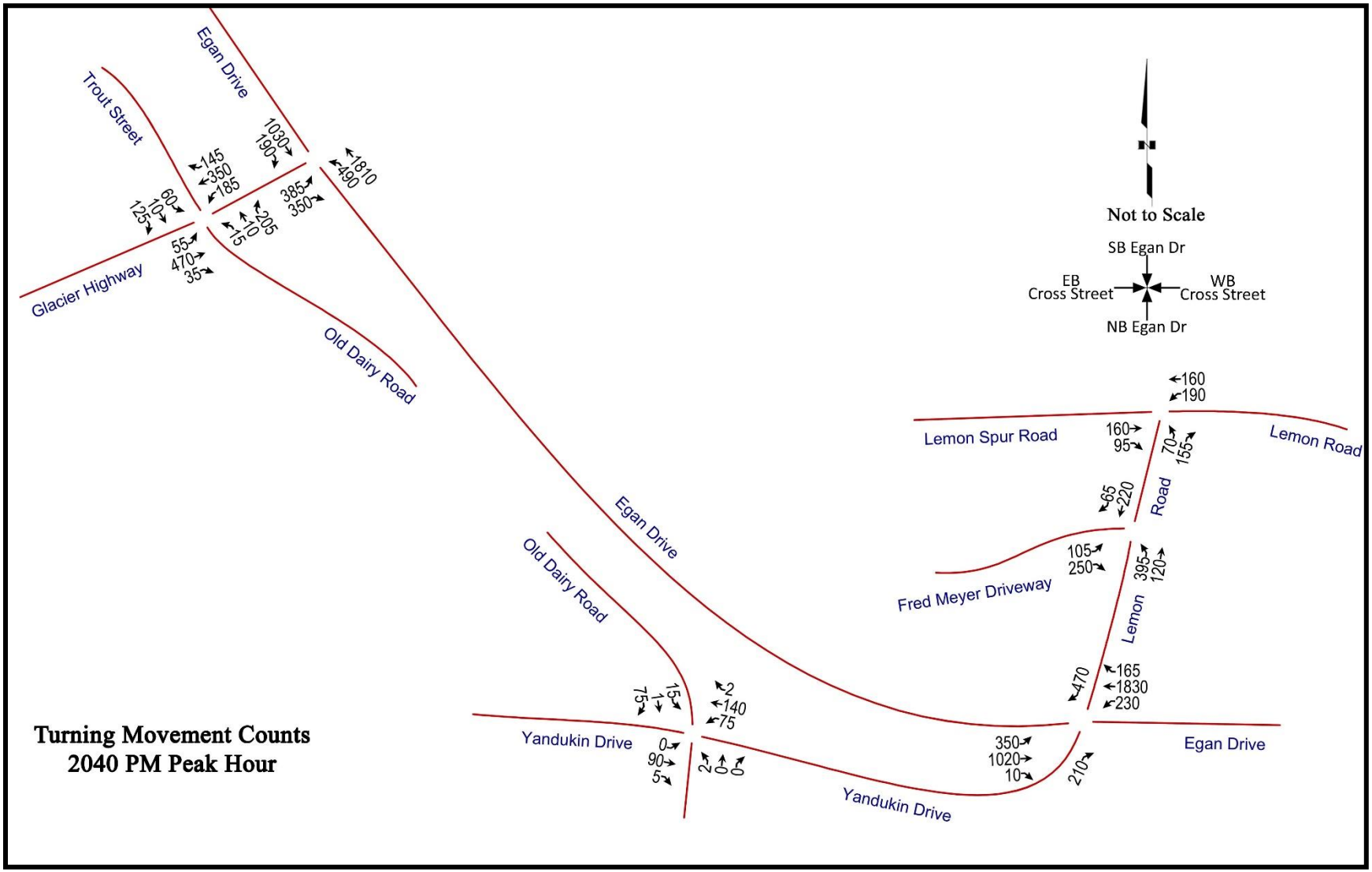


Figure 31. Turning Movement Volumes, 2040, PM Peak Hour

6.2 Intersection Operations

To determine the future intersection operations for critical peak hours under the no-build alternative (Alternative Concept A), the intersections of Glacier Highway/Nugget and Fred Meyer were analyzed using future volumes, with existing PHFs and HV%. The analysis was conducted using HCM methodologies in Synchro. Results are shown in Table 18 and Table 19.

The future intersection LOS is similar to existing LOS. The intersection LOS remains at LOS C and is still in the range that would be considered comfortable for average driver populations. The movements that were shown to experience uncomfortable delays under the existing condition are forecasted to experience more delay in 2040. Specifically, at the Glacier Highway/Nugget intersection during the morning peak period, the northbound left-turn vehicles (330 vehicles per hour) experience about 160 seconds of delay per vehicle (LOS F), with a volume-to-capacity ratio above 1.0, meaning that the demand for this movement is higher than the capacity of the intersection. The eastbound left-turn vehicles (130 vehicles per hour) continue to experience about 60 seconds of delay per vehicle (LOS E). At the Fred Meyer intersection, the northbound left turn (155 vehicles per hour) experiences an average delay of almost 60 seconds (LOS F) in the morning peak hour, and in the PM peak hour the southbound left turn (350 vehicles per hour) experiences an average delay of about 115 seconds (LOS F). The southbound left turns in the PM peak have a volume-to-capacity ratio above 1.0, meaning there is more demand in the PM peak hour than the intersection can serve, therefore the queues will grow throughout the hour and delay will be compounded as the demand remains at this level.

The tables also show the 95th percentile queue lengths for each movement, as calculated using the HCM deterministic method. While the southbound left-turn queues are shown to fit within the existing southbound left-turn lane length of 750 feet, the volume-to-capacity ratio is forecasted to be above 1.0 in the PM peak, so the queues will likely be much longer.

Operations for other intersections in the study area were also calculated. The intersection of the most interest is the intersection of Old Dairy Road at Glacier Highway/Nugget. This intersection currently has left turns prohibited from the side streets in the evening; however, turning movement counts show that vehicles are still turning left from the side streets during this time period. Additionally, this intersection has a higher than expected crash rate. Appendix E on page 177 shows the level of service at this intersection under 2040 volumes. The analysis shows that left turns from the side street will continue to experience significant delay in the PM peak and that this delay will extend to the AM and midday periods, as well.

Table 18. Intersection LOS at Egan Drive & Glacier Highway/Nugget, Alternative Concept A, 2040

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	57.3	-	0.0	**156.9**	2.2	-	-	26.1	0.0	**31.5**
LOS	E	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.7	-	-	**1.2**	0.3	-	-	0.9	-	-
Queue Length (ft)	100	-	-	525	125	-	-	1025	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	43.5	-	0.0	48.5	4.5	-	-	27.3	0.0	**21.1**
LOS	D	-	Free	D	A	-	-	C	Free	**C**
v/c Ratio	0.8	-	-	0.9	0.4	-	-	0.7	-	-
Queue Length (ft)	150	-	-	350	175	-	-	625	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	46.0	-	0.0	54.3	10.8	-	-	41.3	0.0	**25.0**
LOS	D	-	Free	D	B	-	-	D	Free	**C**
v/c Ratio	0.86	-	-	0.95	0.78	-	-	0.91	-	-
Queue Length (ft)	200	-	-	475	600	-	-	650	-	-

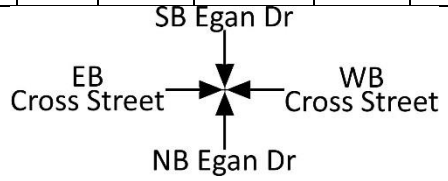


Table 19. Intersection LOS at Egan Drive & Yandukin Drive at Fred Meyer, Alternative Concept A, 2040

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**		
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*
Delay (sec/veh)	-	-	0.0	-	-	0.0	**57**	-	-	12	-	-
LOS	-	-	Free	-	-	Free	**F**	-	-	B	-	-
v/c Ratio	-	-	-	-	-	-	0.75	-	-	0.30	-	-
Queue Length (ft)	-	-	-	-	-	-	125	-	-		-	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**		
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*
Delay (sec/veh)	-	-	0.0	-	-	0.0	14	-	-	13	-	-
LOS	-	-	Free	-	-	Free	B	-	-	B	-	-
v/c Ratio	-	-	-	-	-	-	0.40	-	-	0.40	-	-
Queue Length (ft)	-	-	-	-	-	-	50	-	-	50	-	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**		
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*
Delay (sec/veh)	-	-	0.0	-	-	0.0	13	-	-	**114**	-	-
LOS	-	-	Free	-	-	Free	B	-	-	**F**	-	-
v/c Ratio	-	-	-	-	-	-	0.35	-	-	**1.10**	-	-
Queue Length (ft)	-	-	-	-	-	-	50	-	-	350	-	-

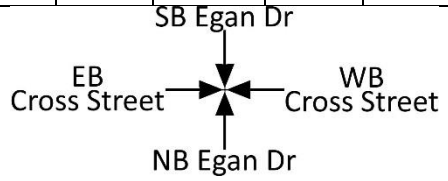
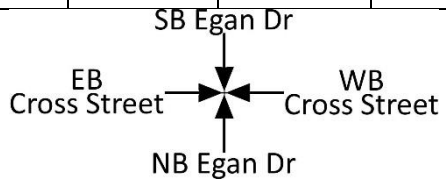


Table 20 shows the ramp LOS analysis for the right turn movements at the two intersections that operate like on-ramps to a highway. LOS for these movements remains LOS C or better at all times of the day.

Table 20. 2040 On-Ramp LOS

Intersection	**Ramp**	**Ramp Free Flow Speed** (mph)	**Merge Length** (feet)	**AM LOS**	**Midday LOS**	**PM LOS**
Egan Dr & Glacier Hwy/Nugget	Southbound	30	780	B	B	B
Egan Dr & Yandukin Dr	Southbound	40	720	B	B	B
	Northbound	45	680	A	B	C
		25	200	B	B	C



6.3 Future Pedestrian Crossing Analysis

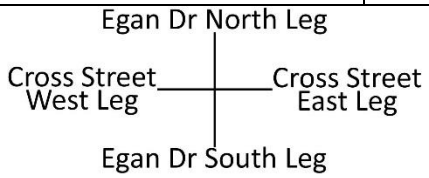
Future pedestrian delay for intersections within the study area was estimated using the HCM 2010 methodology. Pedestrian volumes were observed, but forecasted pedestrian volumes were not calculated. Note that pedestrian volumes do not change the LOS of a pedestrian crossing using this methodology. Pedestrian crossings outside of dense urban areas are based on available gaps and exposure time while crossing which results in a delay that would be experienced regardless of the number of pedestrians desiring to cross.

6.3.1 Delay for Pedestrian Crossings at Signalized Intersections

Table 21 summarizes the calculated delay at the intersection of Egan Drive and Glacier Highway/Nugget. Similar to existing conditions, pedestrians may feel impatient as they wait for the signal to change and may cross against the pedestrian signal.

Table 21. Future Pedestrian Delay - Egan Drive & Glacier Highway/Nugget

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)
Midday	South Leg	40-60
	West Leg	40-60
PM	South Leg	40-60
	West Leg	40-60



6.3.2 Pedestrian Crossings at Unsignalized Intersections

Table 22 and Table 23 present pedestrian crossing delay for each analyzed unsignalized crossing location at the 2040 Midday and PM peaks, respectively. Only the uncontrolled crossings are analyzed. For stop-controlled approaches, pedestrians are assumed to experience no delay, as all vehicles are required to yield to pedestrians at stop-controlled approaches.

Table 22. 2040 Pedestrian Delay for Unsignalized Intersections – Midday Peak Hour

Intersection	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
Glacier Highway & Old Dairy Road/Trout Street	South Leg	No Pedestrian Delay – Stop-Controlled	
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	38	High
	East Leg	>45	Very High
Yandukin Drive & Old Dairy Road/Livingston Way	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	18	Moderate
	East Leg	18	Moderate
Egan Drive & Yandukin Drive	South Leg	>45	Very High
	North Leg	>45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	
Glacier Hwy/Lemon Spur & Glacier Hwy/Lemon Road	South Leg	39	High
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	No Pedestrian Delay – Stop-Controlled	

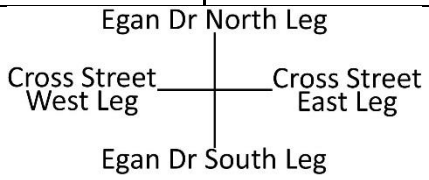
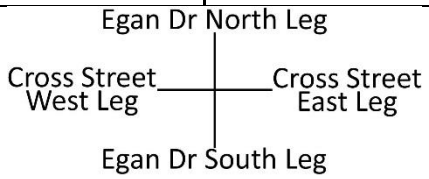


Table 23. 2040 Pedestrian Delay at Unsignalized Intersections – PM Peak Hour

Intersection	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
Glacier Highway & Old Dairy Road/Trout Street	South Leg	No Pedestrian Delay – Stop-Controlled	
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	>45	Very High
	East Leg	>45	Very High
Yandukin Drive & Old Dairy Road/Livingston Way	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	9	Low-Moderate
	East Leg	10	Low-Moderate
Egan Drive & Yandukin Drive	South Leg	>45	Very High
	North Leg	>45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	
Glacier Hwy/Lemon Spur & Glacier Hwy/Lemon Road	South Leg	>45	Very High
	North Leg	No Pedestrian Delay – Stop-Controlled	
	West Leg	No Pedestrian Delay – Stop-Controlled	



7 Alternative Concepts Analysis

7.1 Summary of Concerns

The study of crashes and intersection capacity has identified two main concerns for the Fred Meyer intersection on Egan Drive:

- Left-turning vehicles have difficulty judging gaps in oncoming traffic, resulting in injury crashes. The high speed of oncoming vehicles (85^{th} percentile speeds of around 60 mph) within 3 oncoming lanes contributes to this condition, as does wet, icy, or snowy roads and high traffic volumes.
- There is no marked crosswalk at the intersection of Egan Drive at the Fred Meyer intersection. Pedestrians experience delay greater than 30 seconds per pedestrian crossing Egan Drive at this location.

Some additional concerns have been raised by the public:

- There are no parallel routes to by-pass the Fred Meyer intersection at Egan Drive and Yandukin Drive. When accidents occur at the intersection, the highway shuts down.
- Some drivers have difficulty recognizing the traffic control for the northbound right turn from Egan Drive towards the Fred Meyer. Because the right turn is channelized, the right turns have a yield sign and those drivers should yield to southbound left-turning traffic; however, not all drivers are aware of this and there are sometimes conflicts.
- Some commenters feel that vehicles slow too much before entering the turn lanes, causing delay on Egan Drive.
- Some commenters would like to be able to turn left onto Egan Drive from the side streets, while others are not bothered by being forced to take indirect routes.

Three methods of eliminating or reducing the severity of the left-turn crashes were presented at the Open House in December 2017 and on the project website:

- **Control left-turn movements with a signal.** Install a traffic signal so that left-turn movements are only made during a protected left-turn signal when oncoming traffic is stopped by a red signal.
- **Eliminate left-turn movements.** No longer allow left turns from Egan Drive towards either the Fred Meyer or towards the airport. Drivers would have to take another route to reach their destination. Connecting Lemon Spur through to the Nugget intersection could aid in reducing out-of-direction travel.
- **Provide physical separation of the left-turn and through movements.** This would involve building an overpass to grade separate conflicting movements.

Some additional options suggested by the public include:

- Control movements with a roundabout.
- Extend Lemon Spur all the way to Mendenhall Loop Road to provide a better parallel route to Egan Drive.
- Build a signal at the Fred Meyer intersection and also extend Lemon Spur to the Nugget intersection.
- Prohibit left turns only at certain times of the day.
- Increase visibility of yield sign for northbound right turn vehicles.
- Increase police enforcement of speed limits.
- Install signs to remind drivers to turn on their headlights and enforce the use of headlights.

7.2 Alternative Concepts

After the Open House and with consultation with DOT&PF, Kinney Engineering refined the three alternative concepts that were carried forward for more detailed analysis, design, and cost-benefit comparison. These three alternative concepts are:

1) Signalized intersection at Egan Drive and Yandukin Drive that would allow all movements.
2) Extension of Lemon Spur to form a 4-leg intersection at the existing intersection of Egan Drive and Glacier Highway/Nugget. (This concept has two variations: 1. With a one-way Lemon Spur connection, and 2. With a two-way Lemon Spur connection).
3) Separated grade overpass of Egan Drive over Yandukin Drive with intersection treatments at the ramp terminals.

7.3 Analysis Methods

The alternative concepts were each analyzed using Synchro and HCM 2010 methodology to develop a design for each concept that can adequately achieve the LOS design standards for the project, which are LOS D for average total delay at the Egan Drive/Yandukin Drive intersection and the Egan Drive/Glacier Highway/Nugget intersection in the various 2040 design year periods.

After a design for each concept was established, each concept was analyzed using multiple methods to determine the approximate cost or benefit. This analysis applied a monetary value to the delay and safety over the 20-year design period. The monetary cost or benefit was added to the estimated construction costs to determine the final net present worth of each alternative concept which can then be compared to assist in the decision-making process.

7.3.1 Traffic Volume Distributions

The forecasted 2040 TMVs were redistributed to recognize new movements that would be available under each alternative concept. New movements include eastbound and westbound left and through movements at Yandukin Drive. Currently, vehicles that desire to cross Egan Drive at Yandukin Drive either travel north to the Glacier Highway/Nugget signal or south to the Sunny Point/Switzer interchange. Drivers that desire an eastbound left turn from Yandukin Drive travel to the Glacier Highway/Nugget signal, while drivers that desire a westbound left turn from the Fred Meyer use the Sunny Point/Switzer interchange. Allowing these movements at the intersection of Egan Drive at Yandukin Drive would eliminate some out-of-direction travel, removing some traffic from the current routes.

Existing turning movement volume proportions and the collected Bluetooth data (see Section 5.4 on page 41) were used to estimate this shift in traffic in the AM, midday, and PM peak hours. The redistribution assumed that some movements were represented in the Bluetooth data, other movements were represented in the turning movement counts, and that no new traffic will be entering the study area, meaning the volume shifts would only occur with volumes shown in the 2040 TMV maps attached in Appendix C starting on page 148. It was assumed that drivers prefer to take the shorter route to their destination.

7.3.2 Intersection Functional Area

The functional area of an intersection represents the area upstream and downstream of the physical intersection where the traffic control of the intersection adds to the cognitive load of drivers, increasing the number of things drivers have to think about and actions the driver has to take or be ready to take. The mixture of these maneuvers within the traffic flow creates conflicts which may increase crash potential and decrease operational efficiency. It is desirable to limit access within the functional area of the intersection so that drivers can focus on safely maneuvering through the intersection before new conflicts are encountered.

The functional area of the intersection is defined in parts. The upstream functional area encompasses the turn-lane queue and storage lengths, the distance vehicles need to make decisions and movements before reaching the physical intersection (such as changing lanes and decelerating), and perception and reaction distance. The 95th percentile queue lengths were used as the queue and storage distance. The deceleration and maneuvering distance is the distance required to decelerate from the free flow travel speed to a full stop. A perception-reaction time of 1.5 seconds was used to calculate the perception-reaction distance.

The downstream functional area includes the distance it takes to recover from the conditions of the intersection. The downstream length was determined by taking the maximum distance among three distances: stopping sight distance, acceleration distance, and corner clearance distance. The stopping sight distance is the distance it would take for vehicles to come to a full stop from travel

speeds. The acceleration distance is the distance needed to accelerate back to travel speed. The corner clearance is the minimum distance from the nearest face of curb of a public roadway intersection to the nearest edge of the driveway. Corner clearance distances were taken from the Alaska Highway Preconstruction Manual, which is based on speed and hourly traffic volumes.

The existing functional area of the Egan Drive intersection at Yandukin Drive does not reach the Fred Meyer driveway off of Glacier Highway/Lemon Road, indicating that there is currently adequate space between the driveway and the intersection so that vehicles using the driveway do not create additional conflicts for the vehicles going through the Yandukin Drive intersection.

The intersection of Glacier Highway/Nugget with Old Dairy Road/Trout Street is within the functional area of the Glacier Highway/Nugget signal on Egan Drive. This means that currently there is inadequate space between the two intersections to allow vehicles adjusting speed or changing lanes to interact with vehicles entering or exiting Old Dairy Road/Trout Street separately.

7.3.3 Delay Forecast and Value Calculations

The value of time for a vehicle user was calculated with the methodology presented in the United States Department of Transportation (USDOT) publication *The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations, Revision 2*. This report describes how to calculate the value of time for personal and business travel. The value of time is found by dividing the median household income by 2080 work hours a year and then multiplying by the average vehicle occupancy rate. The value is then multiplied by 50% to estimate the value of personal travel and by 100% to estimate the value of business travel.

The median 2016 household income for the CBJ is $87,436, given by the United States Census in inflated 2010 dollars. As vehicle occupancy rates could not be found for Juneau, the average vehicle occupancy rate of 1.1 was taken from the Municipality of Anchorage *Congestion Management Process Update & Status of the System* report (2016). Using these values, the value of time in Juneau is $23.12 per vehicle hour for personal travel and $46.24 per vehicle hour for business travel. Per USDOT guidance, these values are weighted at 95.4% personal travel and 4.6% business travel. The weighted average value of time of $24.18 per vehicle hour was used to calculate the value of delay.

To find the total value of delay for each alternative concept as compared to the no-build alternative concept, 24-hour weekday delays were calculated for the Egan Drive intersections at Glacier Highway/Nugget and at Yandukin Drive for the 2020 construction year through the 2040 design year. These were brought to yearly delays by multiplying by 260 (the number of weekdays per year). The yearly cost of delay was calculated by multiplying the yearly delay by the value of time. The total value of delay over the 20-year design life for each alternative

concept was calculated by summing the present value of the delay over the 20-year period using a 3% discount rate (per DOT&PF).

The value of the delay benefit for each alternative concept is the difference in the value of delay from 2020 to 2040 compared to the no-build alternative concept. Under the existing condition, only left-turn vehicles from Egan Drive experience delay at the Yandukin Drive intersection. Vehicles experience more delay at the signalized Glacier Highway/Nugget intersection. The design life value of delay for the no-build condition (combined value for both intersections) is approximately $30,330,000.

7.3.4 Crash Prediction and Value Calculations

The expected number of crashes for the design life of the project (2020 to 2040) was calculated using Method 4 in the *Highway Safety Manual* (HSM), *section 7.4.1 Estimating Change in Crashes for a Proposed Project*. Method 4 was chosen because there are no safety performance functions (SPFs) that pertain to the Egan Drive/Yandukin Drive intersection because of its unusual control type (left-in-right-in-right-out with right-turn merge lanes). In addition, the SPFs in the HSM have not been calibrated for Juneau. Method 4 involves using the observed crash frequency at the existing intersections and estimating the crash frequency under different alternative concepts by applying a crash modification factor (CMF). A CMF is a value that indicates how crashes are expected to change after the proposed modification to the intersection. It is the ratio between the number of crashes expected after a modification to the number of crashes expected without any modifications. This value can also be expressed as a crash reduction factor (CRF), which is the percentage of existing crashes that are expected to be eliminated if a modification is made. To account for the uncertainty in the CMFs, a confidence interval is calculated around the expected crash frequency estimate using the standard error for each CMF, if a standard error is available.

CMFs may apply to all crashes at an intersection, to specific crash types, or to crashes of specific severities. For the no-build case, crash type and severity distributions for the existing condition (2005 to 2014) were assumed to continue through the project design life (2020 to 2040). For the build alternative concepts, the crash types and severities were estimated by applying CMFs to the no-build values.

A dollar value is assigned to each crash according to the severity of the crash, using the value of statistical life (VSL) published yearly by DOT&PF. DOT&PF also provides a low and high value of VSL, to be used in a sensitivity analysis of crash costs, and a discount rate, to be used to bring future values back to net present value.

The DOT&PF crash values by severity use the FHWA 5-level KABCO severity index; however, DOT&PF crashes are assigned only 4 levels of severity. The DOT&PF Highway Safety

Improvement Program (HSIP) Handbook was used to determine the methodology of converting the values for the 5-level KABCO severity to values for the 4-level Alaska severity, as shown in Table 24.

Table 24. Crash Values by Severity for Crash Benefit Calculation

5-Level KABCO Severity	2019 FHWA Value per Crash	4-Level Alaska Severity	2019 Alaska Equivalent Value per Crash
K – Fatal	$10,300,000	Fatal	$ 10,300,000
A – Incapacitating Injury	$ 710,000	Major Injury	$ 713,000
B – Non-incapacitating Injury	$ 140,000	Minor Injury	$ 109,000
C – Possible Injury	$ 75,000		
O – Property Damage Only	$ 7,900	Property Damage Only	$ 7,920

The total dollar value of expected crashes for each alternative concept was calculated for the period from 2020 (assumed build year) to 2040 (project design life year). These values were combined and brought back to net present value (NPV) using the published DOT&PF discount factor of 3%.

The crash severity experience at Egan Drive intersections in the study area was compared to the crash severity experience for similar high-speed expressway unsignalized and signalized intersections throughout the state. Overall, the crash history indicated lower severities and costs than what is expected. It is anticipated that over time the severity of crashes will rise to coincide with the population levels. A factor of 1.4 would normalize this intersection with the severity that we observed statewide. Based on this analysis, a factor of 1.4 was applied to the calculated crash costs for each scenario, to account for the likelihood of a fatal crash.

Table 25 shows the resulting value of crashes for the no-build condition. Because all of the alternative concepts affect both the Yandukin Drive intersection and the Glacier Highway/Nugget intersection, values are calculated for both intersections.

Table 25. Expected Net Present Value of Crashes, Alternative Concept A – No Build, 2020 to 2040

Intersection	Expected Number of Crashes, 2020 to 2040	Net Present Value Cost of Crashes, 2020 to 2040
Yandukin Dr	176	$ 17,736,600
Glacier Hwy-Nugget	243	$ 12,038,600
TOTAL	**419**	**$ 29,775,200**

7.3.5 Construction and Maintenance Cost Assumptions

Construction cost estimates were developed using planning-level designs with current construction cost data (i.e., not adjusted for future construction years). The construction costs include contingency (20%), construction engineering (20%), and ICAP (4.66%). Design costs are estimated at 10% of the total construction costs.

The right of way impacts are also based on planning-level designs and right of way data from the CBJ GIS. Cost information is based on CBJ GIS data, multiplied by two to account for overhead costs and a contingency amount (for uncertainty). Land needed from the airport or the United States Forest Service was assumed to have no cost, although there will likely be significant effort involved in obtaining approvals for the land transfers. The right-of-way impacts do not include temporary construction permits/easements that may be required.

Maintenance and operation costs are estimated based on rates found in the HSIP handbook. Costs are calculated based on new construction that is required.

The total No Build delay NPV is estimated at $30,3300,000 and the No-Build crash NPVs are estimated at $24,200,400. The delay cost and crash NPVs of each alternative concept will be compared to these values.

7.4 Alternative Concept B – Signalized Yandukin Drive Intersection at Fred Meyer

7.4.1 Alternative Concept

Alternative Concept B would install a traffic signal at the existing Egan Drive and Yandukin Drive intersection. The intersection would be rebuilt to allow full through and left-turn movements from the side streets with protected left-turn movements off Egan Drive. The existing channelized right-turn movements would remain as they are currently designed.

The signal at Egan Drive and Glacier Highway/Nugget would not physically be changed for this alternative concept; however, the number of vehicles traveling through this intersection would be reduced slightly because crossing movements would be allowed at Yandukin Drive. The design goal for both intersections is an average overall LOS D throughout the day.

This design would provide a protected pedestrian crossing of Egan Drive at Yandukin Drive. However, a signal at Yandukin Drive would not provide an additional parallel secondary route.

Section Highlights

- The proposed signalized intersection at Egan Drive and Yandukin Drive/ Fred Meyer would allow all through and left-turn movements at the intersection.
- A third northbound through lane would be added that extends to Mendenhall Loop Road.
- Average intersection delay would be unsatisfactory in the AM peak hour when pedestrians are present crossing Egan Drive. Otherwise, performance would be LOS D or better.
- The Fred Meyer driveway at Glacier Highway/Lemon Road would be closed to southbound left-turn movements exiting Fred Meyer.
- The project would cost approximately $19M, with a $6M benefit in reduced crashes compared to the No Build alternative. The cost in increased delay would be about $47M due to the delay added to the through movements which are currently free flowing

7.4.2 Signal Warrants

Per the Manual on Uniform Traffic Control Devices (MUTCD), an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics are needed to determine whether installation of a signal at the intersection is justified.

The MUTCD signal warrant analysis uses existing and future traffic conditions at the intersection and compares them with the historical performance for similar intersections in the state to determine whether the location is a favorable candidate for a traffic signal. The warrants include:

- Warrant 1 – 8-Hour Vehicular Volume
- Warrant 2 – 4-Hour Vehicular Volume
- Warrant 3 – Peak Hour Volume
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience
- Warrant 8 – Roadway Network
- Warrant 9 – Intersection Near a Grade Crossing

A signal should be considered only if one or more of the warrants are satisfied. However, satisfying a warrant does not necessarily mean that a signal should be installed. Other factors should be examined as part of an engineering study to determine if a signal will improve the overall safety and/or operation of the intersection. The MUTCD recommends that other treatments or strategies be evaluated and, if feasible, be deployed before signalization.

Because the only vehicles that experience delay at the Yandukin Drive intersection are left-turning vehicles, the left-turn volumes were treated as the minor road volumes and the opposing Egan Drive traffic volumes as the major road volumes for comparison to the warrant thresholds. The MUTCD states that this methodology can be used at intersections where there is a high volume of left-turning vehicles on the major road.

Table 26 presents the signal warrant analysis. The intersection meets the requirements for 3 signal warrants: Warrant 1 (8-hour vehicular volume, all conditions), Warrant 2 (4-hour vehicular volume), and warrant 7 (crash experience).

Table 26: Signal Warrant Analysis for the Fred Meyer Intersection of Egan Drive at Yandukin Drive

MUTCD Warrant	Criteria	Criteria Met?
Warrant 1 8-Hour Vehicular Volume, Condition A *Large volume of intersecting traffic*	Meets minimum threshold volumes for 8 hours of the day	**Yes.** Meets minimum threshold volumes for 12 hours of the day.
Warrant 1 8-Hour Vehicular Volume, Condition B *Very heavy major road through volumes*	Meets minimum threshold volumes for 8 hours of the day	**Yes.** Meets minimum threshold volumes for 8 hours of the day.
Warrant 1 8-Hour Vehicular Volume, Combination of Condition A and B	Meets minimum threshold volumes for 8 hours of the day	**Yes.** Meets minimum threshold volumes for 10 hours of the day.
Warrant 2 4-Hour Vehicular Volume	Meets minimum threshold volumes for 4 hours of the day	**Yes.** Meets minimum threshold volumes for 11 hours of the day.
Warrant 3 Peak Hour Volume	Meets minimum threshold volumes for 1 hour of the day due to a generator which discharges a large number of vehicles in a short period of time	No. While volume thresholds are met, the land use condition is not met.
Warrant 4 Pedestrian Volume	Pedestrian and vehicular volumes meet minimum threshold volumes	No. Does not meet pedestrian minimum threshold volumes.
Warrant 5 School Crossing	Insufficient gaps to accommodate school children crossing the road	No. This location is not part of a publish school route plan.
Warrant 6 Coordinated Signal System	Would provide adequate platooning of vehicles in the coordinated system	No. Adequate platooning of vehicles on Egan Drive.
Warrant 7 Crash Experience	Five or more crashes susceptible to correction by a signal within a 12-month period, meet minimum traffic volumes	**Yes.** Meets crash requirement and minimum threshold for 12 hours of the day.
Warrant 8 Roadway Network	Intersection of major routes with at least 1,000 entering vehicles per hour and 5-year projected volumes would meet Warrant 1, 2, or 3	No. This is not an intersection of major routes.
Warrant 9 Intersection Near a Grade Crossing	At-grade railroad crossing with stop- or yield control within 140 feet of the intersection and minimum volumes	No. The intersection is not near a highway-railroad grade crossing.

7.4.3 Design Volumes

Installing a signal on Egan Drive at Yandukin Drive would allow full side street movements at the intersection. Drivers currently making eastbound right turns at the Glacier Highway/Nugget signal and then making a southbound left turn at Yandukin Drive could instead make eastbound through movements under the signal alternative concept. Likewise, from the Fred Meyer area, rather than traveling north to the Glacier Highway/Nugget signal to cross Egan Drive, vehicles would be allowed to travel westbound through the intersection. In addition, vehicles desiring to make eastbound or westbound left turns at Yandukin Drive will not have to make indirect movements to turn left.

The turning movement diagrams for this alternative concept are attached in Appendix B starting on page 148.

7.4.4 Design Development and Operations

A traffic signal at Egan Drive and Yandukin Drive was initially analyzed as a possible, low-impact, signal design that used the existing road design with some minor reconstruction to the side streets to allow left turns onto Egan Drive and new signal poles for control on new and existing median islands in the quadrants. The number of lanes northbound and southbound on Egan Drive were held constant for this initial design. This design, however, did not achieve the recommended operational goals in 2040. The overall LOS in the AM and PM peak hours would be LOS E with an average delay of greater than 65 seconds for each design period. In this condition, the critical northbound demand of 1,680 vehicles per hour in the evening would experience 112 seconds of average delay per vehicle and drivers making the AM southbound commute would experience 103 seconds per vehicle. Additionally, the southbound left turns, which are one of the significant movements which the project is addressing, would have 197 seconds of average delay in the PM peak hour, since they are in direct conflict with the northbound through movements which are demanding such a large portion of the total cycle length. Additional operational results for this analysis are provided in Appendix D, starting on page 162.

The next option that was considered was to add an additional northbound through lane. This lane would develop south of the Yandukin Drive intersection and would continue north through both the Yandukin Drive intersection and the Glacier Highway/Nugget intersection and eventually become the right-turn lane onto Mendenhall Loop Road. This concept design is shown in Figure 32.

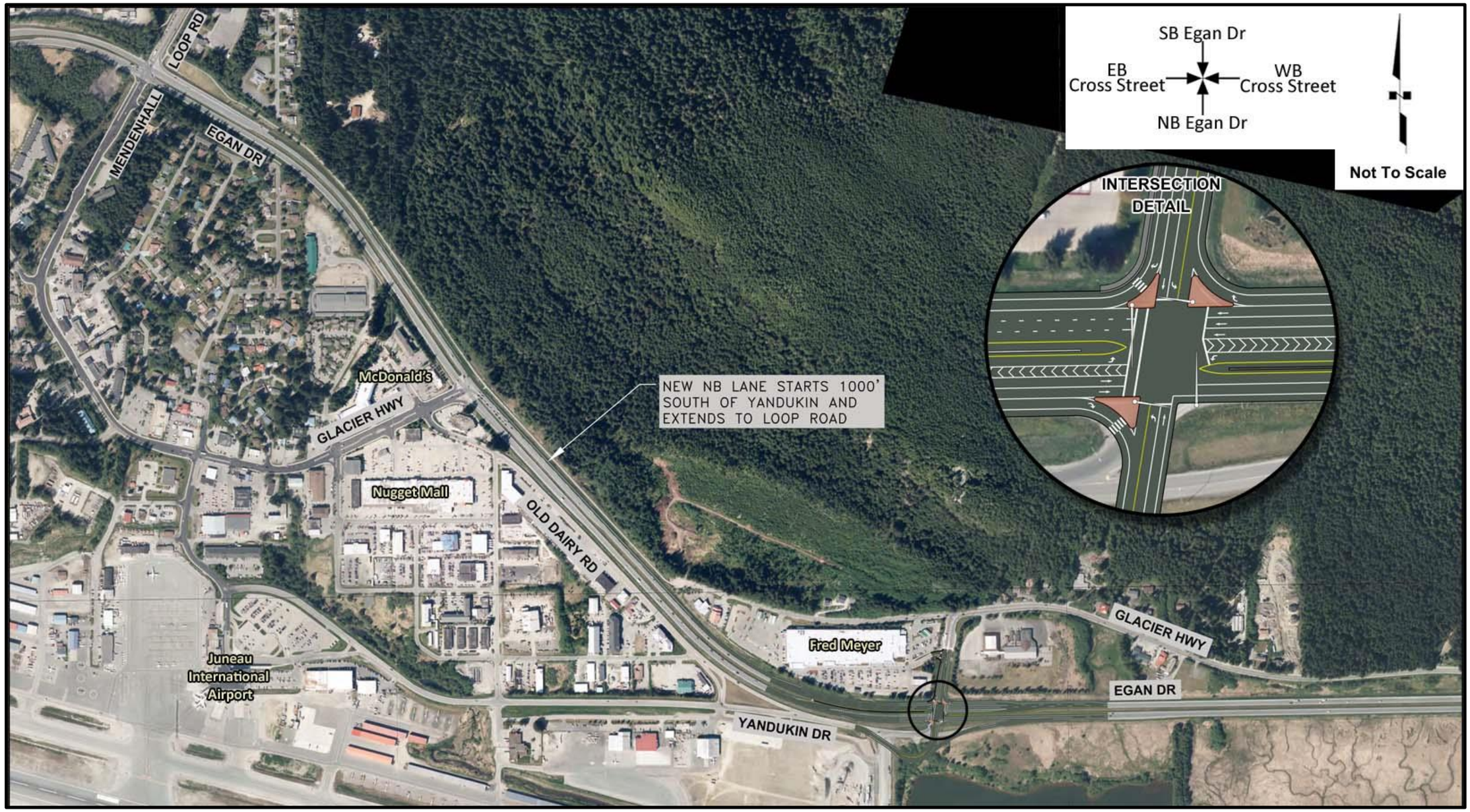


Figure 32. Concept Map, Alternative Concept B, Signal at Fred Meyer Intersection of Egan Drive at Yandukin Drive

The design shown in Figure 32 is projected to perform with adequate LOS of D in the PM and midday peak hour in the 2040 design year. However, two southbound through lanes do not provide adequate capacity in the AM peak hour; the delay during the AM commute would be 142 seconds per vehicle, resulting in overall intersection LOS in the AM period of 92 seconds per vehicle average, which is LOS F.

Note, in all cases, the performance of the signal at Egan Drive and Glacier Highway/Nugget is projected to operate at LOS C. The addition of a third northbound through lane will indirectly improve the performance of the northbound left; however, the performance of this movement is still LOS F.

A full summary of the intersection delay and performance under this alternative concept can be found in Appendix D starting on page 162.

7.4.4.1 Sensitivity to pedestrian volumes

One of the factors driving delay for a signalized intersection alternative concept at Yandukin Drive is the time needed for a pedestrian to cross Egan Drive. If a pedestrian crosses Egan Drive (activating the pedestrian signal timing), then the side street green time is longer than what is needed to serve the side street traffic. If a pedestrian does not cross Egan Drive, then the side street vehicles do not use all of the green time allotted to them and the additional green time is used for the major road movements instead. Thus, the amount of green time allocated to the major street is dependent on the frequency of pedestrian calls for crossing Egan Drive. The delay values presented in the previous paragraphs assume a pedestrian call occurs with each cycle, which is the worst-case scenario. A sensitivity analysis was performed that assumes that no pedestrian crosses Egan Drive, to give an idea of the range of possible delay values. The true delay for the intersection will fall somewhere between the calculation with and without pedestrian calls. Note in Figure 33 that the AM peak hour is especially sensitive to the number of pedestrians.

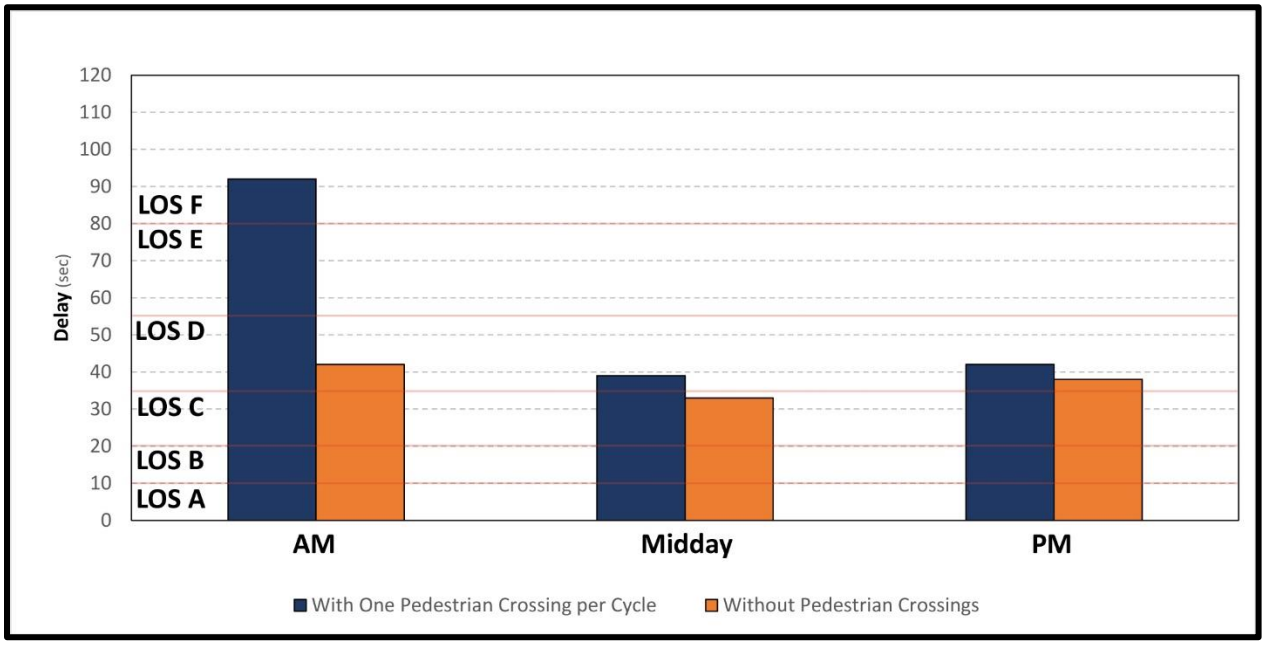


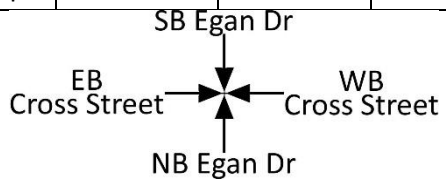
Figure 33. Comparison of Signalize Intersection Delay with or without Pedestrian Crossings of Egan Drive (Two Southbound and Three Northbound Through Lanes), Alternative Concept B, 2040

7.4.4.2 Ramp Performance

As shown in Figure 32, the eastbound and westbound right turns will continue to enter the highway as merge lanes. Table 27 presents the ramp LOS analysis for these right-turn movements. These movements operate at LOS C or better throughout the day.

Table 27. On-Ramp LOS, Alternative Concept B, 2040

Intersection	Ramp	Ramp Free Flow Speed (mph)	Merge Length (feet)	AM LOS	Midday LOS	PM LOS
Egan Dr & Glacier Hwy/Nugget	Southbound On-Ramp	30	780	B	B	B
Egan Dr & Yandukin Dr	Southbound On-Ramp	40	720	B	B	B
	Northbound Off-Ramp	45	680	A	B	B
		25	200	B	B	C



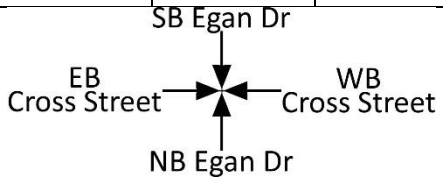
7.4.4.3 Auxiliary Lane Lengths

Auxiliary lane lengths should follow the guidelines in Table 1150-1 from the DOT&PF Chapter 11 *Alaska Preconstruction Manual*. For speeds of 35 mph or less, auxiliary lane lengths need only accommodate queue storage and not deceleration. For speeds of 40 mph or greater, auxiliary lanes need to accommodate both queue storage and deceleration. The desirable auxiliary lane length is a length which is long enough to accommodate deceleration from posted speed to stop at the back of the 95th percentile queue. The minimum lane length presumes that the entering vehicle slows to 10 mph less than posted speed within the through travel lanes before the bay taper, begins deceleration while within the bay taper, and continues the deceleration within the fully developed lane to stop behind the 95th percentile queue. An auxiliary lane length of 400 feet is the practical maximum cited by some agencies (for example, the Municipality of Anchorage), and is the maximum length recommended for this project; however, many turn lanes already constructed in Juneau are much longer and therefore longer lane lengths may be considered by local officials. Lanes which are longer than 400 feet in length run a greater risk of being used as passing lanes by some motorists.

Recommended auxiliary lane lengths are included in Table 28.

Table 28. Auxiliary Lane Lengths at Egan Drive and Yandukin Drive Signalized Intersection, Alternative Concept B

Auxiliary Lane Movement	Approach Speed (mph)	95th Percentile Auxiliary Lane Queue (ft)	95th Percentile Adjacent Lane Queue (ft)	Auxiliary Lane Deceleration and Storage		Recommended Auxiliary Lane Length (ft)
				Minimum Auxiliary Lane Length (ft)	Desirable Auxiliary Lane Length (ft)	
Northbound Left Turn	55	374	655	650	850	650
Northbound Right Turn	55	28	655	300	650	400
Southbound Left Turn	55	383	1,224	650	1,225	650
Southbound Right Turn	55	48	1,224	325	1,225	400
Westbound Left Turn	25	139	168	150	175	175
Westbound Right Turn	25	0	168	150	175	175
Eastbound Left Turn	25	118	191	150	200	200
Eastbound Right Turn	25	0	191	150	200	200



7.4.4.4 Performance of Fred Meyer Driveway at Glacier Highway/Lemon Road

The operation and the proximity of the Fred Meyer driveway on Glacier Highway/Lemon Road and the new signal at Egan Drive and Yandukin Drive may cause some conflicts and should be considered for retrofitting as an extension of the Alternative Concept B signal project.

7.4.4.4.1 Intersection Delay

Southbound left turns out of Fred Meyer are expected to have delays of over 90 seconds per vehicle during the PM peak hour. Data was not collected at this intersection during other periods, but it is assumed that the lack of gaps in this particular movement would extend to other periods of the day as well. The performance of the eastbound left turn into Fred Meyer, however, would operate at LOS A in the PM peak period, with a 50-foot 95th percentile queue length.

7.4.4.4.2 Intersection Functional Area and Impacts

The presence of a signal causes queues on Glacier Highway/Lemon Road, which extends the upstream functional area past the Fred Meyer driveway. Figure 34 presents the east leg functional area at the Yandukin Drive signal.

Because the queues from the proposed signal extend past the Fred Meyer driveway, the southbound left-turn exit movement experiences poorer performance. There are alternative routes to enter and exit the Fred Meyer parking lot onto Lemon Spur, so it is recommended for this alternative concept that the Fred Meyer driveway be restricted to right-in-right-out-left-in movements only. The left-in movement, eastbound, should be designed with a raised median and a minimum of a 50-foot fully developed lane length prior to the lane taper.

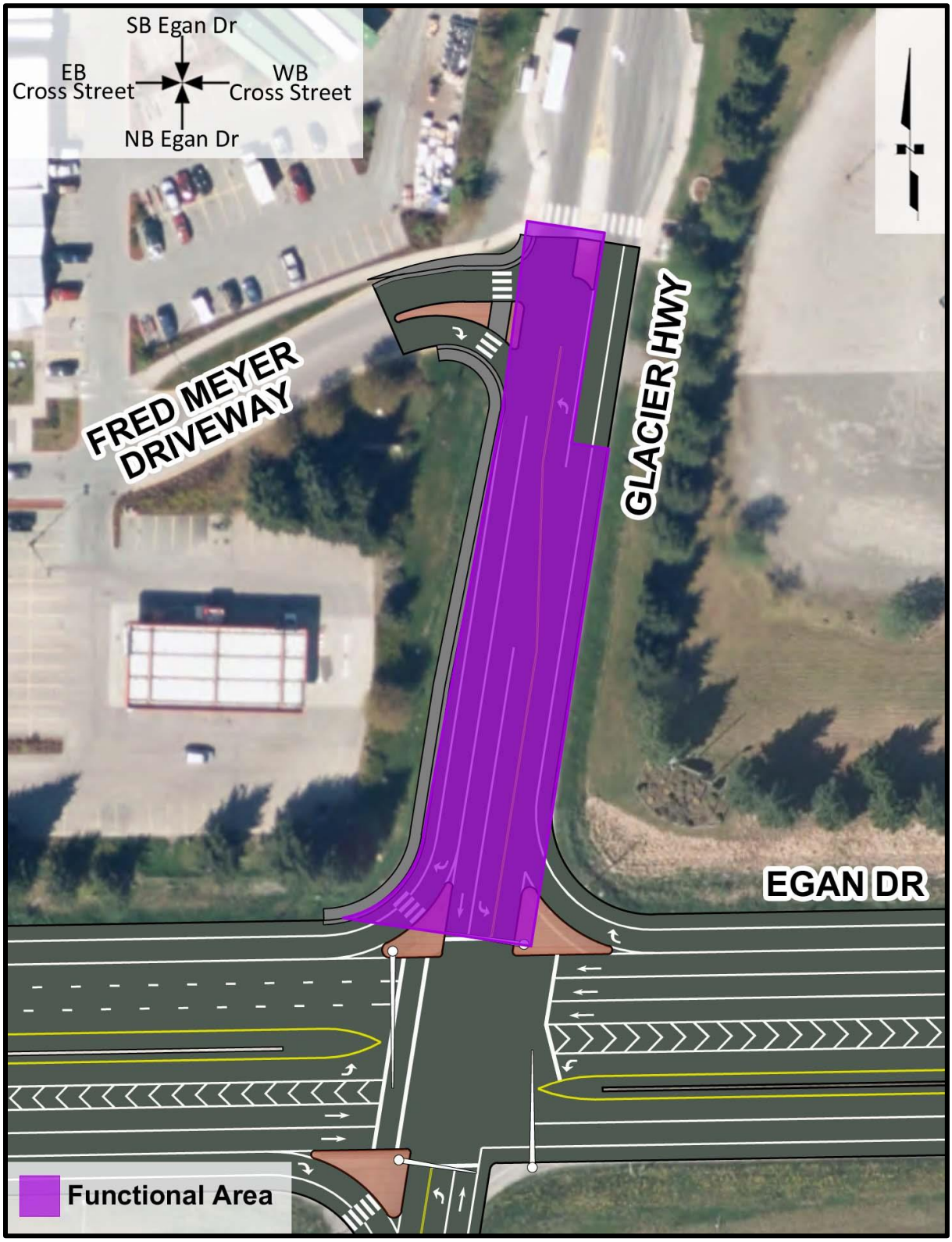


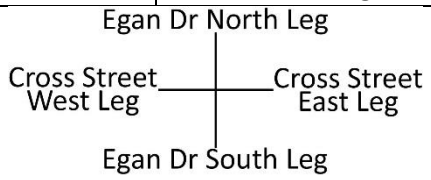
Figure 34. Functional Area, Alternative Concept B (Signal)

7.4.4.5 Pedestrian and Cyclist Crossing Operations

Table 29 presents the pedestrian delays at the Egan Drive signals at Glacier Highway/Nugget and at Yandukin Drive. Overall, pedestrians are expected to experience long delays. During the PM peak, pedestrians will have delays greater than one minute at both intersections, suggesting that there is a very high chance of pedestrians ignoring the pedestrian signals and crossing during a "Do Not Walk" phase.

Table 29. 2040 Pedestrian Delay for Signalized Intersections, Alternative Concept B

Intersection	**Peak Hour**	**Crossing Location**	**Average Pedestrian Delay** (sec)
Egan Drive and Glacier Hwy/Nugget	Midday	South Leg	40-60
		West Leg	40-60
	PM	South Leg	> 60
		West Leg	> 60
Egan Drive and Yandukin Drive	Midday	South Leg	40-60
		North Leg	> 60
		West Leg	40-60
		East Leg	> 60
	PM	South Leg	> 60
		North Leg	> 60
		West Leg	> 60
		East Leg	> 60



7.4.5 Cost-Benefit Analysis

7.4.5.1 Delay Cost Benefit

The value of the delay benefit of the alternative concept is the difference in the value of delay from 2020 to 2040 under installation of a signal at the Fred Meyer intersection of Egan Drive at Yandukin Drive compared to the no-build alternative concept. The value of the change in delay is shown in Table 30. A negative benefit value indicates that the proposed alternative concept has more delay than the no-build alternative concept.

Table 30. NPV of Delay Compared to No Build, Alternative Concept B, 2020 to 2040

Intersection	NPV of Delay
Egan Drive at Yandukin Drive	-$48,433,000
Egan Drive at Glacier Highway/Nugget	$1,217,000
Total	**-$47,216,000**

There is a significant increase in overall delay for the intersection of Egan Drive at Yandukin Drive. Because of the installation of a signal, many north- and southbound vehicles will be stopped while the left-turn or side street traffic have green indications. At the Glacier Highway/Nugget intersection, there will be a small decrease in the number of vehicles using the signal, resulting in a slight decrease in overall delay.

7.4.5.2 Safety Cost Benefit

The installation of a traffic signal has been shown to reduce the number of crashes related to crossing maneuvers, such as angle and left-turn crashes. At the same time, installation of a traffic signal tends to increase crashes related to vehicles slowing down or stopping, such as rear-end and sideswipe crashes. The HSIP handbook provides CMFs for installation of a signal of 0.35 for angle and left-turn crashes (CRF = 65%) and 1.25 for rear-end and sideswipe crashes (CRF = -25%). (CMFs less than 1.00 or positive CRFs indicate that crashes are reduced; CMFs greater than 1.00 or negative CRFs indicate that the number of crashes increases.) Table 31 shows the resulting value of crashes for the installation of a signal at the Egan Drive intersection at Yandukin Drive. Note that the number of expected crashes at the Glacier Highway/Nugget intersection has changed slightly due to some vehicles being able to cross Egan Drive at the new signalized intersection, and therefore, are no longer using the Glacier Highway/Nugget intersection.

Table 31. Expected Net Present Value of Crashes, 2020 to 2040, Alternative Concept B

Intersection	Expected Number of Crashes, 2020 to 2040	Net Present Value Cost of Crashes, 2020 to 2040
Yandukin Dr	145	$ 10,760,400
Glacier Hwy-Nugget	225	$ 11,142,600
TOTAL	**370**	**$ 21,903,000**

7.4.5.3 Development, Construction, Maintenance and Operations Costs

The life-cycle present worth costs (borne by DOT&PF) for Alternative Concept B are as follows:

Table 32. Life Cycle Project Costs, Alternative Concept B

Element	Cost
Design	$1,712,000
Utilities	$20,000
Right-of-Way	$31,000
Construction	$17,123,000
Maintenance and Operations (Present Worth of Ongoing Cost)	$288,000
Total Cost of Project	**$19,174,000**

All the costs are computed with 2018 dollars and it is assumed that these costs will hold for the opening year.

7.5 Alternative Concept C1 – One-Way Extension of Lemon Spur to Signal at Egan Drive and Glacier Highway/Nugget

7.5.1 Alternative Concept

Alternative Concept C1 would extend Lemon Spur from its existing cul-de-sac north of Fred Meyer to the intersection of Egan Drive and Glacier Highway/Nugget. The traffic signal at Egan Drive and Glacier Highway/Nugget would be reconstructed to accommodate the new southbound approach leg. Lemon Spur would be a southbound one-lane, one-way street from the Glacier Highway/Nugget intersection to the location of the existing cul-de-sac.

Section Highlights

- Alternative Concept C1 includes a southbound one-way extension of Lemon Spur to the signal at Egan Drive and Glacier Highway/Nugget.
- Average intersection delay would be satisfactory in the AM and PM peak hours.
- The project would cost approximately $15M, with an $8M benefit in reduced crashes compared to the No Build alternative. The cost in increased delay would be about $7M because of additional movements and volume at the Glacier Highway/Nugget intersection

The intersection design would include dual northbound left-turn lanes and an added southbound left-turn lane on Egan Drive. The eastbound approach would still include dual left turns; however, an eastbound through lane would be added. The eastbound right-turn would not change from its current design. Figure 35 shows the concept and the extents of the physical impacts of the design.

The existing unsignalized northbound and southbound left-turn movements at the intersection of Egan Drive and Yandukin Drive would be closed with a median. Right turn entry and exit ramps at Egan Drive and Yandukin Drive would remain in their existing configuration.

The Alternative Concept C1 design would not change conditions for pedestrians crossing Egan Drive. Pedestrians would still cross at a protected crossing at Egan Drive and Glacier Highway/Nugget. This alternative concept would also not change the amount of out-of-direction travel, nor would it provide an additional route parallel to Egan Drive for northbound (outbound) traffic.

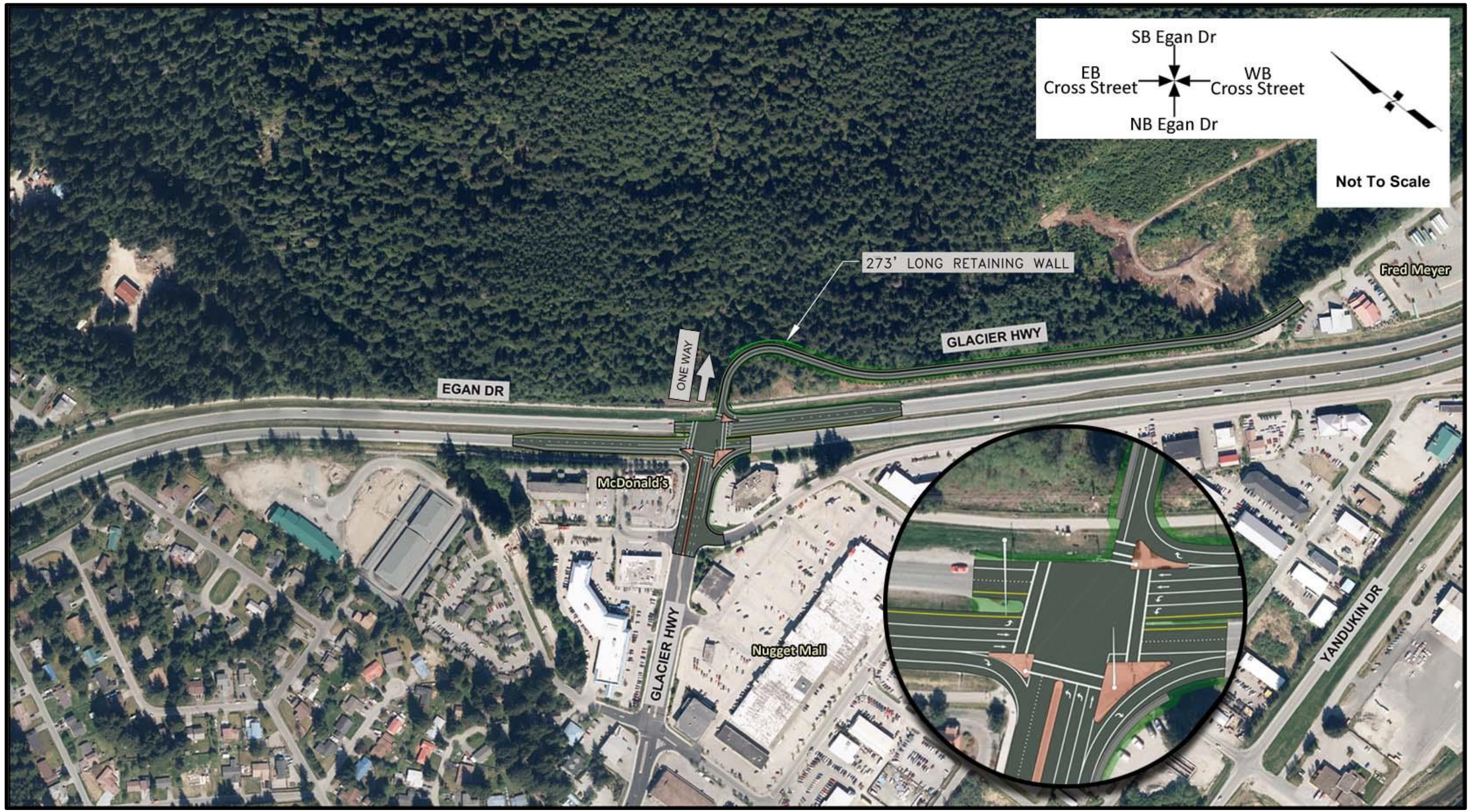


Figure 35. Concept Map, Alternative Concept C1, One-Way Extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget

7.5.2 Design Volumes

This alternative concept prohibits vehicles from making left turns from Egan Drive at Yandukin Drive. Instead, drivers would turn at the Glacier Highway/Nugget signal. Northbound traffic that would normally turn left towards the airport at Yandukin Drive would instead travel to Glacier Highway/Nugget to turn left. Southbound traffic that would normally turn left at Glacier Highway/Lemon Road towards Fred Meyer would instead make a southbound left or eastbound through movement at Glacier Highway/Nugget. Other than these movements, all other vehicles would travel through the area in the same way as currently.

The turning movement diagrams for this alternative concept are attached in Appendix B starting on page 148.

7.5.3 Intersection Performance

7.5.3.1 Signal Performance

The proposed signal design was modeled using HCM 2010 methodologies in Synchro software. The analysis indicates that the Glacier Highway/Nugget intersection will operate with overall satisfactory LOS (intersection LOS D or better). The average intersection delay in the AM is projected to be LOS D at 38 seconds of delay per vehicle, and the PM peak is projected to be LOS D with 43 seconds of delay per vehicle. The northbound left and southbound left movements experience the most delay throughout the day, as they compete with the high volume through movements for signal time.

A full summary of the intersection delay and performance under this alternative concept can be found in Appendix D starting on page 162.

7.5.3.2 Optional dual southbound left turn lanes

The northbound left-turn volumes of 550 to 750 vehicles-per-hour throughout the day justify the need for two northbound left-turn lanes. While the southbound left turn volumes are small enough to be handled by one left turn lane (50 to 250 vehicles per hour), installing two southbound left turn lanes would add a small amount of capacity to the intersection, while not increasing the size of the intersection. However, dual southbound left turn lanes would require two receiving lanes for the proposed one-way extension from the Glacier Highway/Nugget intersection. The two lanes could be merged into one lane downstream from the intersection.

Research has shown that lane utilization is affected at intersections upstream of a lane drop. Lee, Rouphail, and Hummer developed prediction models for lane utilization at intersections with a lane drop. The researchers studied lane utilization in through lanes where a lane is dropped at or just after the intersection, as well as lane utilization for left-turn lanes where one of the receiving lanes is dropped. The test sample included 47 intersections in North Carolina. Of the 47, 11 involved dual left turn lanes turning onto surface streets followed by a lane drop and 19 involved

dual left turn lanes turning onto on-ramps with a lane drop on the ramp. The researchers developed models to determine the lane utilization factor, f_{LU}, for the signalized intersection method in the HCM. The lane utilization factor describes how evenly the traffic is distributed across several lanes making the same movement. A factor of 1 would indicate that the traffic is evenly distributed across lanes, whereas a factor of 0.5 would indicate that all of the traffic uses only one of the available lanes (for a grouping of two lanes).

Based on this research, the two receiving lanes should extend about 750 feet before merging (assuming a taper length of 180 feet). This gives a lane utilization of 0.80 for the southbound left turn lane in the PM peak hour. Using dual southbound turning lanes and these parameters, the intersection delay drops by only 1 or 2 seconds per vehicle in each peak period; however, LOS E is achieved for all movements.

A full summary of the intersection delay and performance under this alternative concept can be found in Appendix D starting on page 162.

7.5.3.3 Old Dairy Intersection Performance

Appendix E presents the vehicle operations for Glacier Highway at Old Dairy Road/Trout Street in 2040 under Alternative Concept C1. Under this alternative concept, the through movements on Glacier Highway/Nugget will increase because the left turns to the airport at Yandukin Drive will instead use Glacier Highway/Nugget. The northbound and southbound left-turn delay is expected to be very poor. Currently, these movements are restricted via signs not allowing left turn movements from the side streets during the PM peak period; however, volume count observations witnessed multiple occasions where drivers still made these movements. The delay analysis shows that the poor performance of these movements will extend into the midday and AM peak periods as volumes continue to grow.

The left-turn movements into these side streets, however, are expected to operate at a LOS B or better, in the 2040 design year.

Figure 36 presents the functional area of the west leg at the Glacier Highway/Nugget signal under Alternative Concept C1. The area extends further west past the Old Dairy Road intersection, resulting in two access points within the functional area. Vehicles entering and leaving these access points create additional conflicts for vehicles traveling through at the Glacier Highway/Nugget signal.

Access control is recommended at the intersection of Old Dairy Road and Trout Street to restrict left turns out of these side streets, due to the performance of the left turns, the crash history, and the location of these side streets within the functional area of the signal at Egan Drive and Glacier Highway/Nugget.

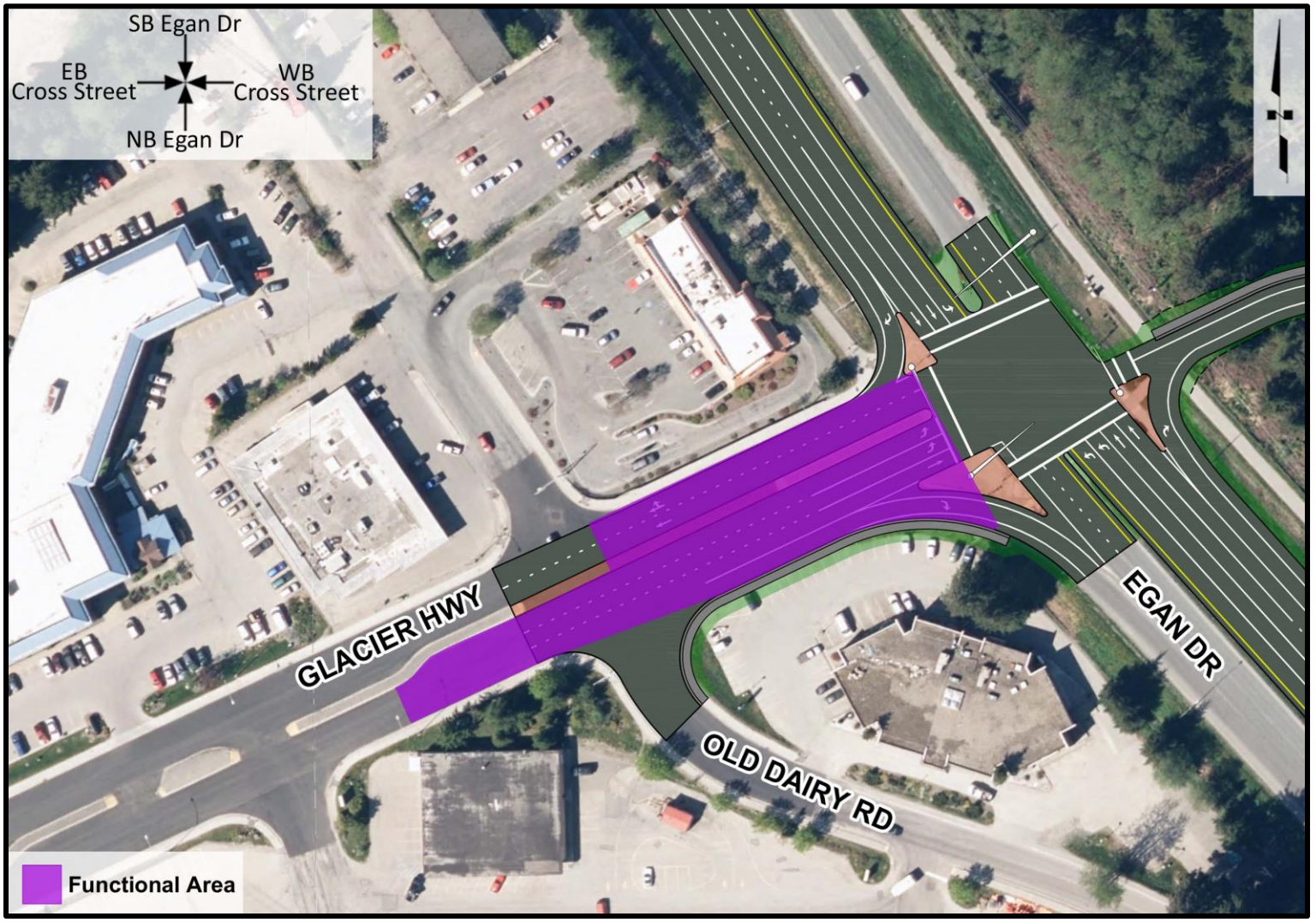


Figure 36. Intersection Functional Area, Alternative Concept C1

Note that the functional area of the existing signal currently extends beyond the intersection of Old Dairy Road, which suggests that the intersection should be closed to left-turn traffic in the future, regardless of the Egan Drive alternative concept selected.

7.5.3.4 Other Possible Intersection Impacts

As left turns are prohibited at the Yandukin Drive intersection, northbound vehicles desiring to get to the airport are required to make left turns at the Glacier Highway/Nugget signal. The redistribution of traffic increases traffic volumes at the Glacier Highway signals at Jordan Avenue and at Shell Simmons Drive, which could impact the vehicle operations at these intersections. These intersections are outside the scope of this project but should be analyzed if Alternative Concept C1 is chosen.

7.5.4 Pedestrian and Cyclist Crossing Operations

Table 33 presents the signalized crossing delay for pedestrians at the Glacier Highway/Nugget signal. The long delays of over 40 seconds suggest that pedestrians are likely to feel impatient at the signal and may be more likely to cross against the "Do Not Walk" pedestrian signal.

Table 33. Pedestrian Delay, Alternative Concept C1 at Egan Drive & Glacier Highway/Nugget, 2040

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)
Midday	South Leg	40-60
	North Leg	40-60
	West Leg	40-60
	East Leg	40-60
PM	South Leg	> 60
	North Leg	40-60
	West Leg	> 60
	East Leg	> 60

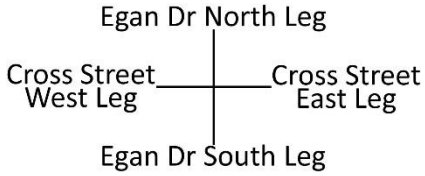
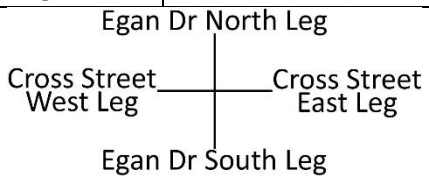


Table 34 presents the unsignalized pedestrian delays at the Egan Drive intersection at Yandukin Drive. The heavy through volumes on Egan Drive cause long pedestrian delays that are much greater than 45 seconds, the level of service F threshold for unsignalized pedestrian crossings. There is a very high likelihood of pedestrians taking the risk of crossing with shorter gaps in traffic.

Even with a continuous median at the Yandukin Drive intersection, pedestrians would continue to cross Egan Drive if the median is flat, such as with a grassy median. Pedestrians would be discouraged to cross if there is a barrier in the median, like a fence, to block them.

Table 34. Pedestrian Delay, Alternative Concept C1 at Egan Drive & Yandukin Drive, 2040

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
Midday	South Leg	> 45	Very High
	North Leg	> 45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	
PM	South Leg	> 45	Very High
	North Leg	> 45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	



7.5.5 Cost-Benefit Analysis

7.5.5.1 Delay

Table 35 presents the value of delay for the Egan Drive intersections compared to the no-build alternative concept.

Table 35. Net Present Value of Delay Compared to No Build, Alternative Concept C1, 2020 to 2040

Intersection	Net Present Value of Delay
Egan Drive at Yandukin Drive	$5,604,000
Egan Drive at Glacier Highway/Nugget	-$12,971,000
Total	**-$7,367,000**

Prohibiting left turns at Yandukin Drive results in no delay at the intersection, an overall reduction in delay at that intersection. However, the positive benefit value at Yandukin Drive is offset by the increased delay to drivers at the Glacier Highway/Nugget signal caused by the additional signal phase at the intersection. Thus, the alternative concept has an overall negative delay benefit.

7.5.5.2 Safety

This alternative concept will close the median opening at Yandukin Drive, thus eliminating all crashes associated with turning movements across the highway (angle, head on, and left-turn crashes). Additional traffic will be introduced at the Glacier Highway/Nugget intersection. However, while a fourth leg will be added to the Glacier Highway/Nugget intersection, it will introduce minimal additional conflicts. The crash reduction at Yandukin Drive was estimated using the HSIP CMF of 0.1 for the closure of a median opening (CRF = 90%), applied to the appropriate crash types. Increased crashes for the Glacier Highway/Nugget intersection were calculated using these increased volumes. Table 36 presents the resulting value of crashes for the closure of the median opening at Yandukin Drive combined with the one-way extension of Glacier Highway-Lemon Spur to the Glacier Highway/Nugget intersection.

Table 36. Expected Net Present Value of Crashes, Alternative Concept C1, 2020 to 2040

Intersection	Expected Number of Crashes, 2020 to 2040	Net Present Value Cost of Crashes, 2020 to 2040
Yandukin Dr-Fred Meyer	81	$ 4,650,800
Glacier Hwy-Nugget	298	$ 14,740,600
TOTAL	**379**	**$ 19,391,400**

7.5.5.3 Development, Construction, Maintenance and Operations Costs

The life-cycle present worth costs (borne by DOT&PF) for Alternative Concept C1 are as follows:

Table 37. Life Cycle Project Costs, Alternative Concept C1

Element	Cost
Design	$1,314,000
Utilities	$120,000
Right-of-Way	$386,000
Construction	$13,142,000
Maintenance and Operations (Present Worth of Ongoing Cost)	$122,000
Total Cost of Project	**$15,084,000**

All the costs are computed with 2018 dollars and it is assumed that these costs will hold for the opening year.

7.6 Alternative Concept C2 – Two-Way Extension of Lemon Spur to 4-Leg Signal at Egan Drive and Glacier Highway/Nugget

7.6.1 Alternative Concept

Alternative Concept C2 would extend Lemon Spur from its existing cul-de-sac north of Fred Meyers to the intersection of Egan Drive and Glacier Highway/Nugget. The traffic signal at Egan Drive and Glacier Highway/Nugget would be reconstructed to accommodate the new approach leg. The intersection design would include a new third northbound lane and dual northbound left-turn lanes on Egan Drive. The new westbound approach would have one left-turn lane, two through lanes, and a single right-turn lane that would yield on entry to Egan Drive. The additional northbound through lane would begin approximately 1,000 feet south of the intersection and would continue through the intersection and become the northbound right turn lane at Mendenhall Loop Road. The eastbound right-turn would not change from its current design. Figure 37 shows the concept and the extents of the physical impacts of the design.

Section Highlights

- Alternative Concept C2 includes extension of Lemon Spur to the signal at Egan Drive and Glacier Highway/Nugget with a new third northbound through lane that extends to Mendenhall Loop Road.
- Average intersection delay would be unsatisfactory in the AM and PM peak hours when pedestrians are present crossing Egan Drive. When no pedestrian calls are being made, the AM peak would operate adequately, but the PM would still fail
- The project would cost approximately $20M, with a $7M benefit in reduced crashes compared to the No Build alternative. The cost in increased delay would be about $48M because of the addition of an additional signal phase.

The existing unsignalized northbound and southbound left-turn movements at the intersection of Egan Drive and Yandukin Drive would be closed with a median. Right turn entry and exit ramps at Egan Drive and Yandukin Drive would remain in their existing configuration.

The Alternative Concept C2 design would not change conditions for pedestrians crossing Egan Drive. Pedestrians would still cross at a protected crossing at Egan Drive and Glacier Highway/Nugget; however, they will need more time to cross the two additional lanes. The extension of Lemon Spur would provide a crucial link in the parallel secondary road networks for Egan Drive.

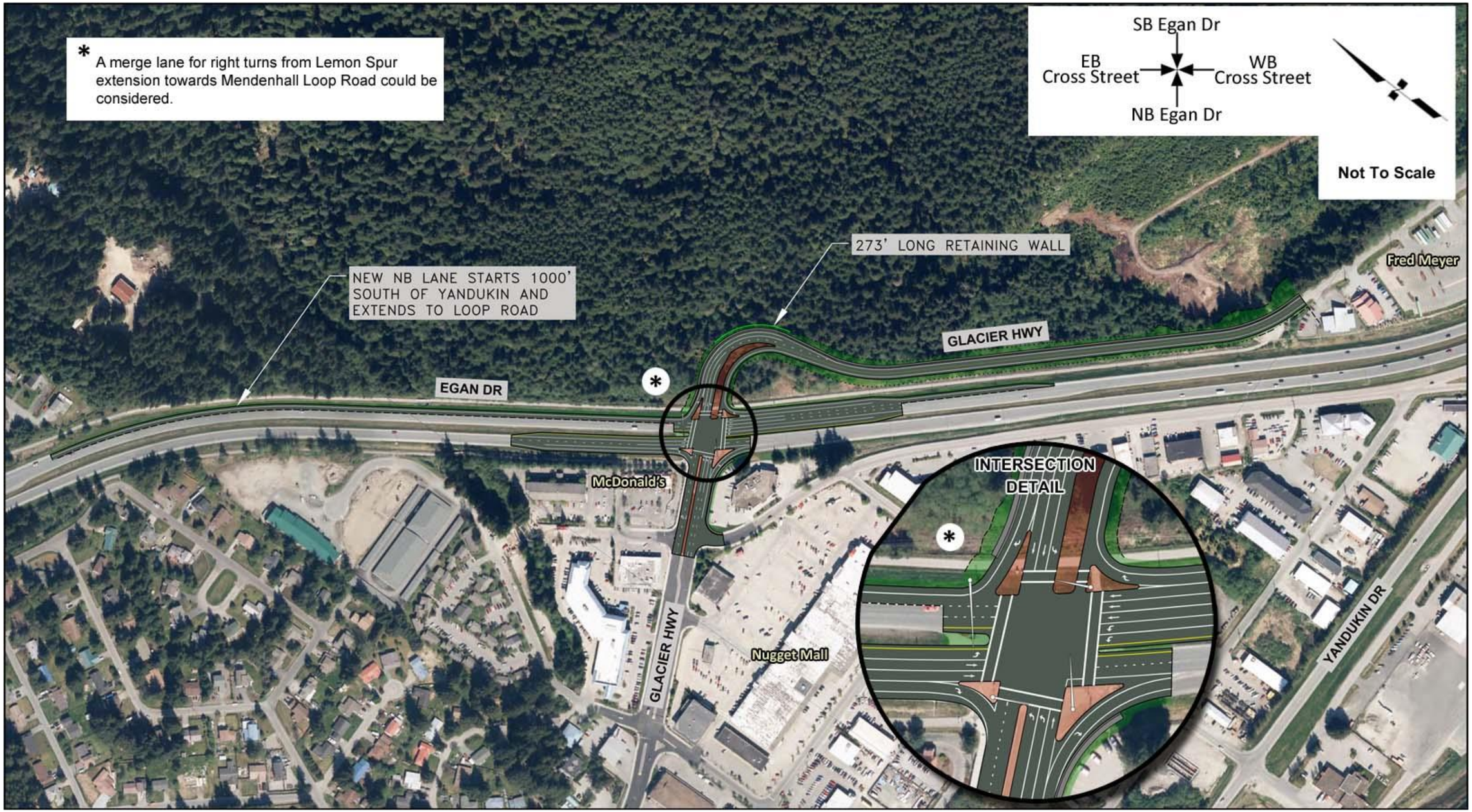


Figure 37. Concept Map, Alternative Concept C2, Extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget

A possible merge lane can be added for the right turns from the Lemon Spur extension towards Mendenhall Loop Road. However, an acceleration lane is undesirable if pedestrians are going to cross the lane. This is not a concern at other acceleration lanes the DOT&PF has been placing at similar locations because there are no pedestrian pathways along the road. Observations at the Egan Drive at Yandukin Drive intersection also showed that drivers are not taking advantage of the northbound acceleration lane and tend to wait for a gap to enter Egan Drive.

7.6.2 Design Volumes

This alternative concept prohibits vehicles from making left turns from Egan Drive at Yandukin Drive. Instead, drivers would need to turn at the Glacier Highway/Nugget signal, which increases northbound through traffic at Yandukin Drive and northbound movements at the signal.

One of the key assumptions of the volume redistribution process was that drivers would prefer to travel on the shortest route. Ideally, the shortest route from the Fred Meyer area north is to make a westbound right-turn at Yandukin Drive and continue northbound through the new 4-leg signal at Glacier Highway/Nugget. However, the increase in northbound left and through movements increased the northbound approach delay at the Glacier Highway/Nugget signal. The additional delay is assumed to result in traffic traveling from Lemon Road and the area of Fred Meyer to the north to instead bypass the Glacier Highway/Nugget intersection and enter Egan Drive at the new westbound right turn. Therefore, a majority of that traffic coming from Fred Meyer and Lemon Road was shifted to make westbound right turns at the Glacier Highway/Nugget signal.

The turning movement diagrams for this alternative concept are attached in Appendix B starting on page 148.

7.6.3 Intersection Performance

7.6.3.1 Signal Performance

The proposed signal design was modeled using HCM 2010 methodologies in Synchro software. The analysis indicates that even with the inclusion of additional northbound through lanes and turn lanes at Glacier Highway/Nugget, the performance of the intersection will be unsatisfactory. The average intersection delay in the AM is projected to be LOS E at 71 seconds of delay, and the PM peak is projected to be LOS F with 110 seconds of delay. The source of this poor performance is a LOS of E or worse in each of the left-turn lanes, and a northbound through movement and a southbound through movement that performs at LOS E or worse at all times of the day.

A full summary of the intersection delay and performance under this alternative concept can be found in Appendix D starting on page 162.

7.6.3.2 Sensitivity to pedestrian volumes

One of the factors driving delay at a 4-leg signalized intersection at Glacier Highway/Nugget is the time needed for a pedestrian to cross Egan Drive. If a pedestrian crosses Egan Drive (activating the pedestrian signal timing), then the side street green time is longer than what is needed to serve the side street traffic. If a pedestrian does not cross Egan Drive, then the side street vehicles do not use all of the green time allotted to them and the additional green time is used for the major road movements instead. Thus, the amount of green time allocated to the major street is dependent on the number of pedestrians crossing Egan Drive. The delay values presented in the previous paragraphs assume at least one pedestrian is crossing during each cycle. A sensitivity analysis was performed, assuming that no pedestrian crosses Egan Drive during the peak hour, to give an idea of the range of possible delay values. Figure 38 shows the results of the delay analysis with and without pedestrian calls. Note that the vehicle operations are still at LOS E in the PM peak, even without any pedestrian calls.

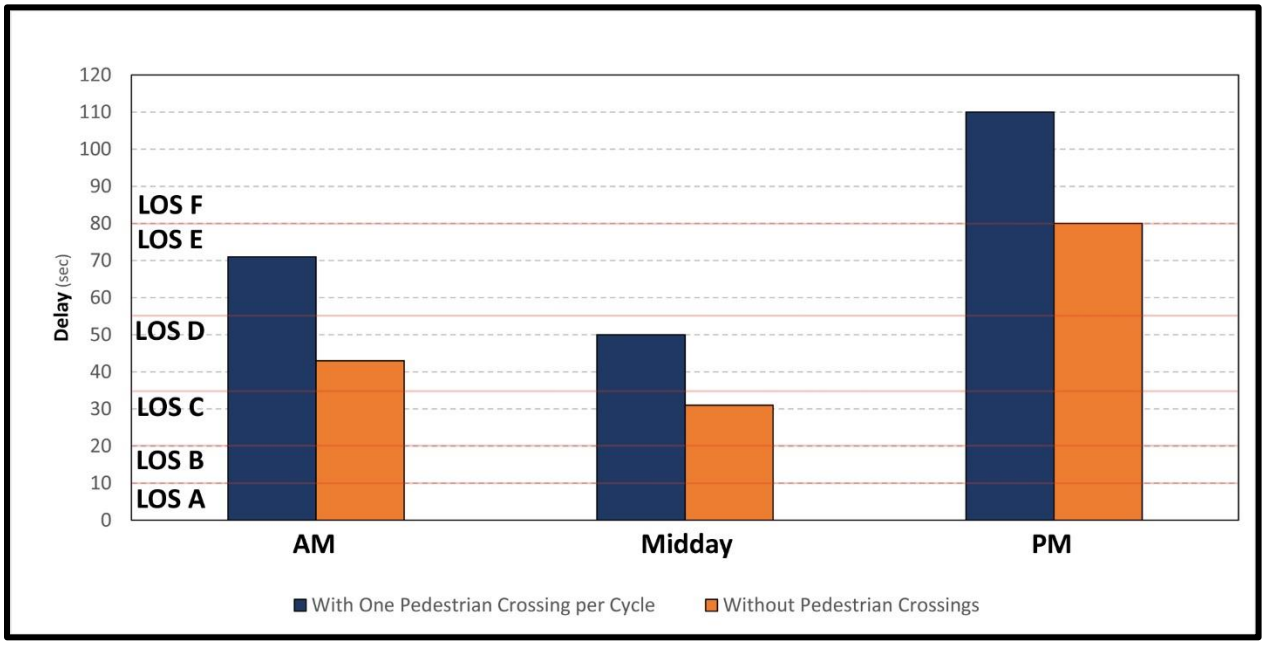


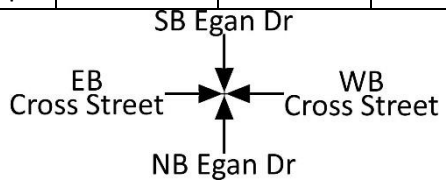
Figure 38. Comparison of Signalized Intersection Delay with or without Pedestrian Crossings of Egan Drive (Two Southbound and Three Northbound Through Lanes), Alternative Concept C2, 2040

7.6.3.3 Ramp Performance

Table 38 presents the LOS for the right-turn movements that operate like on-ramps to Egan Drive. The movements are expected to operate at LOS C or better throughout the day.

Table 38. Ramp LOS, Alternative Concept C2, 2040

Intersection	Ramp	Ramp Free Flow Speed (mph)	Merge Length (feet)	AM LOS	Midday LOS	PM LOS
Egan Drive & Glacier Hwy/Nugget	Southbound On-Ramp	30	780	B	A	A
Egan Drive & Yandukin Drive	Southbound On-Ramp	40	720	B	B	B
	Northbound On-Ramp	45	680	B	B	B
		25	200	B	B	C



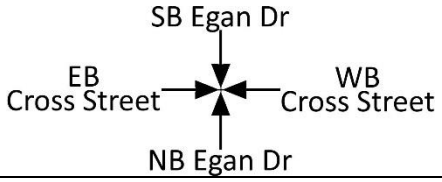
7.6.3.4 Auxiliary Lane Lengths

The design for the signal at Egan Drive and Glacier Highway/Nugget under Alternative Concept C2 requires a calculation of new turn lanes and desirable lane lengths, based on the 95th percentile queues in the peak hours. The recommended auxiliary lane lengths are included in Table 39.

The lane lengths for the entry and exit ramps at Egan Drive and Yandukin Drive would not need to be changed.

Table 39. Auxiliary Lane Lengths at Egan Drive and Glacier Highway/Nugget Signalized Intersection, Alternative Concept C2

Auxiliary Lane Movement	Approach Speed (mph)	95th Percentile Auxiliary Lane Queue (ft)	95th Percentile Adjacent Lane Queue (ft)	Auxiliary Lane Deceleration and Storage		Recommended Auxiliary Lane Length (ft)
				Minimum Auxiliary Lane Length (ft)	Desirable Auxiliary Lane Length (ft)	
Dual Northbound Left Turn	55	339	1,283	475	1,275	400*
Northbound Right Turn	55	< 25	1,283	275	1,275	400
Southbound Left Turn	55	481	1,223	750	1,225	400*
Southbound Right Turn	55	40	1,223	325	1,225	400
Westbound Left Turn	35	70	171	150	175	175
Westbound Right Turn	35	70	171	150	175	175
Dual Eastbound Left Turn	35	389	223	400	400	400
Eastbound Right Turn	35	0	223	150	225	225



**Recommended lengths are less than the minimum calculated auxiliary lane lengths*

For the dual northbound left-turn lanes and the dual eastbound left-turn lanes, the recommended lengths are for both lanes.

7.6.3.5 Old Dairy Road Intersection Performance

Vehicle operations under Alternative Concept C2 at Glacier Highway at Old Dairy Road/Trout Street is the same as for operations under C1. The northbound and southbound left-turn delay is expected to be very poor. Currently, these movements are restricted via signs not allowing left turn movements from the side streets during the PM peak period; however, volume count

observations witnessed multiple occasions where drivers still made these movements. The delay analysis shows that the poor performance of these movements will extend into the midday and AM peak periods as volumes continue to grow.

The left-turn movements into these side streets, however, are expected to operate at a LOS B or better, in the 2040 design year.

Figure 39 presents the functional area of the west leg at the Glacier Highway/Nugget signal under Alternative Concept C2. Because of longer queues at Egan Drive under this alternative concept, the area extends further west past the driveway to the Nugget Mall, resulting in three access points within the functional area. Vehicles entering and leaving these access points create additional conflicts for vehicles traveling through at the Glacier Highway/Nugget signal.

Access control is recommended at the intersection of Old Dairy Road and Trout Street to restrict left turns out of these side streets, due to the performance of the left turns, the crash history, and the location of these side streets within the functional area of the signal at Egan Drive and Glacier Highway/Nugget.

Note that the functional area of the existing signal currently extends beyond the intersection of Old Dairy Road, which suggests that the intersection should be closed to left-turn traffic in the future, regardless of the Egan Drive alternative concept selected.

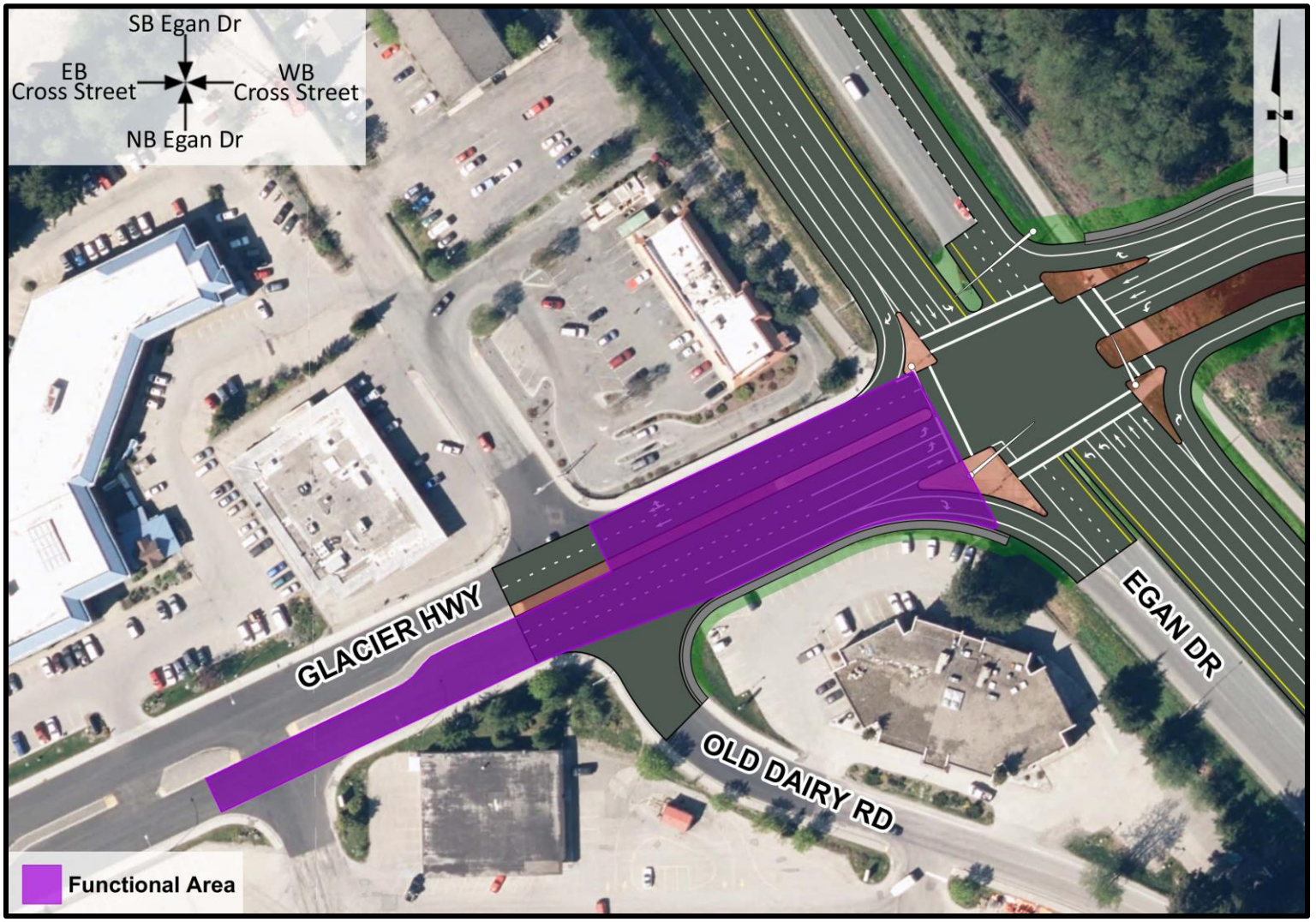


Figure 39. Intersection Functional Area, Alternative Concept C2

7.6.3.6 Other Possible Intersection Impacts

As left turns are prohibited at the Yandukin Drive intersection, northbound vehicles desiring to get to the airport are required to make left turns at the Glacier Highway/Nugget signal. The redistribution of traffic increases traffic volumes at the Glacier Highway signals at Jordan Avenue and at Shell Simmons Drive, which could impact the vehicle operations at these intersections. These intersections are outside the scope of this project but should be analyzed if Alternative Concept C2 is chosen.

7.6.4 Pedestrian and Cyclist Crossing Operations

Table 40 presents the signalized crossing delay for pedestrians at the Glacier Highway/Nugget signal. The long delays of over 40 seconds suggest that pedestrians are likely to feel impatient at the signal and may be more likely to cross against the "Do Not Walk" pedestrian signal.

Table 40. Pedestrian Delay, Alternative Concept C2 at Egan Drive & Glacier Highway/Nugget, 2040

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)
Midday	South Leg	40-60
	North Leg	40-60
	West Leg	40-60
	East Leg	40-60
PM	South Leg	> 60
	North Leg	> 60
	West Leg	> 60
	East Leg	> 60

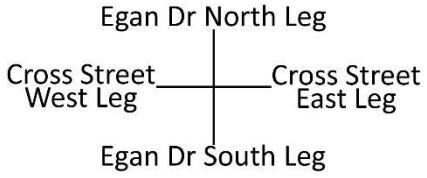
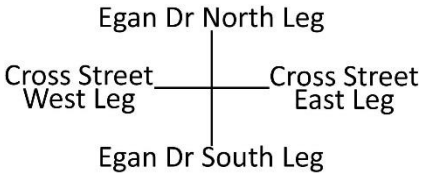


Table 41 presents the unsignalized pedestrian delays at the Egan Drive intersection at Yandukin Drive. The heavy through volumes on Egan Drive causes long pedestrian delays that are much greater than 45 seconds, the level of service F threshold for unsignalized pedestrian crossings. There is a very high likelihood of pedestrians taking the risk of crossing with shorter gaps in traffic.

Table 41. Pedestrian Delay, Alternative Concept C2 at Egan Drive & Yandukin Drive, 2040

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
Midday	South Leg	> 45	Very High
	North Leg	> 45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	
PM	South Leg	> 45	Very High
	North Leg	> 45	Very High
	West Leg	N/A (No Pedestrian Movements)	
	East Leg	N/A (No Pedestrian Movements)	



7.6.5 Cost-Benefit Analysis

7.6.5.1 Delay

Table 42 presents the value of delay for the Egan Drive intersections compared to the no build alternative concept.

Table 42. Net Present Value of Delay Compared to No Build, Alternative Concept C2, 2020 to 2040

Intersection	Net Present Value of Delay
Egan Drive at Yandukin Drive	$5,604,000
Egan Drive at Glacier Highway/Nugget	-$53,764,000
Total	**-$48,160,000**

Prohibiting left turns at Yandukin Drive results in no delay at the intersection, an overall reduction in delay at that intersection. However, the positive benefit value at Yandukin Drive is offset by the increased delay to drivers at the Glacier Highway/Nugget signal caused by the additional signal phase at the intersection. Thus, the alternative concept has an overall negative delay benefit.

7.6.5.2 Safety

This alternative concept will close the median opening at Yandukin Drive, thus eliminating all crashes associated with turning movements across the highway (angle, head on, and left-turn crashes). However, a fourth leg will be added to the Glacier Highway/Nugget intersection, which

will introduce additional traffic and additional conflicts, increasing the likelihood of crashes at that intersection. The crash reduction at Yandukin Drive was estimated using the HSIP CMF of 0.1 for the closure of a median opening (CRF = 90%), applied to the appropriate crash types. A CMF was calculated for the Glacier Highway/Nugget intersection using the SPFs in the Highway Safety Manual for 3-legged and 4-legged signalized intersections, under existing volume and geometric conditions at the Glacier Highway/Nugget intersection. Using this method, the CMF was calculated to be 1.202 (CRF = -20.2%). Table 43 presents the resulting value of crashes for the closure of the median opening at Yandukin Drive combined with the extension of Glacier Highway-Lemon Spur to the Glacier Highway/Nugget intersection.

Table 43. Expected Net Present Value of Crashes, Alternative Concept C2, 2020 to 2040

Intersection	Expected Number of Crashes, 2020 to 2040	Net Present Value Cost of Crashes, 2020 to 2040
Yandukin Dr-Fred Meyer	81	$ 4,650,800
Glacier Hwy-Nugget	325	$ 16,094,400
TOTAL	**406**	**$ 20,745,200**

7.6.5.3 Development, Construction, Maintenance and Operations Costs

The life-cycle present worth costs (borne by DOT&PF) for Alternative Concept C2 are as follows:

Table 44. Life Cycle Project Costs, Alternative Concept C2

Element	Cost
Design	$1,794,000
Utilities	$120,000
Right-of-Way	$386,000
Construction	$17,939,000
Maintenance and Operations (Present Worth of Ongoing Cost)	$226,000
Total Cost of Project	**$20,465,000**

All the costs are computed with 2018 dollars and it is assumed that these costs will hold for the opening year.

7.7 Alternative Concept D – Separated Grade Interchange at Egan Drive and Yandukin Drive/Fred Meyer

7.7.1 Alternative Concept

Alternative Concept D would construct a separated grade interchange with parallel entry and exit ramps onto Egan Drive. There would be two new ramp intersections on Yandukin Drive which would be constructed as single-lane roundabouts.

Figure 40 shows the concept and the extent of the impacts of the design.

The Alternative Concept D design would include a pedestrian pathway that would allow for a fully separated crossing of Egan Drive. Pedestrians would still cross the ramp terminals at the roundabouts. Much of the out-of-direction movements would be eliminated due to the newly available movements at the interchange. The alternative concept would not provide any parallel secondary roads to the area. The entry location for the northbound onramp onto Egan Drive from Yandukin Drive would be moved north as a result of the project and this would increase the difficulty of weaving from the Egan Drive onramp to the northbound left-turn lane at Egan Drive and Glacier Highway/Nugget.

Section Highlights

- Interchange design includes Egan Drive overpass of Yandukin Drive with two intersections at the base of the ramps.
- The ramp intersections are recommended to be single-lane roundabouts since two-way-stop-control intersections would not perform adequately in 2040
- An interchange would provide pedestrian crossings for Egan Drive, eliminate out-of-direction travel, and reduce overall delay without negative impacts on the Egan Drive through traffic.
- The project would cost approximately $34M to construct, with a $8.5M benefit in reduced crashes compared to the No Build alternative. The reduction in overall delay would be a benefit of $7M over the No Build condition.

At this level of the project, the interchange was analyzed at Egan Drive at Yandukin Drive. However, the location of the interchange can be moved if desirable. Based on the relative spacing of the Yandukin Drive intersection from the Glacier Highway/Nugget signal and the Sunny Point interchange, the location of the interchange can be moved closer to Sunny Point but should not be moved closer to Glacier Highway/Nugget. If the interchange location is moved from the Egan Drive intersection at Yandukin Drive to a new location, pedestrian connection, wetland impacts, and the rerouting of vehicles to use the interchange should be considered.

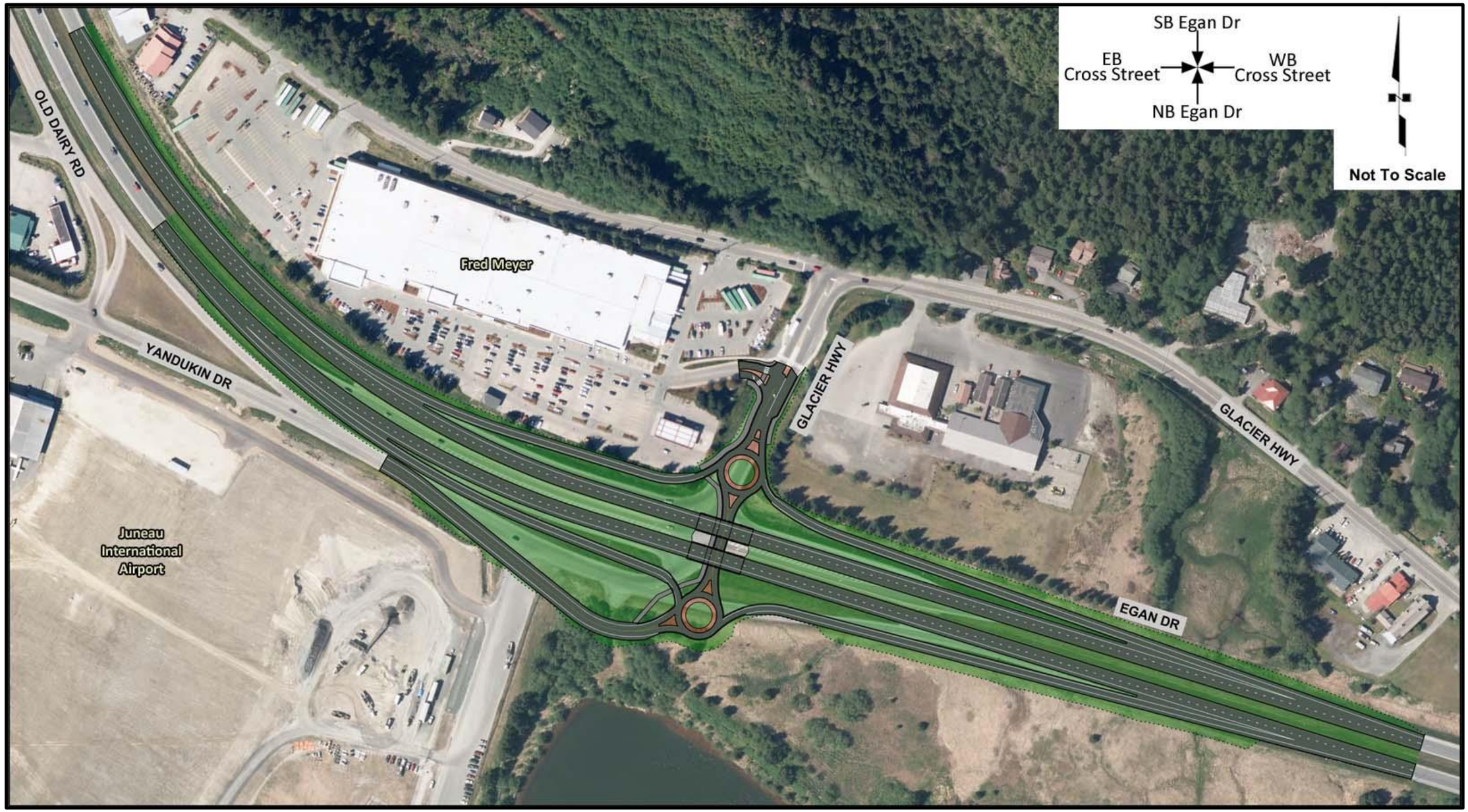


Figure 40. Concept Map, Alternative Concept D

7.7.2 Design Volumes

The redistribution of volumes under the overpass alternative concept is the same as with the signal alternative concept (Alternative Concept B), except at the ramp terminals where the intersection volumes were split to form two separate intersections.

The turning movement volumes at the various intersections are shown in Appendix B starting on page 148.

7.7.3 Design Development and Operations

The performance of the Glacier Highway/Nugget signal is projected to operate at LOS C during the AM peak hour and LOS D or better throughout the rest of the day. The performance of the northbound left at Glacier Highway/Nugget would reduce the delay from 158 seconds per vehicle to 75 seconds per vehicle (LOS F to LOS E) during the AM peak hour.

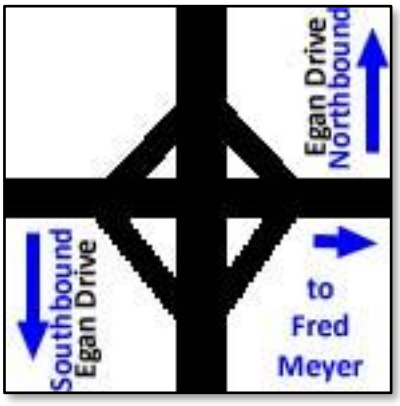
The ramp terminals at the overpass were analyzed under two control conditions: two-way stop control and roundabouts.

7.7.3.1 Two-Way Stop Control

Table 45 and Table 46 show the 2040 vehicle operations at the west and east ramp terminals under two-way stop control conditions. Although the ramp would shorten the delays for left-turning vehicles compared to no build conditions, the left-turn movements from the off-ramps are still expected to have long delays. The southbound left-turn vehicles at the west ramp would have delays of over 30 seconds per vehicle (LOS E), while northbound left-turn vehicles at the east ramp would have over 60 seconds of delay per vehicle (LOS F).

Table 45. Intersection LOS at Egan Drive & Yandukin Drive West Ramp, Two-Way Stop Control, Alternative Concept D, 2040

AM Peak	**Eastbound**			**Westbound**			**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*
Delay (sec/veh)	-	0	0	8	0	-	15	12
LOS	-	Free	Free	A	Free	-	B	B
v/c Ratio	-	-	-	0.1	-	-	0.2	0.0
Queue Length (ft)	-	-	-	< 25	-	-	25	< 25
Midday Peak	**Eastbound**			**Westbound**			**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*
Delay (sec/veh)	-	0	0	9	0	-	22	12
LOS	-	Free	Free	A	Free	-	C	B
v/c Ratio	-	-	-	0.1	-	-	0.4	0.1
Queue Length (ft)	-	-	-	< 25	-	-	50	< 25
PM Peak	**Eastbound**			**Westbound**			**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*
Delay (sec/veh)	-	0	0	9	0	-	**47**	13
LOS	-	Free	Free	A	Free	-	**E**	B
v/c Ratio	-	-	-	0.1	-	-	0.8	0.0
Queue Length (ft)	-	-	-	< 25	-	-	175	< 25



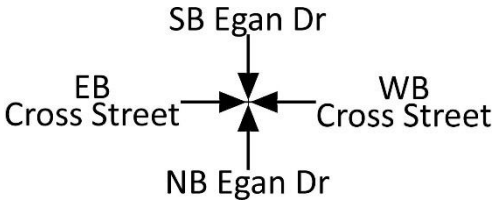
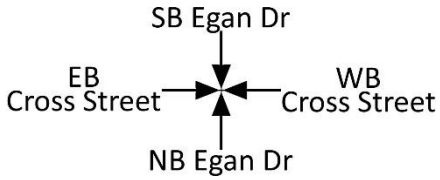


Table 46. Intersection LOS at Egan Drive & Yandukin Drive East Ramp, Two-Way Stop Control, Alternative Concept D, 2040

AM Peak	**Eastbound**			**Westbound**			**Northbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*
Delay (sec/veh)	8	0	-	-	0	0	17	10
LOS	A	Free	-	-	Free	Free	C	B
v/c Ratio	0.0	-	-	-	-	-	0.4	0.1
Queue Length (ft)	< 25	-	-	-	-	-	50	< 25
Midday Peak	**Eastbound**			**Westbound**			**Northbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	-	-	0	0	**39**	11
LOS	A	Free	-	-	Free	Free	**E**	B
v/c Ratio	0.1	-	-	-	-	-	0.8	0.2
Queue Length (ft)	< 25	-	-	-	-	-	150	25
PM Peak	**Eastbound**			**Westbound**			**Northbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	-	-	0	0	**75**	13
LOS	A	Free	-	-	Free	Free	**F**	B
v/c Ratio	0.1	-	-	-	-	-	0.9	0.3
Queue Length (ft)	< 25	-	-	-	-	-	200	25



Since the treatment of the northbound and southbound delay is a large component of the project, it is not recommended to consider stop control intersections at the ramp intersections on Yandukin Drive.

7.7.3.2 Roundabout Control

Single lane roundabouts were analyzed as an alternative to stop control intersections at the ramps. The roundabouts were modeled with a single approach lane on each leg.

Table 47 and Table 48 present the 2040 vehicle operations for the west and east ramp terminals under a roundabout configuration. Movements at the west ramp roundabouts are expected to operate at LOS B or better and movements on the east ramp would operate at LOS C or better.

Table 47. Intersection LOS at Egan Drive & Yandukin Drive West Ramp, Roundabout, Alternative Concept D, 2040

AM Peak	**Eastbound**	**Westbound**	**Southbound**
Delay (sec/veh)	8	7	6
LOS	A	A	A
v/c Ratio	0.4	0.3	0.1
Queue Length (ft)	50	50	25
Midday Peak	**Eastbound**	**Westbound**	**Southbound**
Delay (sec/veh)	11	8	9
LOS	B	A	A
v/c Ratio	0.5	0.4	0.3
Queue Length (ft)	75	50	25
PM Peak	**Eastbound**	**Westbound**	**Southbound**
Delay (sec/veh)	14	8	11
LOS	B	A	B
v/c Ratio	0.6	0.4	0.4
Queue Length (ft)	100	50	50

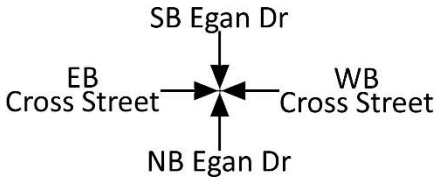
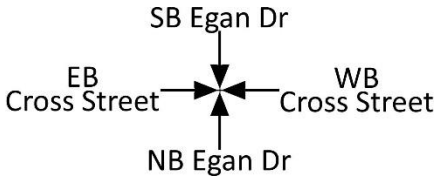


Table 48. Intersection LOS at Egan Drive & Yandukin Drive East Ramp, Roundabout, Alternative Concept D, 2040

AM Peak	**Eastbound**	**Westbound**	**Northbound**
Delay (sec/veh)	5	7	8
LOS	A	A	A
v/c Ratio	0.2	0.3	0.3
Queue Length (ft)	25	25	50
Midday Peak	**Eastbound**	**Westbound**	**Northbound**
Delay (sec/veh)	7	14	13
LOS	A	B	B
v/c Ratio	0.3	0.6	0.5
Queue Length (ft)	50	100	75
PM Peak	**Eastbound**	**Westbound**	**Northbound**
Delay (sec/veh)	8	23	17
LOS	A	C	C
v/c Ratio	0.5	0.8	0.6
Queue Length (ft)	75	200	100



7.7.4 On- and Off-Ramp Performance

Table 49 presents the eastbound right-turn movement operation at the Glacier Highway/Nugget signal, as well as the LOS for the on- and off-ramps at the Yandukin Drive interchange. The ramps are all expected to operate at LOS B or better.

7.7.4.1 Fred Meyer Driveway Performance

The operation and the proximity of the Fred Meyer driveway on Lemon Road and the off-ramps for the new interchange at Yandukin Drive at Egan Drive may cause some conflicts and should be considered for retrofitting as an extension of the Alternative Concept D interchange project.

7.7.4.1.1 Intersection Delay

Table 50 presents the 2040 vehicle operations at the Fred Meyer driveway at Glacier Highway/ Lemon Road. During the PM peak hour, southbound left turns out of Fred Meyer are expected to have delays of over 90 seconds per vehicle.

Table 49. Ramp LOS, Alternative Concept D, 2040

Intersection	**Ramp**	**Ramp Free Flow Speed** (mph)	**Merge Length** (feet)	**AM LOS**	**Midday LOS**	**PM LOS**
Egan Dr and Glacier Hwy/Nugget	Southbound On-Ramp	30	780	B	B	B
Egan Dr and Yandukin Dr	Southbound On-Ramp	35	1,100	B	A	A
	Southbound Off-Ramp	35	650	B	A	A
	Northbound On-Ramp	35	1,100	A	A	B
	Northbound Off-Ramp	35	650	A	A	B

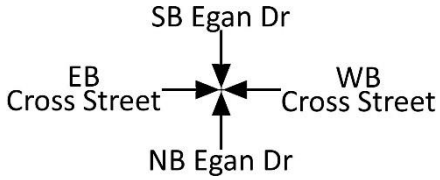
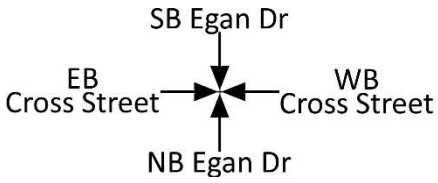


Table 50. Intersection LOS at Glacier Highway/Lemon Road & Fred Meyer Driveway, Alternative Concept D, 2040 PM Peak

PM Peak	**Eastbound**		**Westbound**		**Southbound Fred Meyer Driveway**	
	Left	*Through*	*Through*	*Right*	*Left*	*Right*
Delay (sec/veh)	10	0	0	0	**97**	14
LOS	A	Free	Free	Free	**F**	B
v/c Ratio	0.4	-	-	-	0.7	0.5
Queue Length (ft)	50	-	-	-	75	75



Turning movements were not collected at the Fred Meyer driveway outside of the peak hour period; therefore, no judgments can be made about the performance of the intersection in the AM and midday periods.

7.7.4.1.2 Intersection Functional Area and Impacts

Figure 41 presents the functional area of the east leg at the east ramp roundabout. The functional area extends to the Glacier Highway/Lemon Spur intersection with Glacier Highway/Lemon Road. The Fred Meyer driveway is within the functional area, indicating that vehicles using the driveway would add more conflict to the vehicles traveling through the roundabout; therefore, it is recommended with this alternative concept that the Fred Meyer driveway is restricted with a raised median to right-in-right-out-left-in operation.

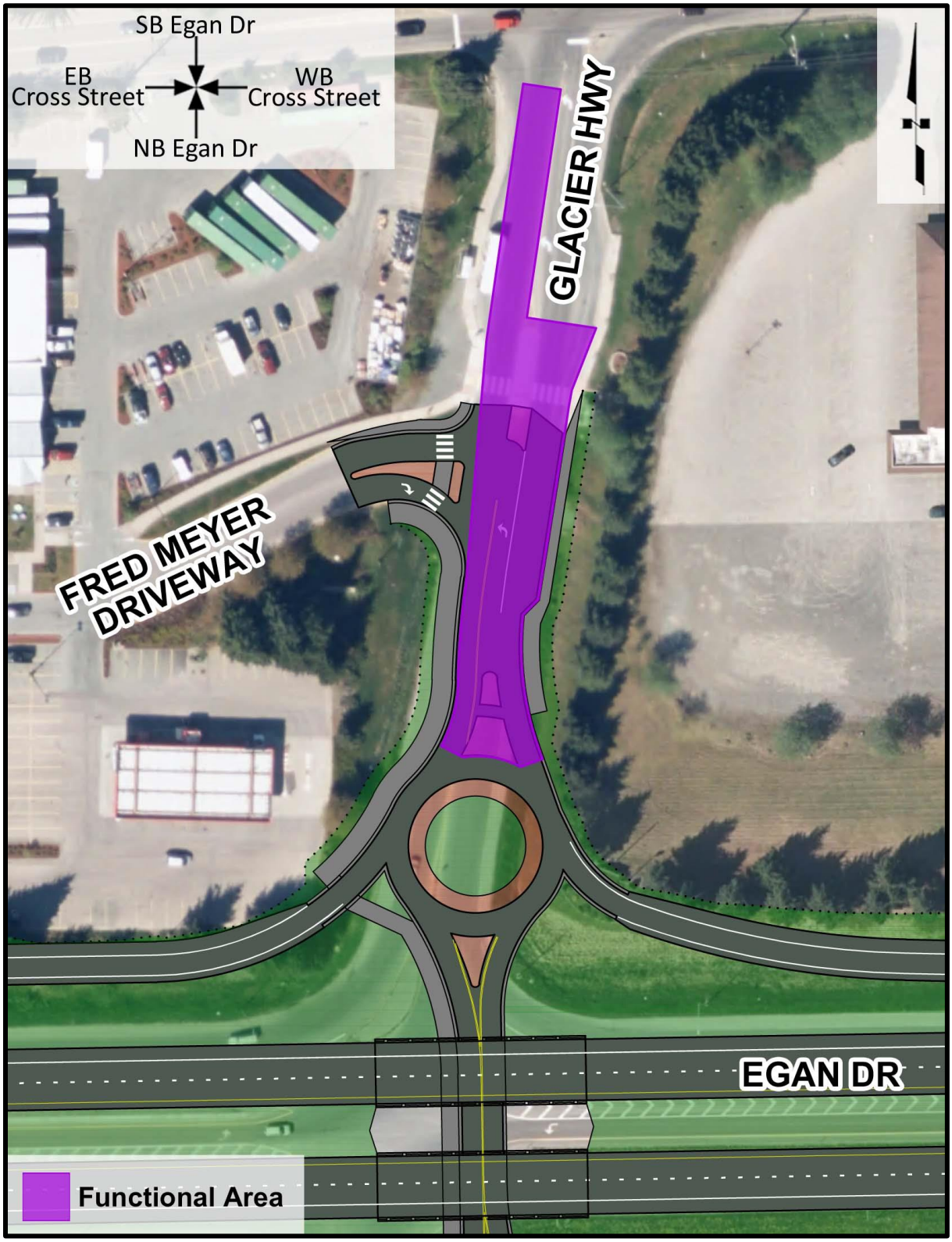


Figure 41. Alternative Concept D – Functional Area

7.7.4.1.3 Lane Consideration

The functional area of east ramp roundabout indicates that the Fred Meyer driveway should be considered to be closed to left-turn traffic both entering and exiting the parking lot. The westbound queue on the east ramp roundabout is 150 feet long during the midday peak and 200 feet long during the PM peak, each longer than the distance between the westbound approach and the Fred Meyer driveway (a distance of about 100 feet). As such, westbound vehicles would queue past the driveway during these peak hours and block vehicles from entering the driveway.

The performance of the Fred Meyer driveway indicates that vehicles turning left out of the driveway (southbound left) will experience long delays of over one minute, while vehicles turning left into the driveway (eastbound left) will experience relatively low delay. Thus, it is recommended that the Fred Meyer driveway is closed to left-turn traffic exiting the parking lot and consider it to be closed for left-turn traffic entering the parking lot.

7.7.5 Pedestrian and Cyclist Crossing Operations

Table 51 presents the pedestrian delay at the Glacier Highway/Nugget signal. As the signal timing at the Glacier Highway/Nugget signal is assumed to stay the same for the overpass alternative concept, the pedestrian delay will be the same as existing and no build conditions. There is a high likelihood of pedestrians crossing against the pedestrian signal.

Table 51. Pedestrian Delay at Egan Drive & Glacier Highway/Nugget, Alternative Concept C2, 2040

Peak Hour	Crossing Location	Average Pedestrian Delay (sec)
Midday	South Leg	40-60
	West Leg	40-60
PM	South Leg	40-60
	West Leg	40-60

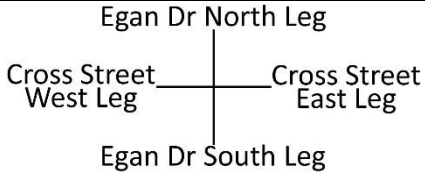


Table 52 and Table 53 present the pedestrian crossing delays at the roundabout ramp terminals for the midday and PM peak hours. Pedestrians are expected to experience delays less than 15 seconds at both roundabouts, with a moderate likelihood of pedestrians taking the risk of crossing Yandukin Drive with shorter gaps in the PM peak.

Table 52. Pedestrian Delay at Overpass Ramp Terminals, Alternative Concept D, 2040 Midday Peak Hour

Ramp Terminal	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
West Ramp	South Leg	3	Low
	North Leg	1	Low
	West Leg	9	Low
	East Leg	9	Low
East Ramp	South Leg	4	Low
	North Leg	3	Low
	West Leg	9	Low
	East Leg	9	Low

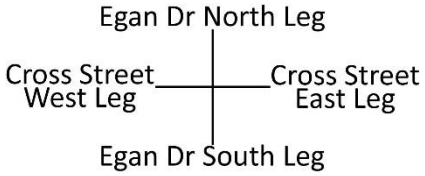
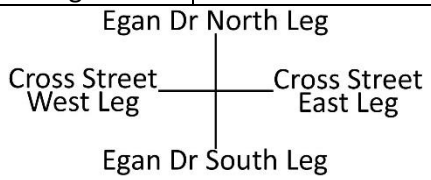


Table 53. Pedestrian Crossing at Overpass Ramp Terminals, Alternative Concept D, 2040, PM Peak Hour

Ramp Terminal	Crossing Location	Average Pedestrian Delay (sec)	Likelihood of Risk-Taking Behavior
West Ramp	South Leg	3	Low
	North Leg	3	Low
	West Leg	8	Low
	East Leg	10	Moderate
East Ramp	South Leg	4	Low
	North Leg	5	Low
	West Leg	10	Moderate
	East Leg	14	Moderate



7.7.6 Cost-Benefit Analysis

7.7.6.1 Delay

Table 54 presents the total value of delay under this alternative concept compared to the no-build alternative concept. Unlike Alternative Concept B, the overall delay of traffic decreases, since the Egan Drive through traffic remains free-flowing on the overpass.

Table 54. Net Present Value of Delay Compared to No Build, Overpass Alternative Concept

Intersection	Net Present Value of Delay
Egan Drive at Yandukin Drive/Fred Meyer	$205,000
Egan Drive at Glacier Highway/Nugget	$6,686,000
Total	**$6,891,000**

The total value of delay is positive, indicating that the overall delay is reduced.

7.7.6.2 Safety

By constructing an interchange at Yandukin Drive, this alternative concept will eliminate high-speed crossing crashes and reduce crashes associated with vehicles slowing or stopping. Some crashes related to running off the road will still be expected, and there will be low-speed merging conflicts associated with the roundabouts at the ramp intersections. The CMFs for this analysis were taken from the CMF Clearinghouse. The CMF Clearinghouse is a website associated with the HSM that provides the user with access to all known published CMFs. The CMF for this alternative concept was taken from this website, based on high-quality studies that were

published in the Handbook of Road Safety Measures, by Elvik & Erke. The CMF Clearinghouse rates the provided CMFs based on the rigor of the study that developed them, with a 5-star rating indicating the highest or best rating. Elvik & Erke's CMFs for the construction of interchanges are applied to crashes depending on severity. The CMF for fatal and injury crashes is 0.43 (5-star rating, standard error 0.05; CRF = 57%) and for property damage only crashes is 0.64 (4-star rating, standard error 0.14; CRF = 36%).

Table 55 presents the value of crashes under this alternative concept. Similar to Alternative Concept B (installation of a signal) there is a small change in the number of expected crashes at the Glacier Highway/Nugget intersection because vehicles can travel directly across Egan Drive at the Yandukin Drive interchange under this alternative concept.

Table 55. Expected Net Present Value of Crashes, Alternative Concept D, 2020 to 2040

Intersection	Expected Number of Crashes, 2020 to 2040	Net Present Value Cost of Crashes, 2020 to 2040
Yandukin Dr/Fred Meyer	99	$ 8,104,600
Glacier Hwy-Nugget	225	$ 11,142,600
TOTAL	**324**	**$ 19,247,200**

7.7.6.3 Development, Construction, Maintenance and Operations Costs

The life-cycle present worth costs (borne by DOT&PF) for Alternative Concept D are as follows:

Table 56. Life Cycle Project Costs, Alternative Concept D

Element	Cost
Design	$3,056,000
Utilities	$20,000
Right-of-Way	$415,000
Construction	$30,559,000
Maintenance and Operations (Present Worth of Ongoing Cost)	$117,000
Total Cost of Project	**$34,167,000**

All the costs are computed with 2018 dollars and it is assumed that these costs will hold for the opening year.

8 Sensitivity Analysis

The estimated benefit and cost values for the alternative concepts are based on a number of assumptions that result in "best guess" values for future conditions, but do not present the possible range of future values. The possible range can be better understood using a sensitivity analysis that addresses the uncertainty of each cost element.

Table 57 shows a range of variables that affect the results of the analysis and how they were accounted for in the sensitivity analysis.

Section Highlights

- A sensitivity analysis was used to estimate the range of possible values for different categories of costs.
- Construction Costs: Alternatives B and C2 have approximately the same costs, while Alternative C1 is less expensive and Alternative D is more expensive.
- Crash Savings: All alternatives will reduce the number and severity of crashes, resulting in cost savings. The amount of cost savings is not very different between alternatives.
- Change in Delay: Both Alternative B and C2 introduce a significant amount of delay to the through traffic on Egan Drive. Alternative C1 introduces a small amount of delay, while Alternative D results in a slight decrease in overall delay.
- Net Present Worth: The construction costs, crash savings, and change in delay value can be combined to determine net present worth. The net present worth of all of the alternatives is negative, indicating that the measurable benefits (increased safety and decreased delay) do not outweigh the costs. However, the DOT&PF does not make decisions based solely on cost. Other factors such are safety, public welfare, and mobility of goods, among others, are considered in making decisions.

Table 57. Assumed Variation in Future Conditions

	Variables	Base Value	Assumed Variation	Reference
Crash Experience	Crash type/Severity	140% of historical crash values	+/-40%	Review of Alaska uncontrolled and signalized intersection crashes on high mobility roadways
	Value of Crash Severity	100% (KABCO Costs)	-44% to +40% of base value	DOT&PF 2018 KABCO costs
	Crash Reduction Factor for mitigation	100% of CRF for applicable crashes	+/-20%	Engineering judgment
Vehicle Delay	Total entering volumes	100% of delay	+/- 20%	Engineering judgment
	Turning movement volume distribution			
	Peak hour factor			
	Traffic control parameters like cycle length and splits			
	Value of Time			
Construction Costs	-	100% of Construction Estimate	-30% to +60%	Advancement of Cost Engineering, Recommended Practice No. 18R; for concept phase of the project

Each of these values can be described by a triangular distribution, in which the area bounded by the limits is equal to 1. The most likely outcome is the value shown as the Base Value in Table 57 and there is no assumed likelihood that values will be outside of the variation values shown in Table 57. As an example, Figure 42 shows the range of possible construction cost values for Alternative Concept B (Signal) and the likelihood that a particular cost is chosen.

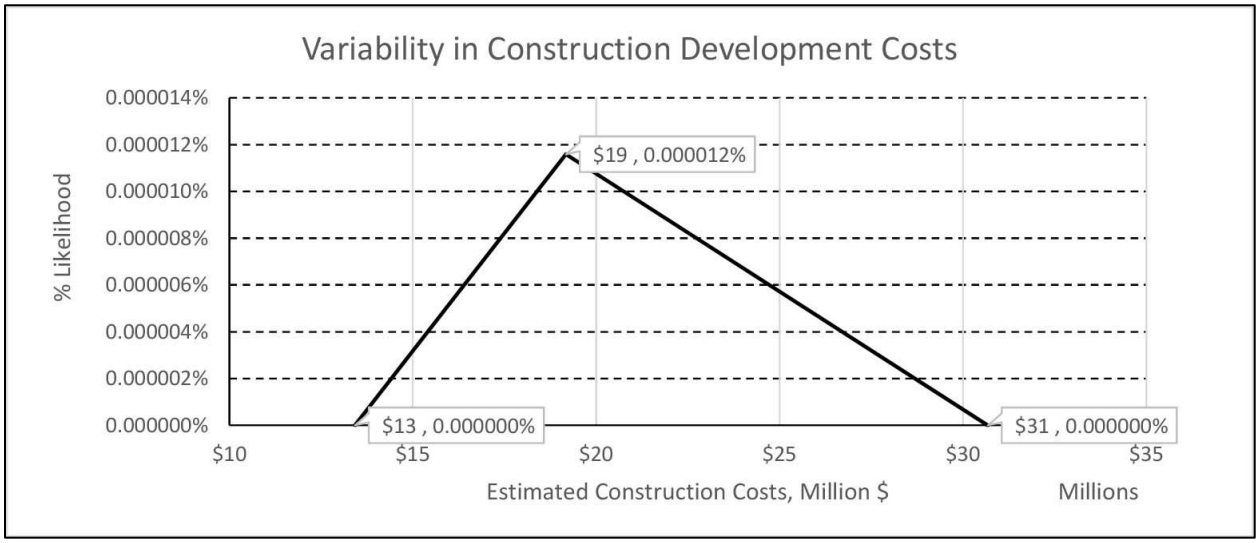


Figure 42. Example Triangular Distribution of Variability (Construction Cost for Alt B – Signal)

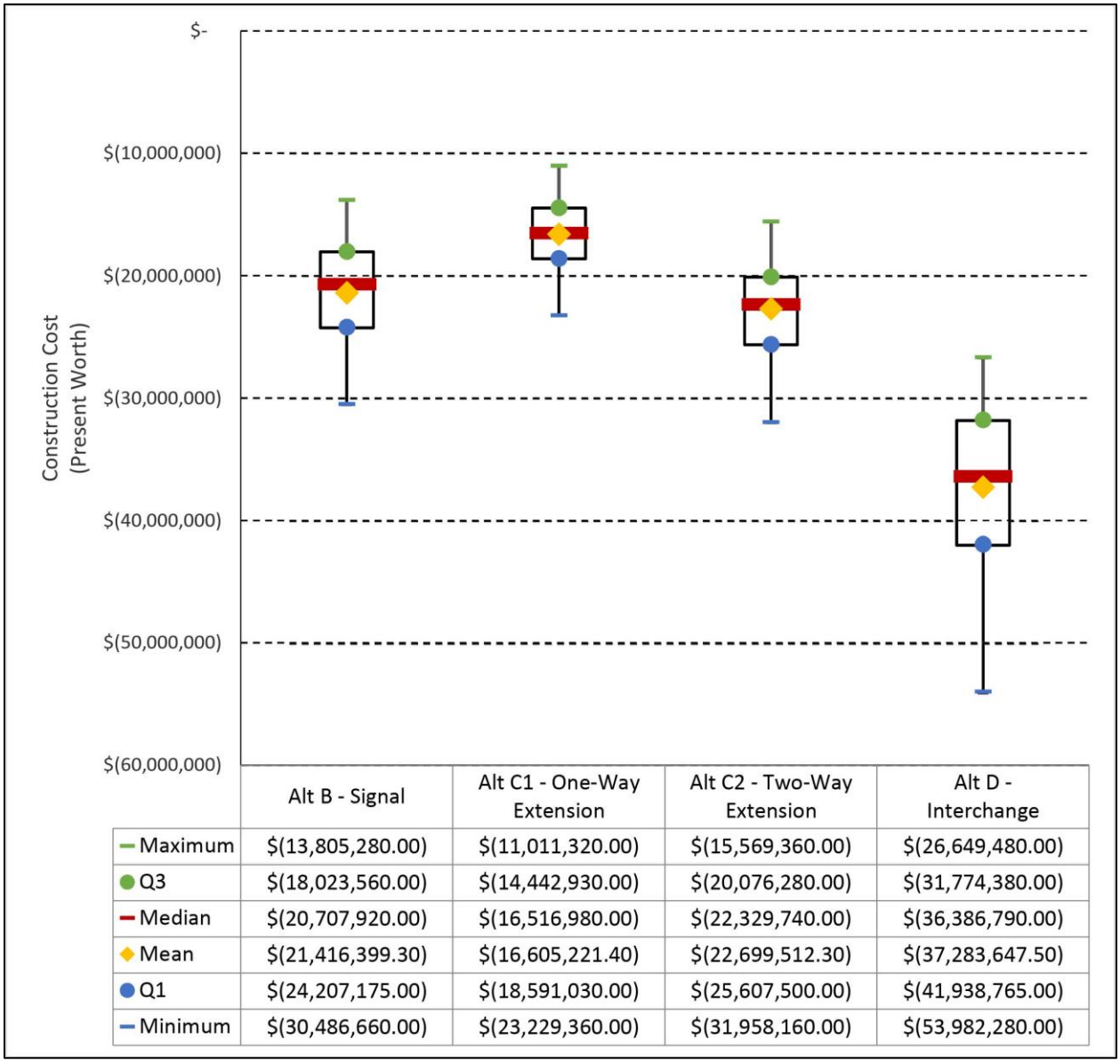
A simulation algorithm was used to determine how changes in each of the values in Table 57, given their respective likelihood distributions would change the overall alternative concept cost. Each cost calculation was repeated 200 times with new values for each category being randomly selected from the variable distribution. From the resulting 200 samples, the following attributes were extracted:

- Sample mean (arithmetical central tendency)
- Sample standard deviation (a measure of dispersion and necessary to estimate the true population mean at a 95% confidence interval)
- Maximum and minimum values of samples
- Median (sample value where 50% of samples are above and below, 50 percentile)
- 25^{th} (Q1) and 75^{th} (Q3) percentile quartiles (measures of dispersion)

Each of the three components (project development and construction cost, crash savings, and change in delay) of the net present worth are evaluated individually and compared to the existing condition. Note that crash costs for the build alternative concepts are positive if the number of crashes is reduced as compared to the no-build alternative concept. Similarly, the delay costs for the build alternative concepts are positive if the delay is reduced compared to the no-build alternative concept (and negative if the delay is increased). The construction costs are shown as negative since there is no design and construction cost for the no-build alternative concept (Alternative Concept A).

Figure 43 compares the construction costs across the build alternative concepts with a “box and whisker” plot that illustrates the statistical attributes of each sample. Alternative Concept B (the

construction of a signal at Yandukin Drive near Fred Meyer) costs about the same as Alternative Concept C2 (the two-way extension of Glacier Highway/Lemon Spur to the Glacier Highway/Nugget intersection). Alternative Concept C1 (the one-way extension of Glacier Highway/Lemon Spur to the Glacier Highway/Nugget intersection) is the least expensive, while Alternative Concept D (the interchange alternative concept) is the most expensive.

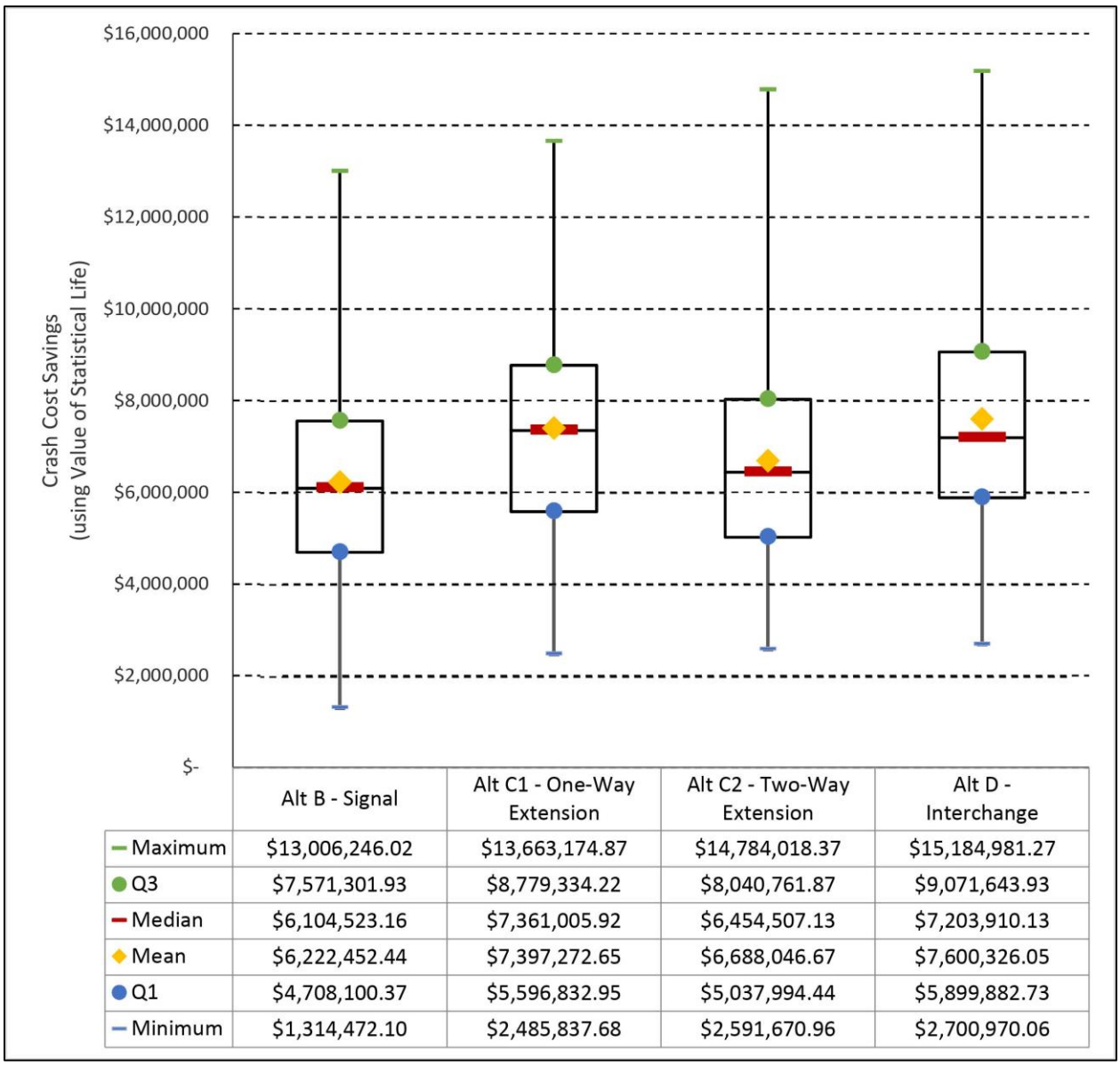


	Alt B - Signal	Alt C1 - One-Way Extension	Alt C2 - Two-Way Extension	Alt D - Interchange
Maximum	$(13,805,280.00)	$(11,011,320.00)	$(15,569,360.00)	$(26,649,480.00)
Q3	$(18,023,560.00)	$(14,442,930.00)	$(20,076,280.00)	$(31,774,380.00)
Median	$(20,707,920.00)	$(16,516,980.00)	$(22,329,740.00)	$(36,386,790.00)
Mean	$(21,416,399.30)	$(16,605,221.40)	$(22,699,512.30)	$(37,283,647.50)
Q1	$(24,207,175.00)	$(18,591,030.00)	$(25,607,500.00)	$(41,938,765.00)
Minimum	$(30,486,660.00)	$(23,229,360.00)	$(31,958,160.00)	$(53,982,280.00)

Figure 43. Comparison of Simulation Present Worth Development Costs (Design, Construction, Maintenance and Operations) for Build Alternative Concepts

Figure 44 shows the change in the present worth costs of crashes (crash cost savings) between the no-build alternative concept and each of the build alternative concepts. While there are

differences in the mean and median crash cost savings over the four build alternative concepts, the interquartile ranges overlap, indicating that the crash savings is approximately the same over the four build alternative concepts.

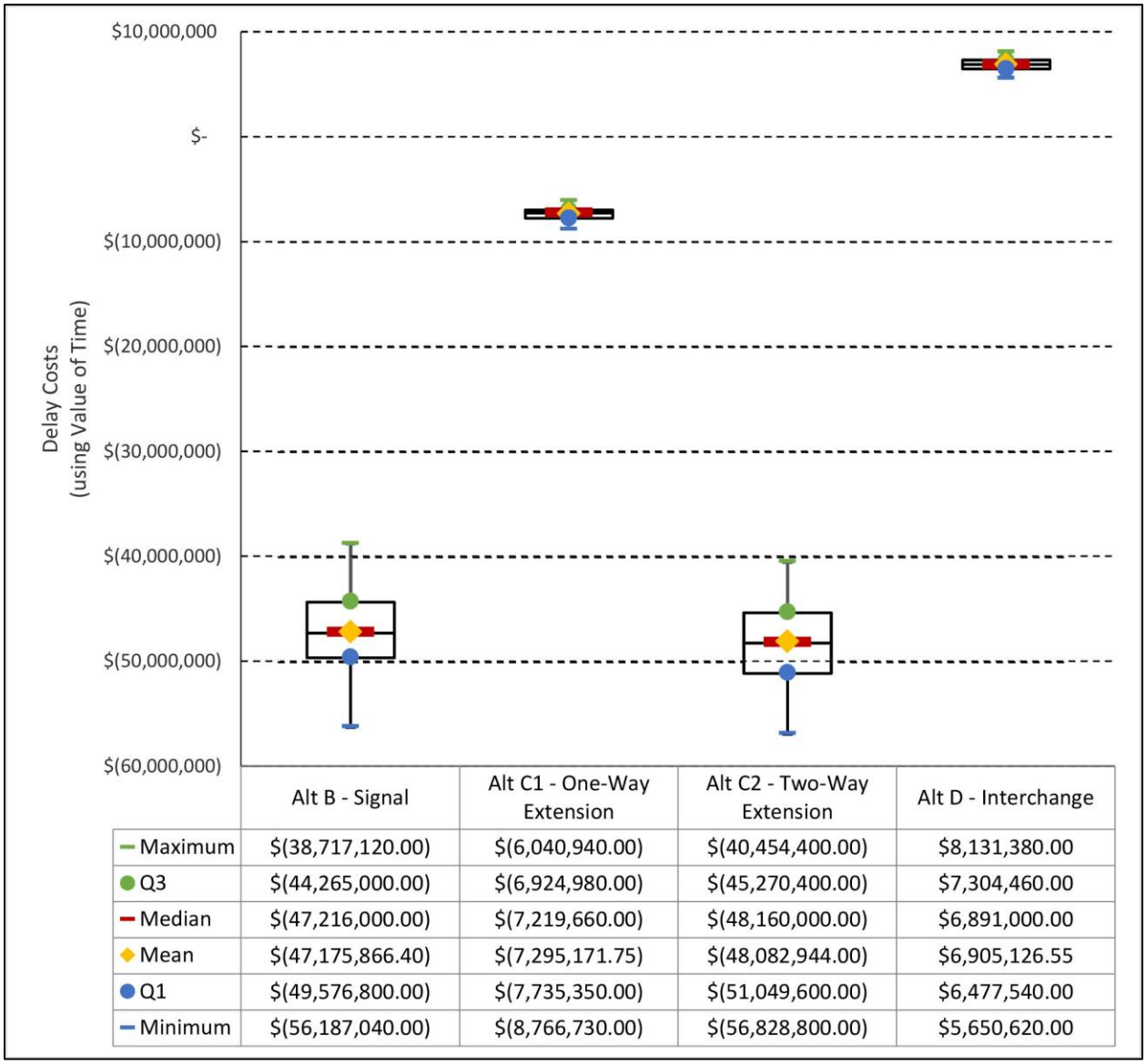


	Alt B - Signal	Alt C1 - One-Way Extension	Alt C2 - Two-Way Extension	Alt D - Interchange
Maximum	$13,006,246.02	$13,663,174.87	$14,784,018.37	$15,184,981.27
Q3	$7,571,301.93	$8,779,334.22	$8,040,761.87	$9,071,643.93
Median	$6,104,523.16	$7,361,005.92	$6,454,507.13	$7,203,910.13
Mean	$6,222,452.44	$7,397,272.65	$6,688,046.67	$7,600,326.05
Q1	$4,708,100.37	$5,596,832.95	$5,037,994.44	$5,899,882.73
Minimum	$1,314,472.10	$2,485,837.68	$2,591,670.96	$2,700,970.06

Figure 44. Comparison of Present Worth Crash Savings for Build Alternative Concepts

Figure 45 shows the change in the cost of delay between the no-build alternative concept and each of the build alternative concepts. Alternative Concept B (installation of a signal at Yandukin Drive near Fred Meyer) and Alternative Concept C2 (two-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) both add a significant amount of delay. This is because all traffic traveling on Egan Drive will have to stop more frequently. Alternative

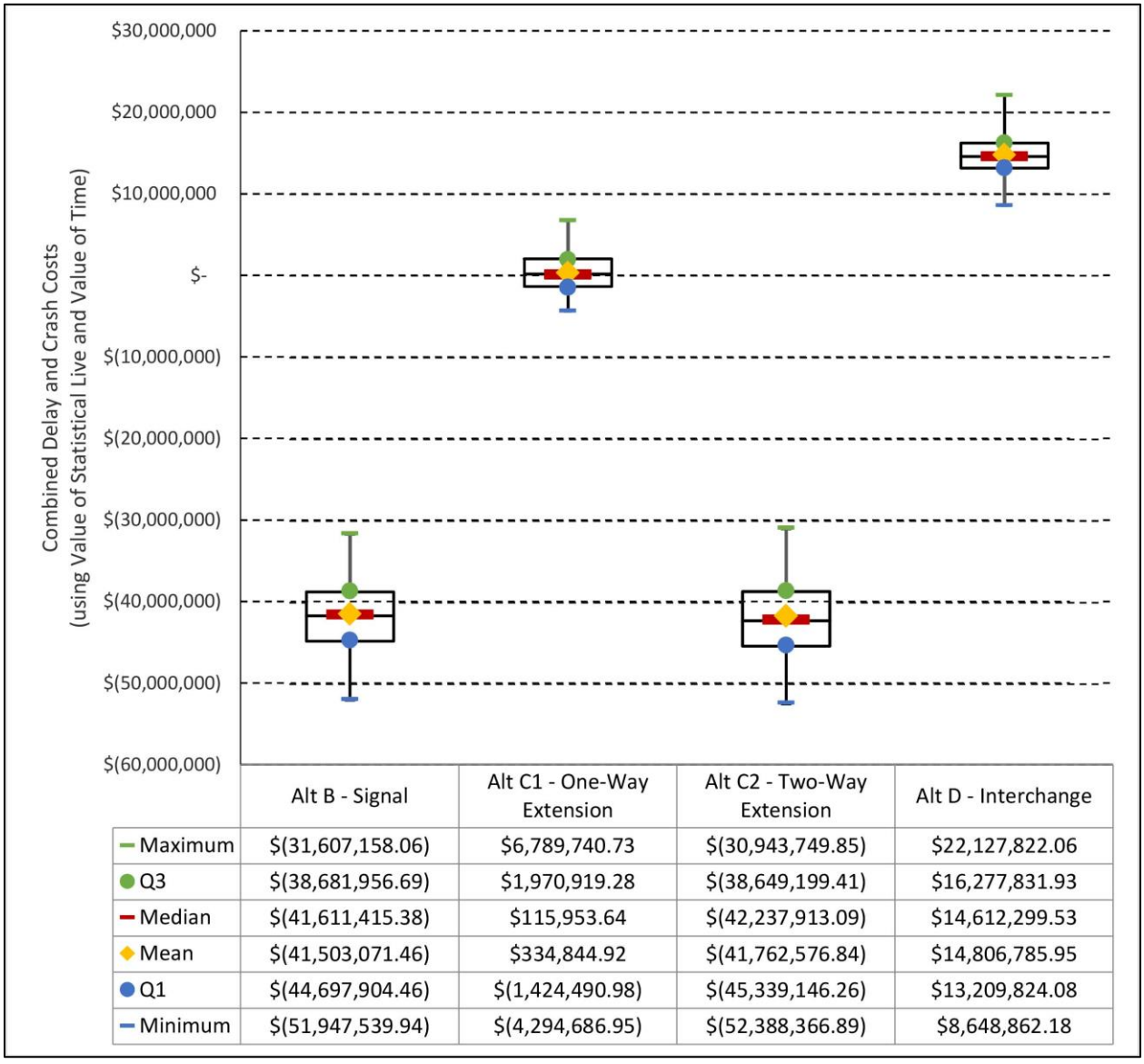
Concept C1 (one-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) adds a small amount of delay. Alternative Concept D (interchange) reduces delay somewhat because left turn vehicles from Egan Drive will experience less delay at the interchange ramps than they currently do. Additionally, a small portion of the traffic currently using the Glacier Highway/Nugget intersection would move to the Yandukin Drive interchange. This traffic would also experience less delay than currently.



	Alt B - Signal	Alt C1 - One-Way Extension	Alt C2 - Two-Way Extension	Alt D - Interchange
Maximum	$(38,717,120.00)	$(6,040,940.00)	$(40,454,400.00)	$8,131,380.00
Q3	$(44,265,000.00)	$(6,924,980.00)	$(45,270,400.00)	$7,304,460.00
Median	$(47,216,000.00)	$(7,219,660.00)	$(48,160,000.00)	$6,891,000.00
Mean	$(47,175,866.40)	$(7,295,171.75)	$(48,082,944.00)	$6,905,126.55
Q1	$(49,576,800.00)	$(7,735,350.00)	$(51,049,600.00)	$6,477,540.00
Minimum	$(56,187,040.00)	$(8,766,730.00)	$(56,828,800.00)	$5,650,620.00

Figure 45. Comparison of Simulation Present Worth Change in Delay Costs for Build Alternative Concepts

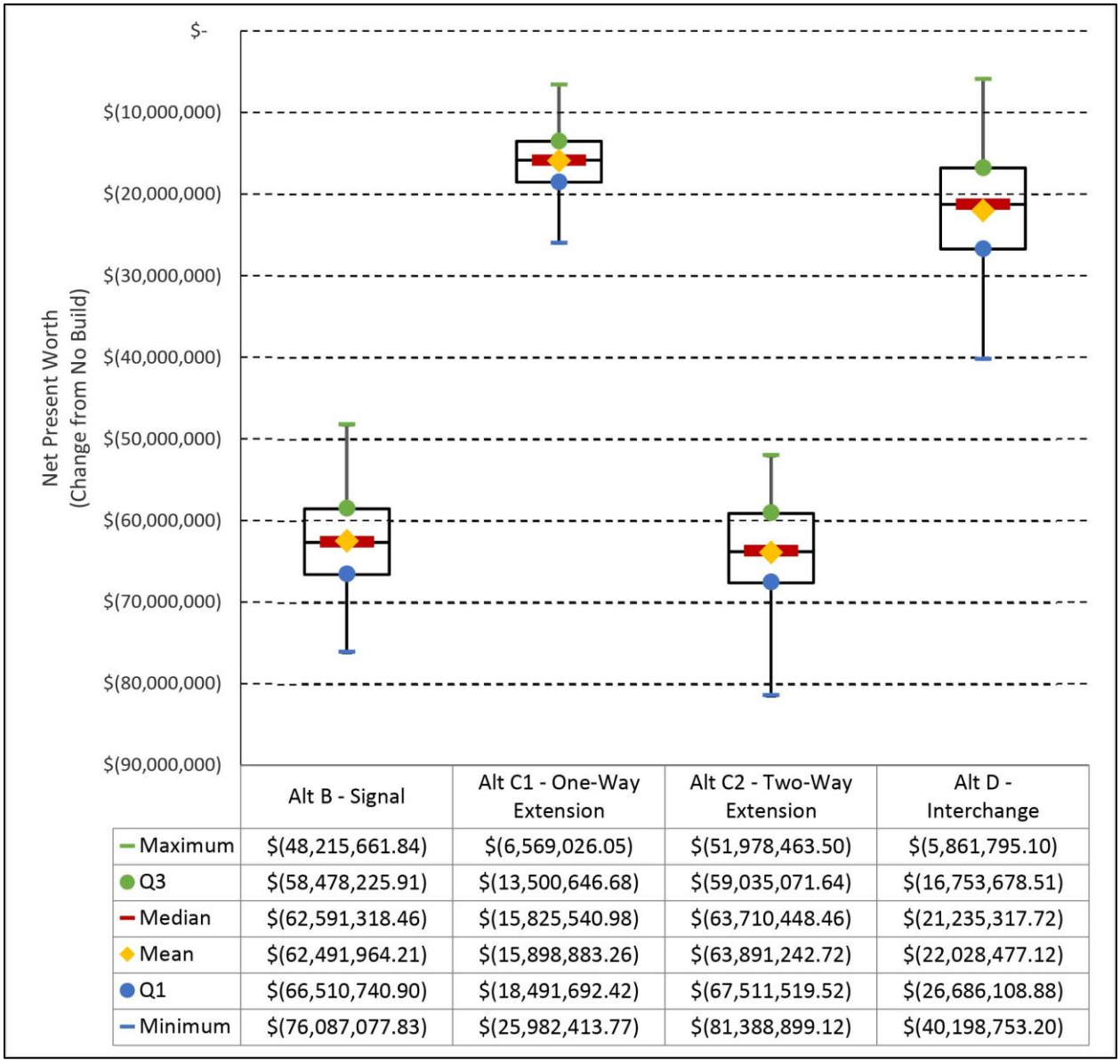
Figure 46 shows the combined present worth value of the crash savings and change in delay costs. These two measures could be considered the measurable benefit of each alternative concept. As with the previous graphs, Alternative Concepts B and C2 are very similar, Alternative Concept C1 provides a net benefit very close to zero, while Alternative Concept D provides a combined positive benefit.



	Alt B - Signal	Alt C1 - One-Way Extension	Alt C2 - Two-Way Extension	Alt D - Interchange
Maximum	$(31,607,158.06)	$6,789,740.73	$(30,943,749.85)	$22,127,822.06
Q3	$(38,681,956.69)	$1,970,919.28	$(38,649,199.41)	$16,277,831.93
Median	$(41,611,415.38)	$115,953.64	$(42,237,913.09)	$14,612,299.53
Mean	$(41,503,071.46)	$334,844.92	$(41,762,576.84)	$14,806,785.95
Q1	$(44,697,904.46)	$(1,424,490.98)	$(45,339,146.26)	$13,209,824.08
Minimum	$(51,947,539.94)	$(4,294,686.95)	$(52,388,366.89)	$8,648,862.18

Figure 46. Comparison of Simulated Present Worth Combined Crash Savings and Change in Delay Costs for Build Alternative Concepts

Figure 47 combines the three measurable components of net present worth simultaneously, comparing the net present worth of all three build alternative concepts. The net present value of all of the alternative concepts is negative, indicating that the construction costs are greater than the crash and delay benefit. Since the error bars all fall within the negative range, it is unlikely that a positive net worth could be achieved with these alternative concepts.



	Alt B - Signal	Alt C1 - One-Way Extension	Alt C2 - Two-Way Extension	Alt D - Interchange
Maximum	$(48,215,661.84)	$(6,569,026.05)	$(51,978,463.50)	$(5,861,795.10)
Q3	$(58,478,225.91)	$(13,500,646.68)	$(59,035,071.64)	$(16,753,678.51)
Median	$(62,591,318.46)	$(15,825,540.98)	$(63,710,448.46)	$(21,235,317.72)
Mean	$(62,491,964.21)	$(15,898,883.26)	$(63,891,242.72)	$(22,028,477.12)
Q1	$(66,510,740.90)	$(18,491,692.42)	$(67,511,519.52)	$(26,686,108.88)
Minimum	$(76,087,077.83)	$(25,982,413.77)	$(81,388,899.12)	$(40,198,753.20)

Figure 47. Sensitivity Analysis Box Plot of Net Present Worth of Alternative Concepts

8.1 User Impacts

Two components of net present worth (crash savings and change in delay) affect a person traveling through the area. A reduction in crashes is an increase in crash cost savings and would

save a person money, while an increase in crashes would be a decrease in crash cost savings and may cost a person more money. For change in delay, a decrease in delay would save a person money while an increase in delay would cost a person more money.

9 Summary and Comparison of Alternative Concepts

Section Highlights

- Alternative D (interchange) provides the most benefit in terms of quantifiable and non-quantifiable factors; however, this alternative also has the highest construction cost.
- Alternatives B (signal at Yandukin Drive) and C2 (extension of Glacier Highway/Lemon Spur) provide about the same measurable benefit, with approximately the same measurable costs.
- Alternative C2 would provide a bypass route for traffic if the Yandukin Drive intersection is closed.

In addition to the quantifiable differences between the alternative concepts that were discussed in Section 8, there are other factors that are more difficult to quantify, but that should also be considered in comparing these alternative concepts. These include:

- System network redundancy. Egan Drive is the primary route between downtown Juneau, Lemon Creek, and the Mendenhall Valley. While Glacier Highway provides a parallel route from downtown Juneau through Lemon Creek to the Fred Meyer area and there are parallel roadways on the airport side from the Fred Meyer area to Brotherhood Bridge, all traffic between downtown Juneau/Lemon Creek and the Mendenhall Valley must pass through the intersection of Egan Drive with Yandukin Drive at Fred Meyer. There is no alternate route for this intersection.
- Pedestrian network. Currently, the pedestrian network travels between Lemon Creek and Fred Meyer only on the Lemon Creek side of Egan Drive. There is no pedestrian infrastructure for crossing Egan Drive between the Glacier Highway/Nugget intersection and the Sunny Point overpass, a distance of about 2 miles. While there is a significant portion of this segment that is unlikely to attract much pedestrian crossing demand, anecdotal evidence suggests that there are pedestrians crossing Egan Drive at the Yandukin Drive intersection near Fred Meyer. A pedestrian would have to walk ¾ mile from the Yandukin Drive intersection to get to the nearest crossing point.
- Pedestrian crossing delay. Different types of traffic control and different crossing distances result in differing amounts of delay for pedestrians. Since the number of pedestrians is much smaller than the number of vehicles, the change in pedestrian delay for each alternative concept is not visible in the change of delay values.
- Out-of-direction vehicle travel. Currently, the Yandukin Drive intersection is right-in-right-out-left in. This results in out-of-direction movements for vehicles from the side streets for whom a left turn or through movement would be most efficient. While some of the benefits of the reduced out-of-direction travel is captured in the cost of change in delay, there are additional travel time benefits that have not been captured in that value.

Table 58 compares the alternative concepts for the three quantifiable categories, as well as the four more subjective categories that were just described.

Table 58. Summary Comparison of Alternative Concepts

Alternative Concept	Construction Cost	Change in Delay Costs	Crash Savings	System Network Redundancy	Pedestrian Network	Pedestrian Crossing Delay	Out-of-direction Vehicle Movement
Alternative Concept A No Build	$0	$0	$0				
Alternative Concept B Signal	- $19 million	-$47 million	**+$7.8 million**		✓		✓
Alternative Concept C1 One-Way Extension	- $15 million	-$7 million	**+$10.4 million**	✓			
Alternative Concept C2 Two-Way Extension	-$21 million	-$48 million	**+$9.0 million**	✓			✓
Alternative Concept D Interchange	-$34 million	**+$7 million**	**+$10.5 million**	✓	✓	✓	✓

KEY: ✓ = this factor is significantly improved by this alternative concept; ✓ = this factor is somewhat improved by this alternative concept

9.1 Construction Costs

Alternative Concept C1 would cost the least of all the alternative concepts. The major cost for Alternative Concept C1 (the one-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) is the construction of about 2,500 feet of new road.

Alternative Concepts B and C2 would cost roughly the same in construction costs. The major cost for Alternative Concept C2 (the two-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) is the construction of about 2,500 feet of new road, as well as the addition of a third lane outbound on Egan Drive. For Alternative Concept B (signal at Yandukin Drive near Fred Meyer), the costs include reconstruction of the intersection approach on the airport side of Egan Drive, as well as a third lane from south of Fred Meyer to the Mendenhall Loop Road signal.

Alternative Concept D (interchange) would cost about 1.5 times the cost of the other build alternative concepts, as it would involve the construction of a bridge and two ramps, in addition to the reconstruction of the intersection approach on the airport side of Egan Drive.

9.2 Change in Delay Costs

Alternative Concept B (signal at Yandukin Drive near Fred Meyer) adds significant delay to Egan Drive, as many through vehicles would have to stop while the left turns and side street vehicles had a green signal. Similarly, Alternative Concept C2 (the two-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) adds delay because it adds an additional phase to the Glacier Highway/Nugget signal. Alternative Concept C1 (the one-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) adds a small amount of delay to the Glacier Highway/Nugget intersection because of increased volumes and additional movements (southbound left and eastbound through). Only Alternative Concept D (interchange) reduces overall delay because it reduces delay for left turns off of Egan Drive and it reduces delay for vehicles that currently must travel to the Glacier Highway/Nugget intersection to cross Egan Drive.

9.3 Crash Savings

A reduction of crashes is the primary goal of this project, due to a history of left turn crashes with relatively high severity. All four of the build alternative concepts would reduce the number and severity of crashes overall. Under Alternative Concept B (signal at Yandukin Drive near Fred Meyer), the high-severity left turn crashes would be reduced, but lower-severity rear-end crashes would likely increase. Under both Alternative Concepts C1 and C2 (the one-way or two-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget), left turn and other cross-median crashes would be eliminated at the Yandukin Drive intersection, but crashes would likely increase slightly at the Glacier Highway/Nugget intersection. Under Alternative Concept

D (interchange), there would be a significant decrease in higher-severity crashes and a moderate decrease in lower-severity crashes.

9.4 System Network Redundancy

Only Alternative Concept C2 (the two-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) adds significant system redundancy. Under this alternative concept, if there was an accident at the Egan Drive intersection with Yandukin Drive at Fred Meyer, vehicles could use Glacier Highway/Lemon Spur to bypass it and still reach destinations in the Mendenhall Valley. Alternative Concept C1 (the one-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) adds additional redundancy for traffic headed towards downtown (southbound) but does not improve redundancy for the northbound movement. Alternative Concept D (the interchange) also provides some redundancy, since if there was an accident on the overpass, traffic could divert off of Egan Drive onto the ramps and then back onto Egan Drive. However, if there was an accident at one of the ramp intersections that closed Yandukin Drive/Glacier Highway/Lemon Road, drivers could still reach their destinations, but they would have to travel out of their way to get there.

9.5 Pedestrian Network

Both Alternative Concept B (signal at Yandukin Drive at Fred Meyer) and Alternative Concept D (interchange) would provide infrastructure for a new pedestrian crossing of Egan Drive.

9.6 Pedestrian Crossing Delay

Pedestrian delay for crossing Egan Drive would not be reduced to better than LOS F by either Alternative Concepts B or C. Under Alternative Concept D (interchange), pedestrian delay at the Glacier Highway/Nugget intersection would not be reduced; however, pedestrians crossing through the interchange ramp roundabout intersections would experience very little delay.

9.7 Out-of-Direction Vehicle Travel

All four build alternative concepts could reduce some out-of-direction vehicle travel. The biggest decreases in out-of-direction travel are for Alternative Concept B (signal at Yandukin Drive near Fred Meyer) and Alternative Concept D (interchange), as both of these alternative concepts would allow full movements at the Yandukin Drive intersection. Alternative Concepts C1 and C2 (the one-way or two-way extension of Glacier Highway/Lemon Spur to Glacier Highway/Nugget) could reduce a small amount of out-of-direction travel since some drivers avoid making a southbound left at Lemon Road towards Fred Meyer and use the interchange to the south instead. These drivers may be more comfortable turning at the Glacier Highway/Nugget intersection, reducing their out-of-direction travel.

10 Possible Cost-Effective Options

Section Highlights

- A raised channelizing island for the outbound right turn from Egan Drive towards the Fred Meyer could be installed as a short-term improvement to reduce left-turn crashes.
- Innovative intersections such as a Continuous Flow Intersection (also known as a Displaced Left Turn intersection) could be considered as a way to provide more capacity at the existing at-grade intersections without adding as much delay as a conventional intersection type.

In addition to the alternative concepts discussed in this report there are several other ideas that may be considered which were outside the scope of this project. These improvements have the potential to cost-effectively improve safety or reduce delay.

10.1 Low-Cost Options for No Build Alternative Concept

One of the difficulties that the public reported for assessing whether or not there is an adequate gap for turning left from Egan Drive towards Fred Meyer is the difficulty of discerning whether or not the oncoming traffic is in the right turn lane. If an oncoming vehicle is in the right lane, then the left-turning vehicle should be able to turn in front of them, as the right turn lane is channelized, with a Yield sign indicating that right turns should yield. The public also expressed that there are frequently conflicts with right-turn and left-turn vehicles from Egan Drive because some right-turn drivers do not expect to yield.

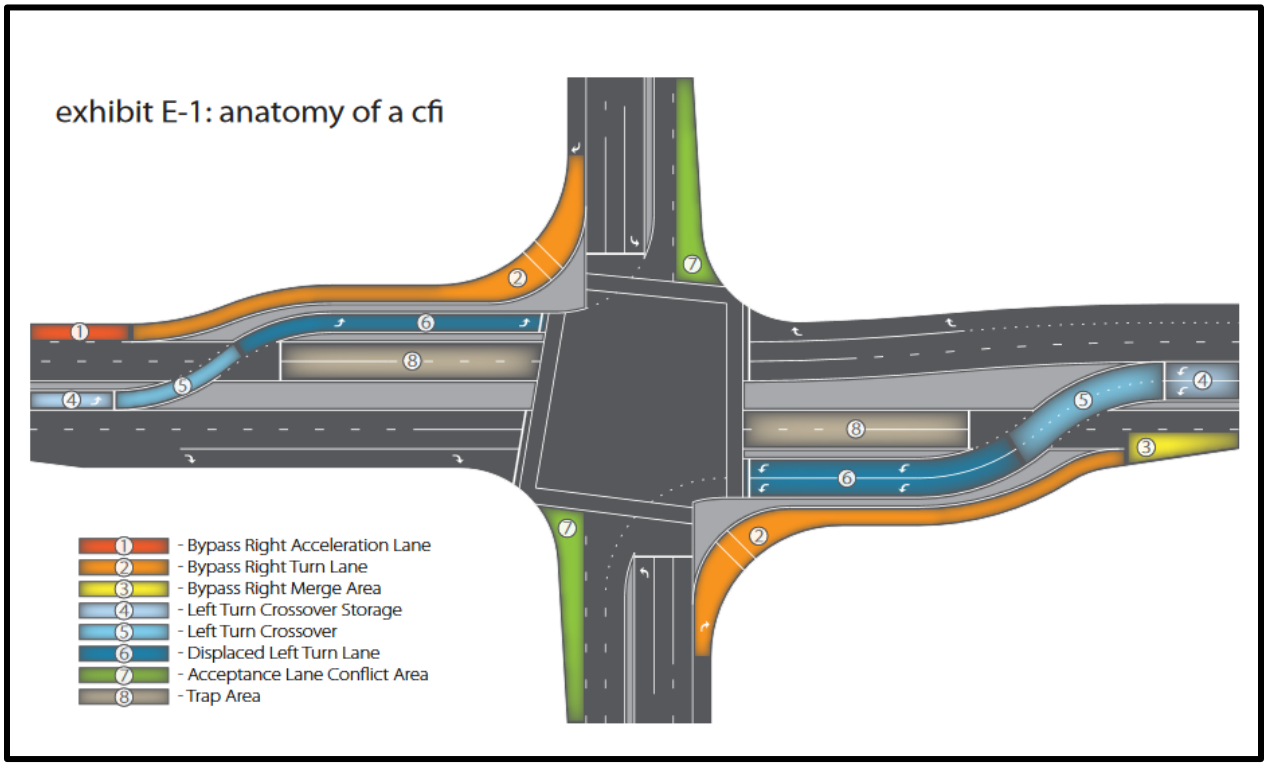
In April 2018, an additional Yield Ahead sign was installed to help right turn drivers recognize the need to yield.

To help left-turn drivers discern when vehicles are in the right turn lane, consideration could be given to developing a channelizing island for the right turns and off-setting the right turn lanes. Currently, the right turn channelization is pavement markings only.

10.2 Innovative Intersections

While both the Yandukin Drive intersection near Fred Meyer and the Glacier Highway/Nugget signalized intersection with a fourth leg operate poorly under conventional intersection control, these intersections may operate better if converted to Continuous Flow Intersections (or Displaced Left-Turn Intersections). Utah DOT installed 7 of these type of at-grade intersection along Bangerter Highway in the Salt Lake City area, as described in an FHWA case study found on the FHWA website. Figure 48 provides a diagram of this type of intersection, from a Utah DOT publication, *CFI Guidelines: A UDOT Guide to Continuous Flow Intersections*. The signal shown in this diagram can operate with only 2 or 3 phases:

- Major street left turns cross over opposing through lanes in advance of the intersection, at the same time as side street traffic has the green. This stage can be 1 phase if the side street left turns are permissive, or 2 phase if the side street left turns are protected or protected-permissive.
- Major street through traffic and major street left turn traffic use the same phase.



SOURCE: Utah DOT, CFI Guidelines: A UDOT Guide to Continuous Flow Intersections, July 2013.

Figure 48. Example of Continuous Flow Intersection (Displaced Left Turn)

According to the FHWA website, Utah DOT was able to build the Continuous Flow Intersections (Displaced Left Turns) for about $6 to $8 million dollars each and capacity increased by 20 to 50%.

11 Recommendations

None of the concept alternatives has a positive net present worth. However, a proposed action to be advanced and implement is warranted for two reasons:

- There is wide-spread public support for a solution to the ongoing crash occurrence at this intersection.
- The crash pattern, although occurring at a frequency and overall rate that is not excessively high, does have a higher than normal severity level compared to the overall population. Previous actions by the DOT&PF, including prohibition of high-risk movements and left-turn lane offset that improves sight distance, have appeared to reduce severity, but have not reduced frequency. There remains a left-turn crash pattern (turning from Egan to Yandukin), in which the severity of crashes is greatly exacerbated by the high-speed approach traffic on Egan (85^{th} percentile speeds of 60 mph and higher). As a result, any of the left-turn collisions that dominate the intersection patterns have the potential to cause major incapacity injuries, or deaths, a fact that is no doubt in the public mind.

Alternative Concept D, a grade separated interchange, is recommended to be advanced. As discussed in the preceding sections and summarized in Table 58 on page 131, Alternative Concept D is superior to other alternatives in almost every performance measure. Other points that support selection of Alternative Concept D are:

- Alternative Concept D's crash reduction is through the physical separation of the conflicting movements involved in problem crashes. The other alternatives rely on signal control to assign movement right of way which, while effective, may still have conflicts caused by red-light running or driver error. In addition, there are increased crash types caused by signalization that would not occur with an interchange (such as rear end crashes). The increased crashes associated with signal control may at some point need to be addressed with additional treatments, one of which would be the interchange. Therefore, the interchange is the most-effective and the longest-term crash reduction tool.
- Alternative Concept D is the only alternative that effectively reduces travel delay over what is currently experienced by intersection users. All other alternatives have increased delay because traffic entering the intersection under those alternatives is subject to control and potential stopping by the signal, whereas the mainline traffic on Egan Drive continues to be free-flow with an interchange.
- As an uninterrupted flow facility, Alternative Concept D has significant reserve capacity to accommodate future travel demand well beyond this study's design evaluation period.

In fact, the interchange itself is not the limiting factor for corridor capacity in this area, and instead the capacity of the segment becomes the constraint. With signalization, the corridor within this area operates as an interrupted flow facility, and the intersections become the constraint, with much less capacity, and therefore less time until another treatment may have to be implemented.

- Finally, Alternative Concept D is consistent with the planning for this area that was previously developed and accepted by public interests and agencies. Most, notably, Alternative D agrees with the results of the WEDCOR study. It becomes the second interchange solution for the controlled access corridor (following Sunny Point), moving the corridor towards the uninterrupted flow corridor envisioned by WEDCOR. As WEDCOR indicates, the final location of the Alternative Concept D interchange can be moved as required to minimize impacts.

This recommendation is solely based on this Traffic Study which does not provide an analysis or consideration of other factors that may affect any final determinations by the Department. This Traffic Study will be integrated into a Planning and Environmental Linkage (PEL) study that will consider environmental and socio-economic issues through a more comprehensive public and agency involvement process. The PEL study will conclude with a final recommendation that could be advanced for future project development.

12 References

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- *Bangerter Corridor, Salt Lake County, UT: Displaced Left-Turn Intersection* (webpage), Federal Highway Administration, last modified May 20, 2016. Accessed at https://safety.fhwa.dot.gov/intersection/innovative/crossover/case_studies/salt_lake/index.cfm on April 30, 2018

Appendix A Statistical Before/After Crash Comparison

The AASHTO Highway Safety Manual (HSM, 2010) provides a methodology for conducting a before/after safety effectiveness evaluation that accounts for statistical effects such as regression to the mean, as well as external effects such as changes in traffic volumes.

Using the HSM methodology, the number of crashes per year at an urban intersection is predicted by *safety performance functions* that use independent variables attributed to intersection characteristics such as the AADTs of the legs of the intersection, the number of left and right turn lanes and other pertinent features. The number of crashes observed at the intersection for the study period is then used to modify the *predicted* number of crashes, resulting in an *expected* number of crashes that reflects characteristics of the intersection that are not otherwise quantifiable in the analysis. A comparison of the expected number of crashes after treatment to the observed number of crashes after treatment is an indication of the effect of the treatment on crashes.

What does the Highway Safety Manual mean when it refers to "predicted" and "expected" crashes?
Predicted: An estimate of the number of crashes at an intersection or on a roadway segment based on specific characteristics such as AADT, number of lanes, lighting, etc. All places with these same characteristics are estimated to have the same number of predicted crashes.
Expected: The number of predicted crashes is modified based on actual crash experience at an intersection or on a roadway. Expected crashes will be unique for each intersection or roadway segment.

Selection of Safety Performance Function

The safety performance functions used in the HSM were developed using a sample of locations from several states in the US. For this analysis, we are using the functions developed for 4-leg intersections with stop control on the minor-road approaches. Note that this is the closest intersection type to the study intersection; however, the study intersection does not allow certain movements that are typically allowed at stop-controlled intersections, namely left turns or through movements from the side streets. Thus, the HSM functions are used here simply to guide the analysis, and are not intended to reflect actual conditions.

The HSM has separate functions depending on the area type. Table 59 shows the characteristics for the two area types that most closely match the study intersection.

Table 59: Characteristics for Highway Safety Manual Safety Performance Functions

	Population	Major Road AADT	Minor Road AADT
Rural Multilane	Less than 5,000	0 to 78,300 per day	0 to 7,400 per day
Urban	More than 5,000	0 to 46,800 per day	0 to 5,900 per day

The study intersection is in an area with a population of around 30,000 people, the Egan Drive AADT is around 30,000 vehicles per day, and the Glacier Highway/Lemon Road AADT is around 8,000 vehicles per day. Once again, the study intersection does not perfectly fit the available functions (the minor road AADT is higher than those used for developing the function); however, the urban function was chosen, as it is closest to the study intersection.

Calibration of HSM Methodology for Southcoast Region

Studies comparing the number of crashes predicted using the HSM equations to observed numbers of crashes have found that the HSM consistently underestimates the number of crashes in Alaska. In December 2016, Professor Osama Abaza at UAA prepared a report of appropriate calibration factors for implementing the HSM in Alaska. The calibration factor for 4-way unsignalized intersections that was published in this report is 1.04 for the Southcoast Region of DOT&PF. Dr. Abaza used crash data from 2007 to 2012 for 11 of the 17 4-way unsignalized urban intersections found in the Southcoast Region to develop the calibration.

Before Left Turn Realignment and Lighting Reconstruction Projects (2005 to 2011)

Table 60 shows the crash characteristics and HSM results for the period before the intersection was reconstructed, from 2005 through 2011.

Table 60: Characteristics of Fred Meyer Intersection on Egan Drive Before Reconstruction

Using urban safety performance function	**2005 to 2011**	**Per Year**
Average Annual Daily Traffic on Egan Boulevard (vehicles per day)	23,800	
Annual Average Daily Traffic on Glacier-Lemon (vehicles per day)	8,000	
Observed number of crashes	42	6.000
Predicted number of crashes	15	2.091
Expected number of crashes	33	4.693

NOTE: For the HSM calculation, the highest AADT segment is used in each year of the analysis.

After Left Turn Realignment and Lighting Reconstruction Projects (2014 to 2017)

Table 61 shows the crash characteristics and HSM results for the period after the intersection was reconstructed, from 2014 through 2017. The HSM “predicted” and “expected” number of crashes are results of the analysis for those values, given the observed AADTs and crash frequencies.

Table 61: Characteristics of Intersection of Fred Meyer Intersection on Egan Drive After Reconstruction

Using urban safety performance function	**2014 to 2017**	**Per Year**
Average Annual Daily Traffic on Egan Boulevard (vehicles per day)	29,300	
Annual Average Daily Traffic on Glacier-Lemon (vehicles per day)	8,100	
Observed number of crashes	27	6.750
Predicted number of crashes	10	2.468
Expected number of crashes, given observation	23	5.764

NOTE: For the HSM calculation, the highest AADT segment is used in each year of the analysis.

Before/After Comparison

The expected number of crashes during the "after" period, given only a change in AADTs (assuming no reconstruction had occurred) is given by:

$$N_{expected,After} = N_{expected,Before} \times \frac{N_{predicted,After}}{N_{predicted,Before}} = 4.693 \times \frac{2.468}{2.091} = 5.539$$

The odds ratio that the observed number of crashes after reconstruction is different from what would be expected, assuming that no reconstruction had been done is given by:

$$OR = \frac{N_{observed,After}}{N_{expected,After}} = \frac{6.750}{5.539} = 1.22$$

This ratio of 1.21 indicates that the safety effectiveness for the intersection improvement is greater than 1.0, meaning crashes are increased (less than 1.0 would indicate crash reduction). However, the standard error of the safety effectiveness is 0.61 and the 95% confidence interval for the safety effectiveness is computed as 1.21 ± 2(0.61), yielding a confidence interval of -0.01 to 2.45. Since the confidence interval contains the value 1.0, there is insufficient statistical evidence that crash frequency at the intersection changed due to the improvements.

Note that for both periods (before and after reconstruction), the "expected" number of crashes is less than the "observed" number of crashes, indicating that the crash frequency is higher than would be expected based on the HSM equations and calibration.

Method Sensitivity

To check the sensitivity of the results to the particular function used, the method described above was followed using the Rural Multilane safety performance function. Table 62 and Table 63 show that the "expected" crashes matches more closely to the "observed" crashes using this methodology. However, the resulting OR (of 0.94) and confidence interval of (-0.03 to 1.91) indicates that once again, there is insufficient statistical evidence that crash frequency at the intersection changed due to the improvements.

Table 62: Characteristics of Fred Meyer Intersection on Egan Drive Before Reconstruction

Using urban safety performance function	**2005 to 2011**	**Per Year**
Average Annual Daily Traffic on Egan Boulevard (vehicles per day)	23,800	
Annual Average Daily Traffic on Glacier-Lemon (vehicles per day)	8,000	
Observed number of crashes	42	6.000
Predicted number of crashes	40	5.686
Expected number of crashes	42	5.985

NOTE: For the HSM calculation, the highest AADT segment is used in each year of the analysis.

Table 63: Characteristics of Intersection of Fred Meyer Intersection on Egan Drive After Reconstruction

Using urban safety performance function	**2014 to 2017**	**Per Year**
Average Annual Daily Traffic on Egan Boulevard (vehicles per day)	29,300	
Annual Average Daily Traffic on Glacier-Lemon (vehicles per day)	8,100	
Observed number of crashes	27	6.750
Predicted number of crashes	27	6.823
Expected number of crashes, given observation	29	7.179

NOTE: For the HSM calculation, the highest AADT segment is used in each year of the analysis.

Appendix B Vehicle Speed Study Results

The following figures present the speed-frequency curves for the vehicle speed study discussed in Section 5.3 on page 39.

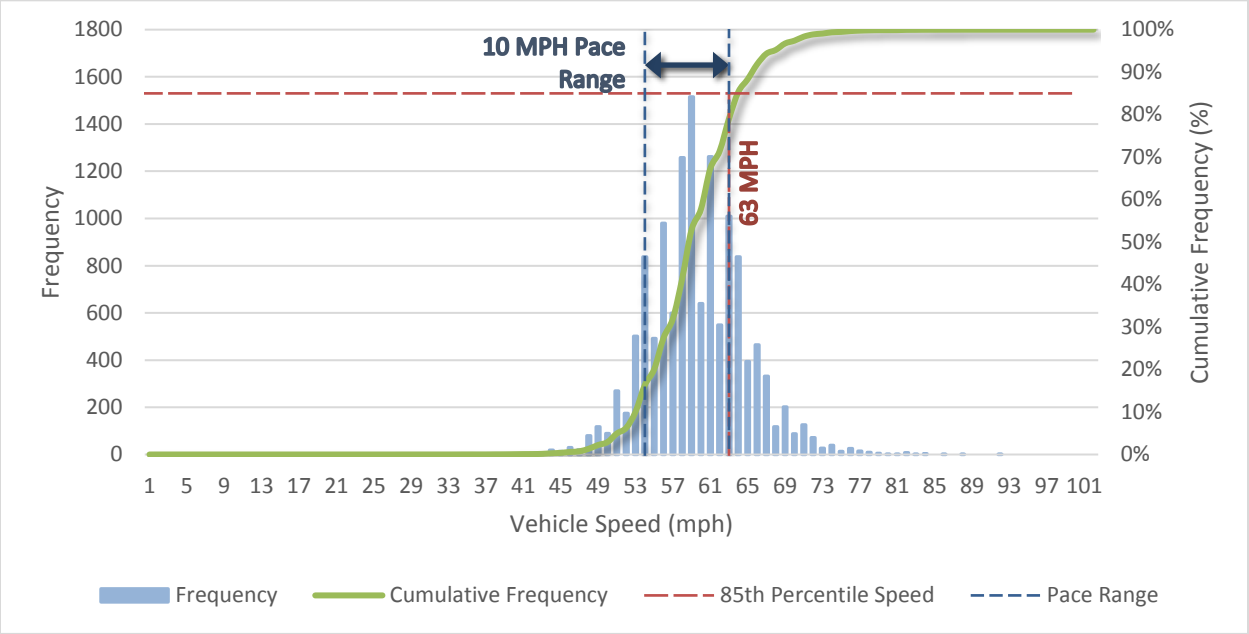


Figure 49. Location 1, Northbound Egan Drive

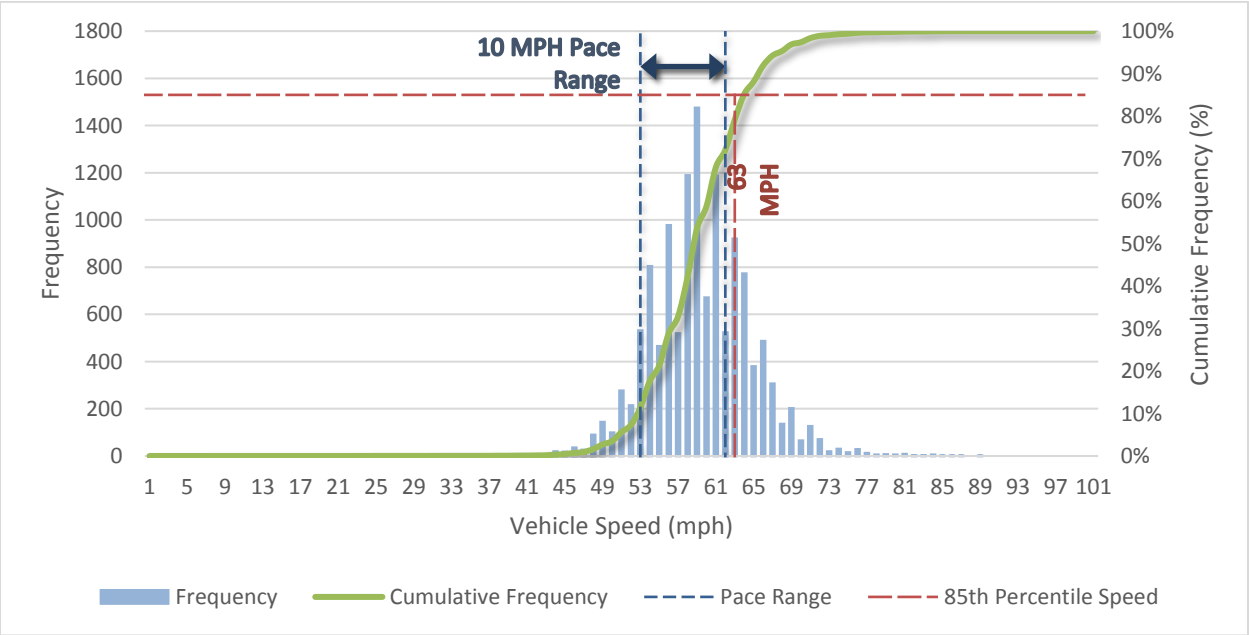


Figure 50. Location 1, Southbound Egan Drive

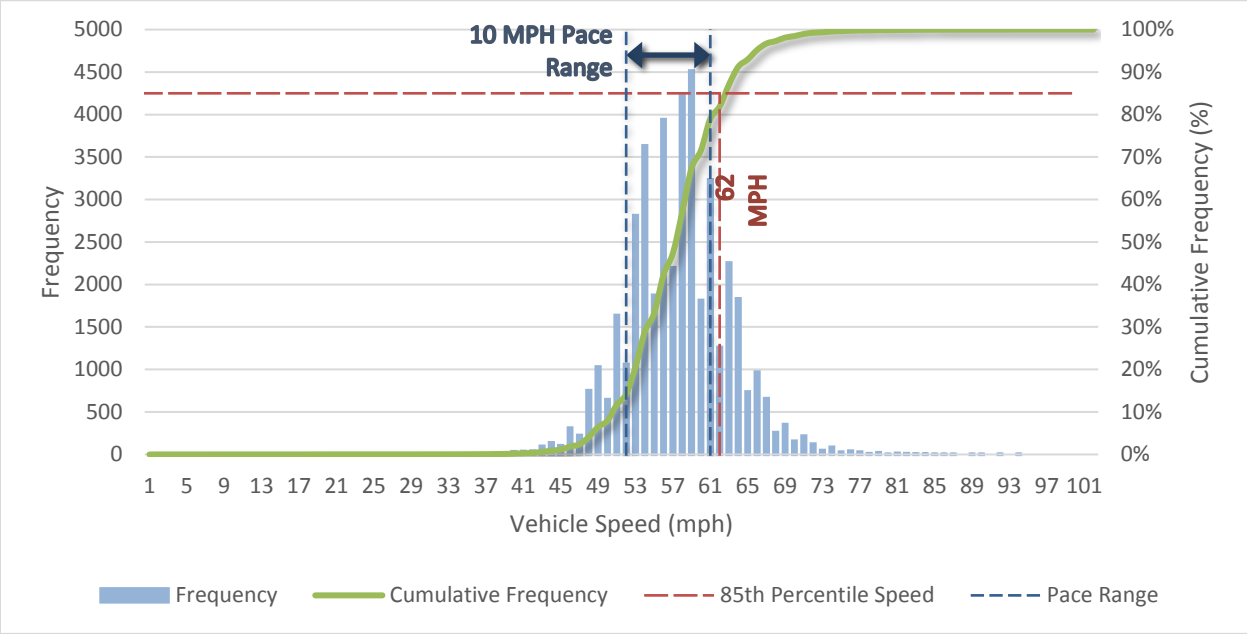


Figure 51. Location 2, Northbound Egan Drive

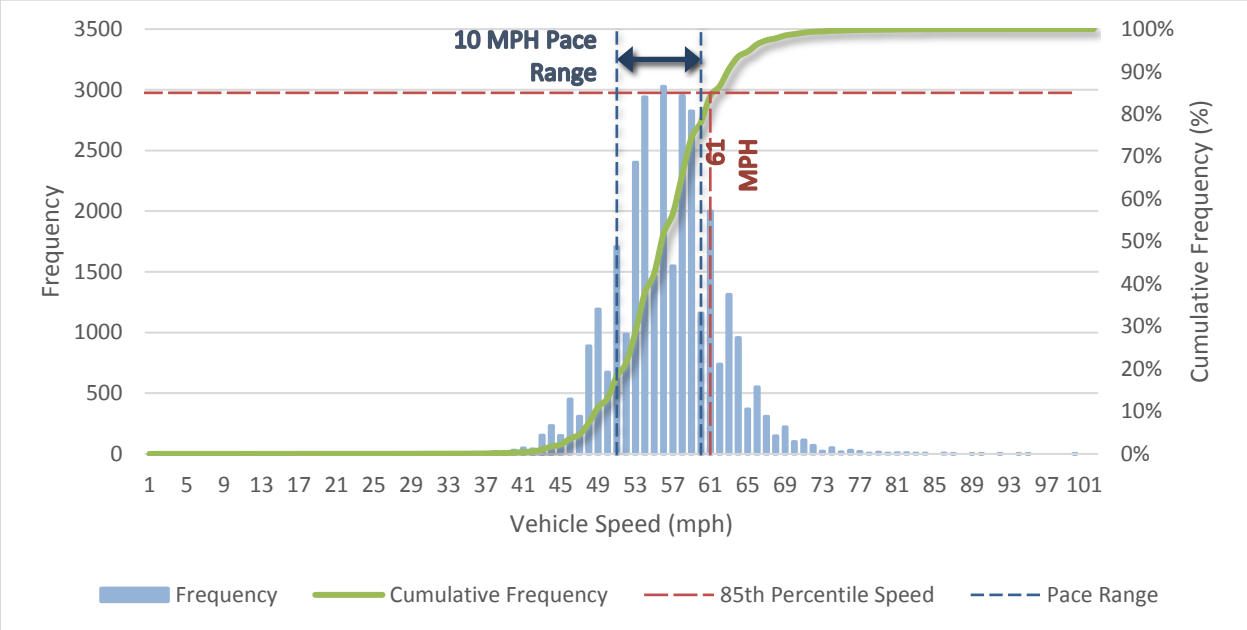


Figure 52. Location 2, Southbound Egan Drive

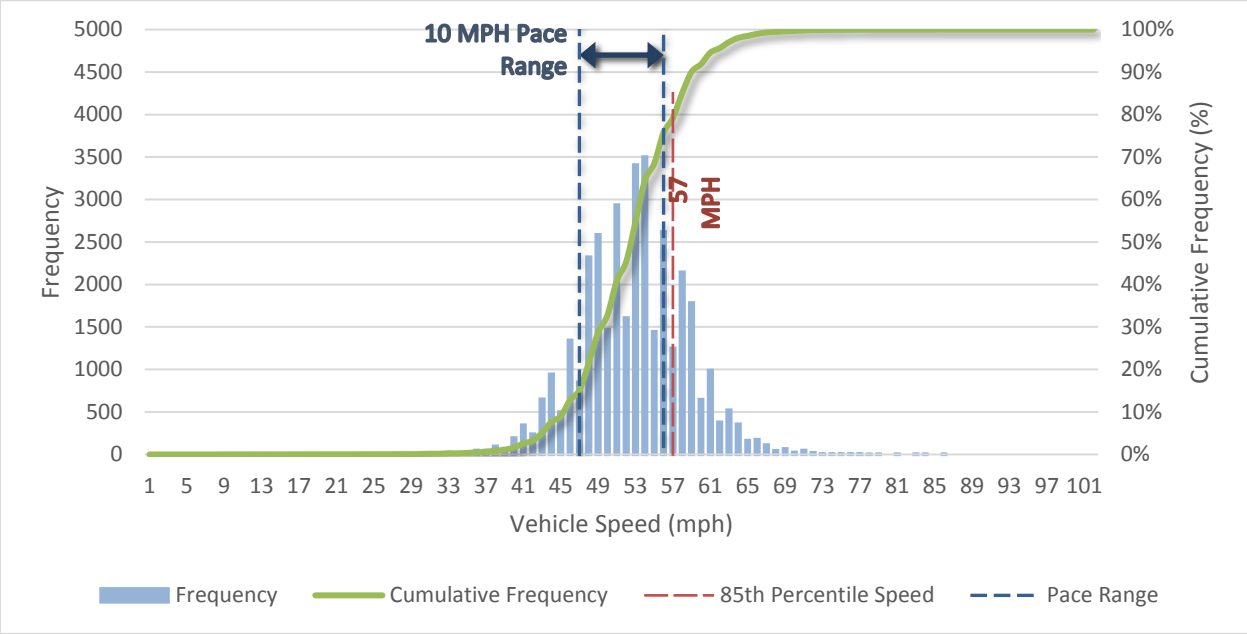


Figure 53. Location 3, Northbound Egan Drive

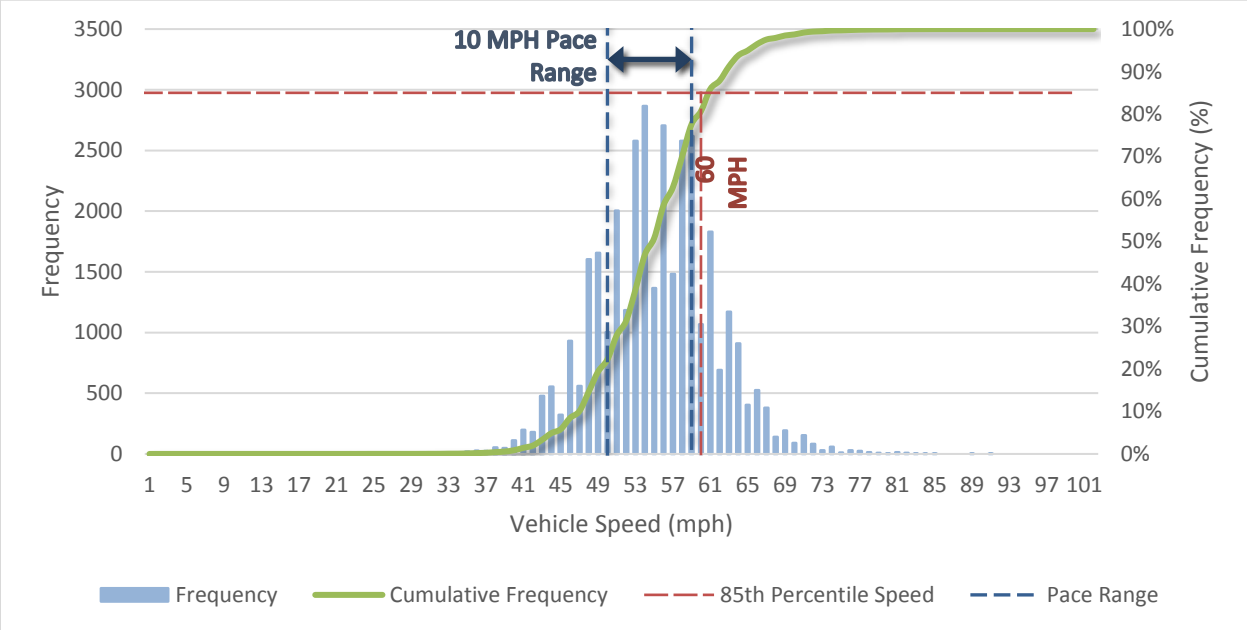


Figure 54. Location 3, Southbound Egan Drive

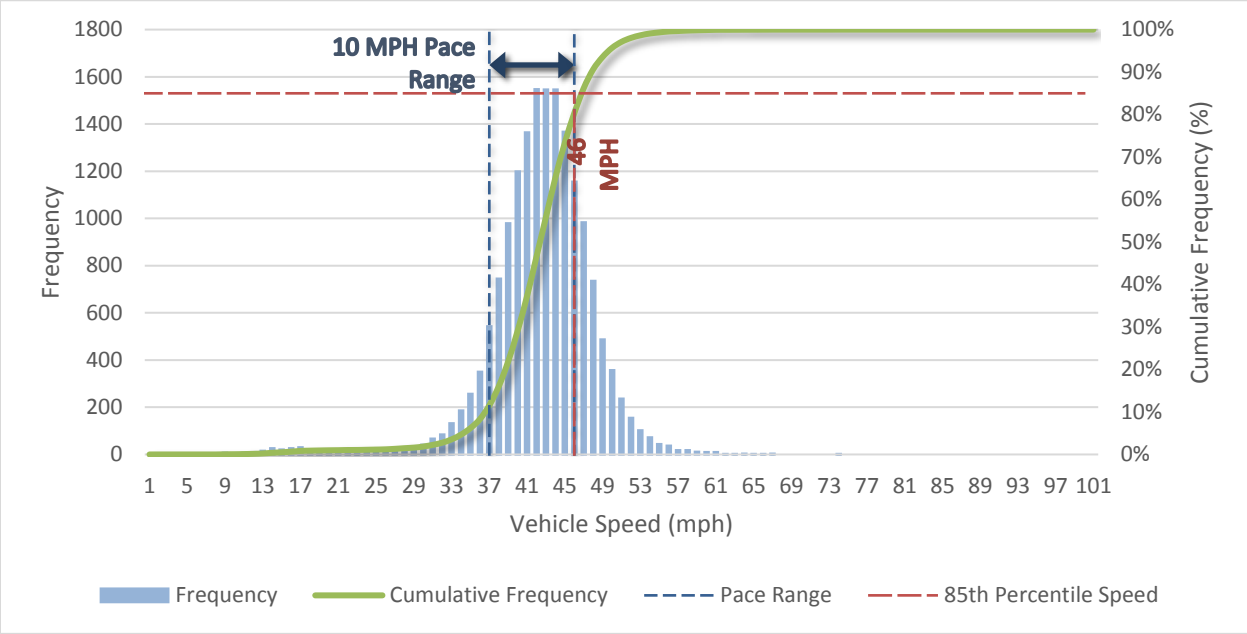


Figure 55. Location 4, Glacier Highway/Lemon Road

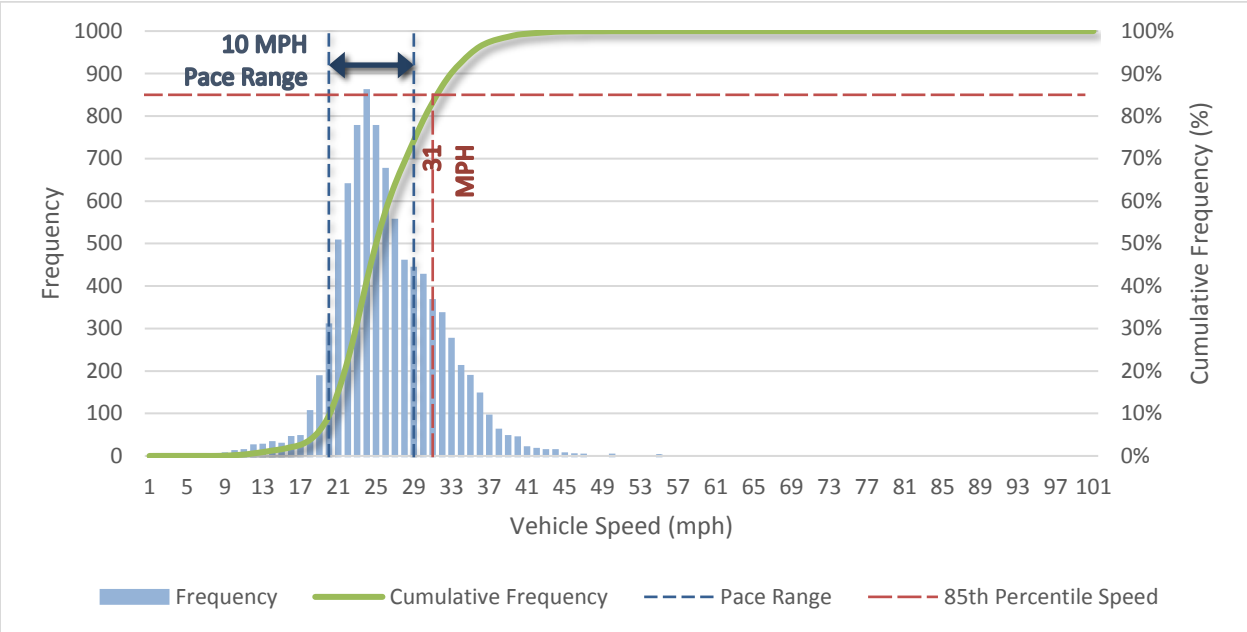


Figure 56. Location 5, Glacier Highway/Lemon Spur

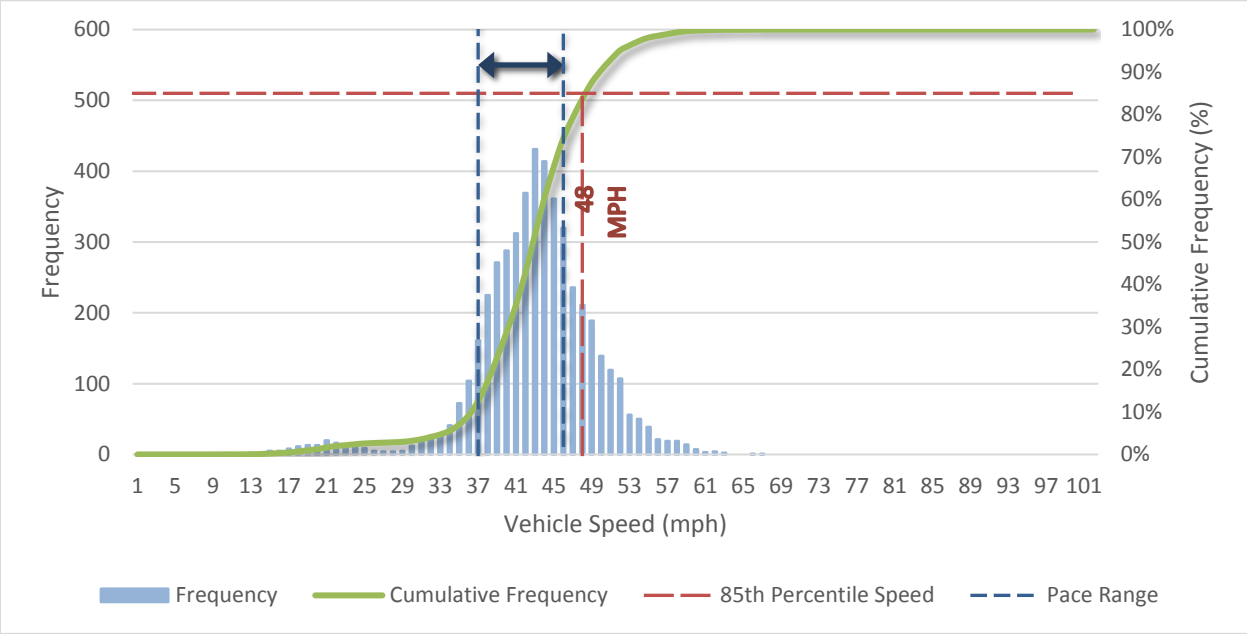


Figure 57. Location 6, Yandukin Drive

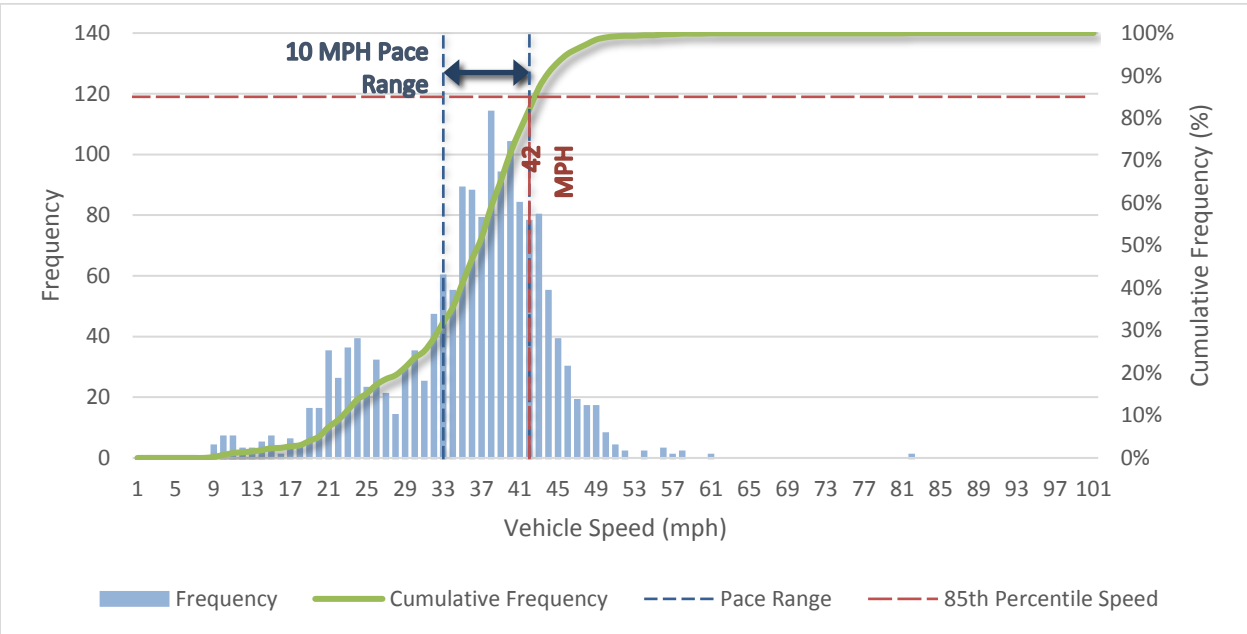


Figure 58. Location 7, Old Dairy Road

Appendix C Design Turning Movement Volumes

The following figures present the 2040 design turning movement volumes that were used for each alternative concept.

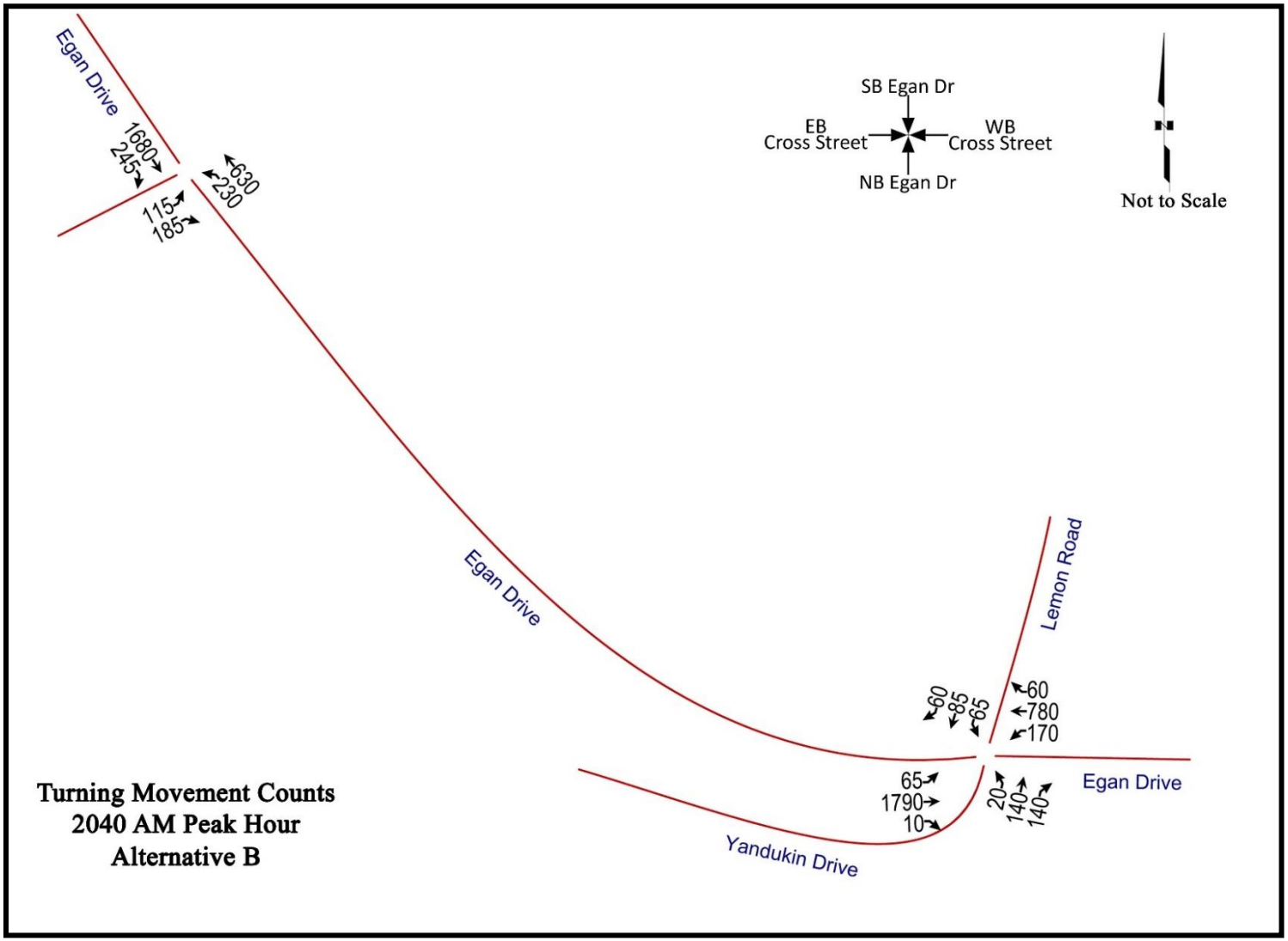


Figure 59. Turning Movement Volumes, Alternative Concept B (Signal), 2040 AM Peak Hour

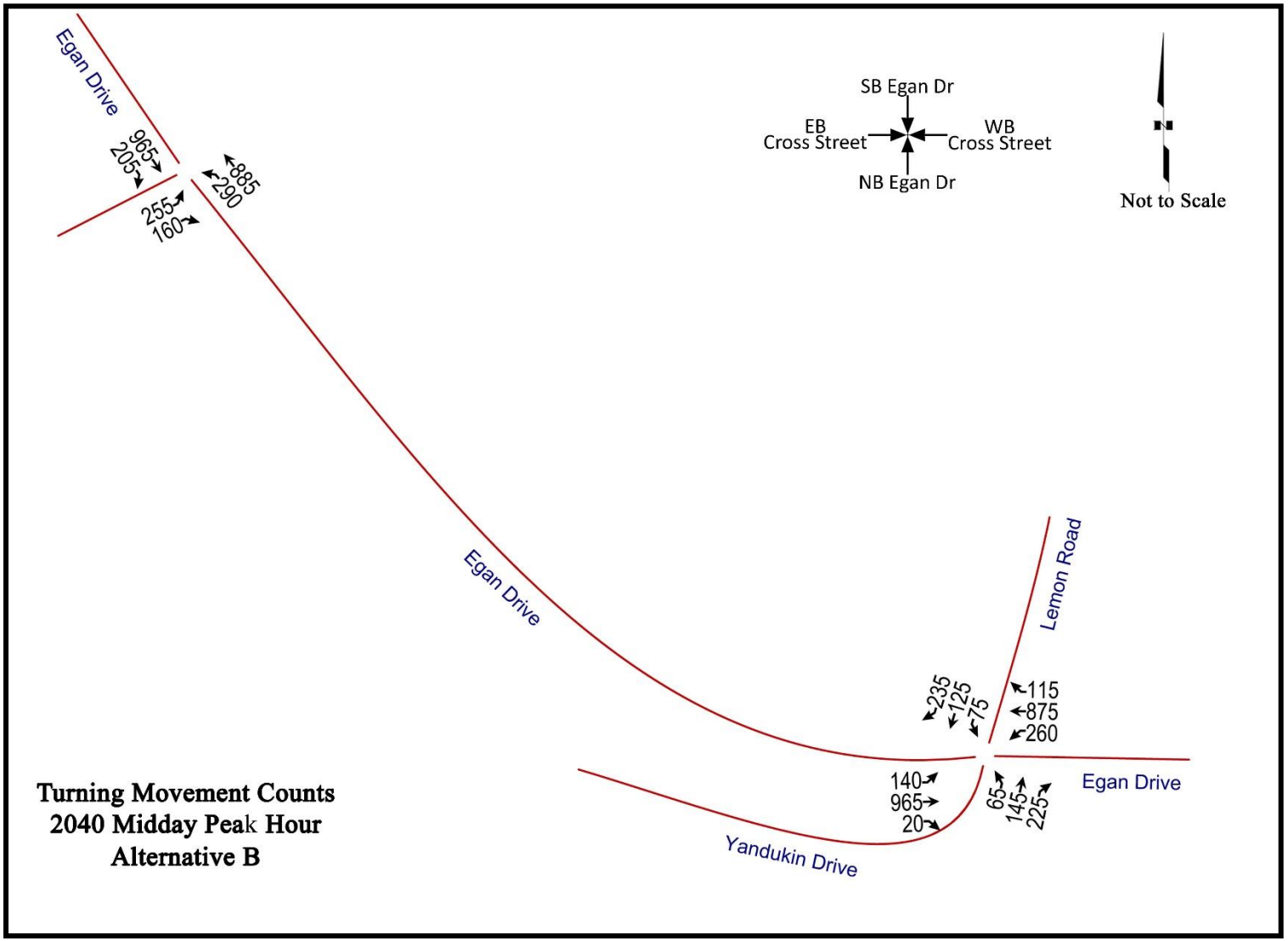


Figure 60. Turning Movement Volumes, Alternative Concept B (Signal), 2040 Midday Peak Hour

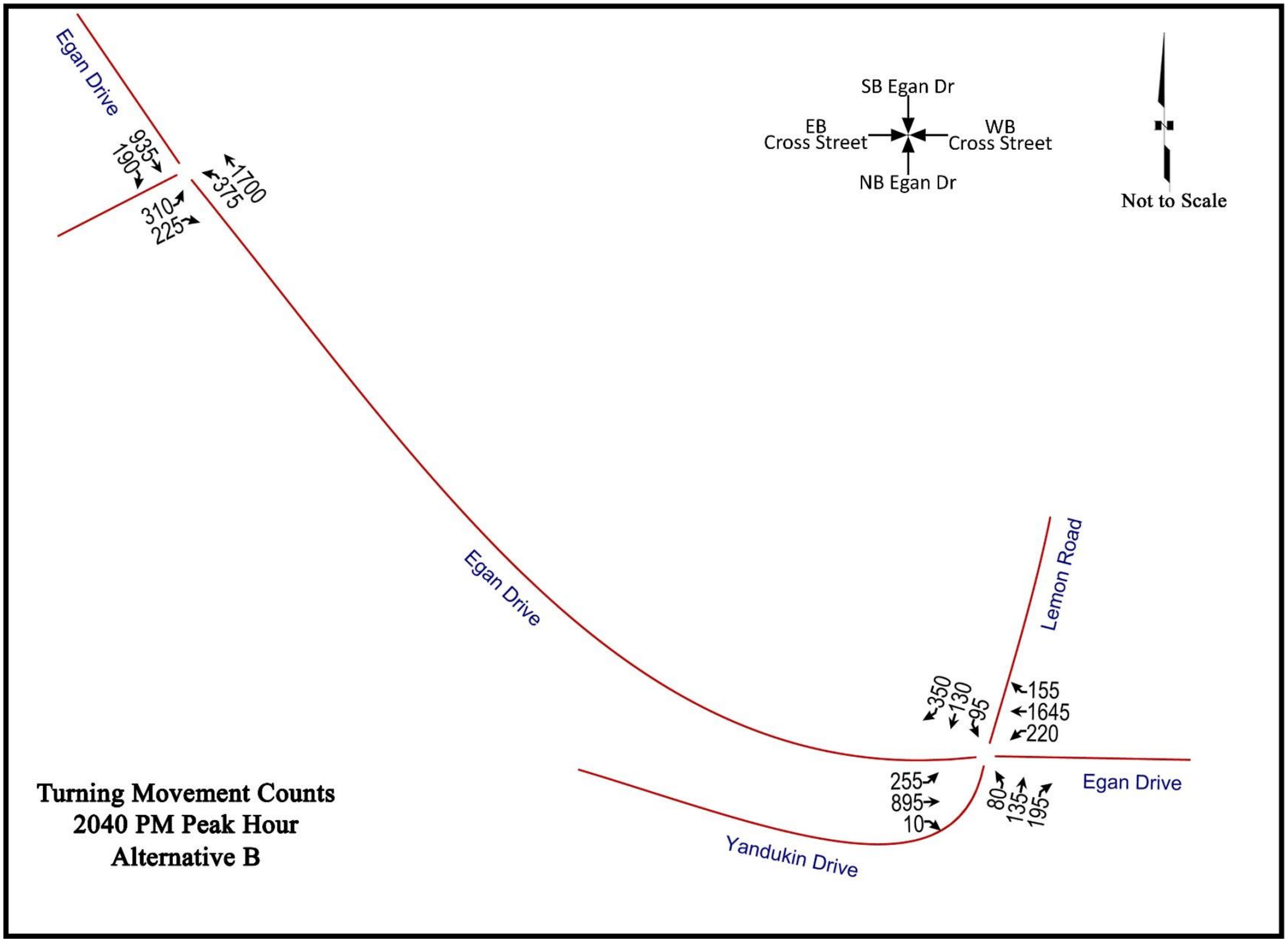


Figure 61. Turning Movement Volumes, Alternative Concept B (Signal), 2040 PM Peak Hour

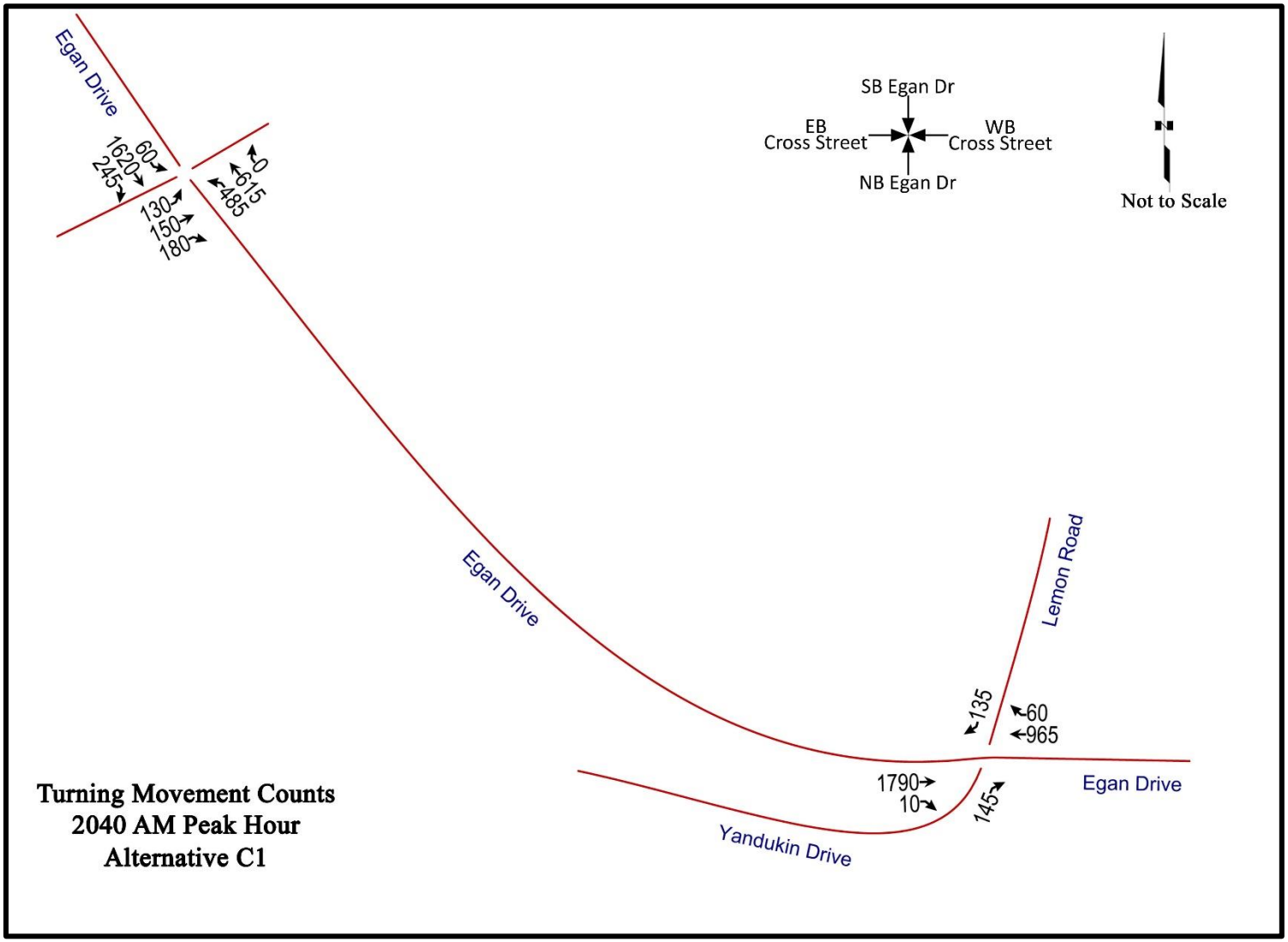


Figure 62. Turning Movement Volumes, Alternative Concept C1 (One-Way Extension), 2040 AM Peak Hour

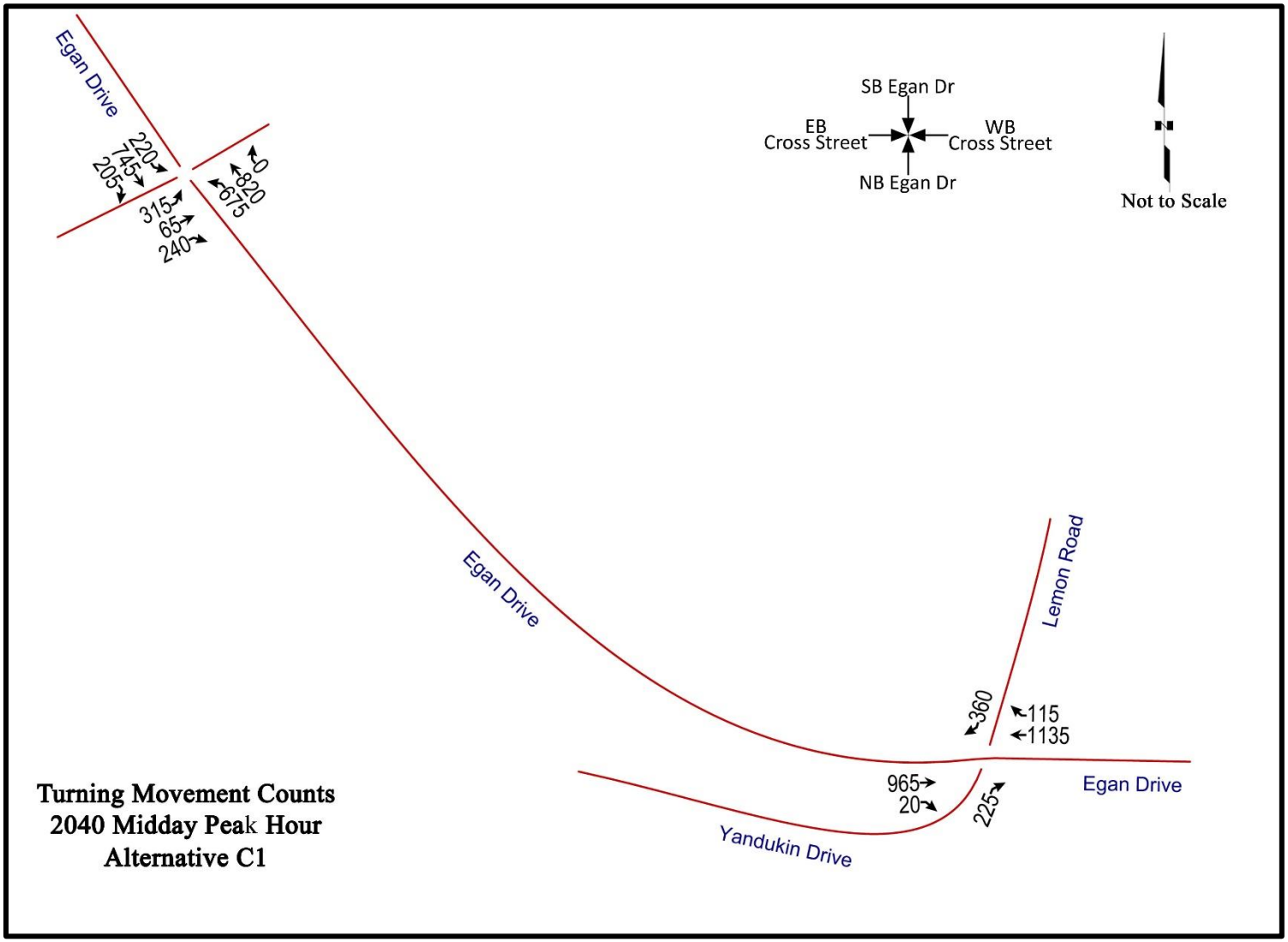


Figure 63. Turning Movement Volumes, Alternative Concept C1 (One-Way Extension), 2040 Midday Peak Hour

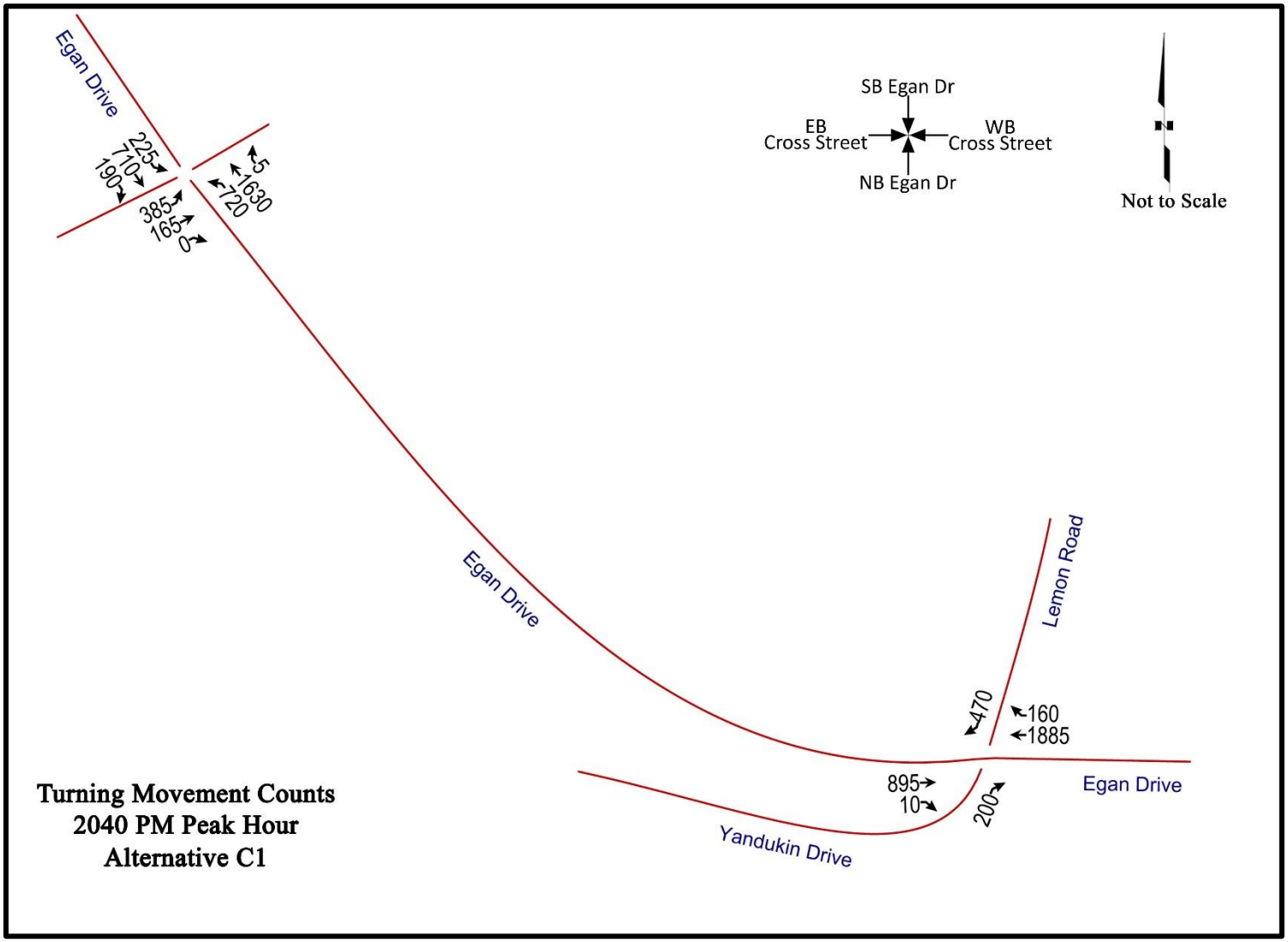


Figure 64. Turning Movement Volumes, Alternative Concept C1 (One-Way Extension), 2040 PM Peak Hour

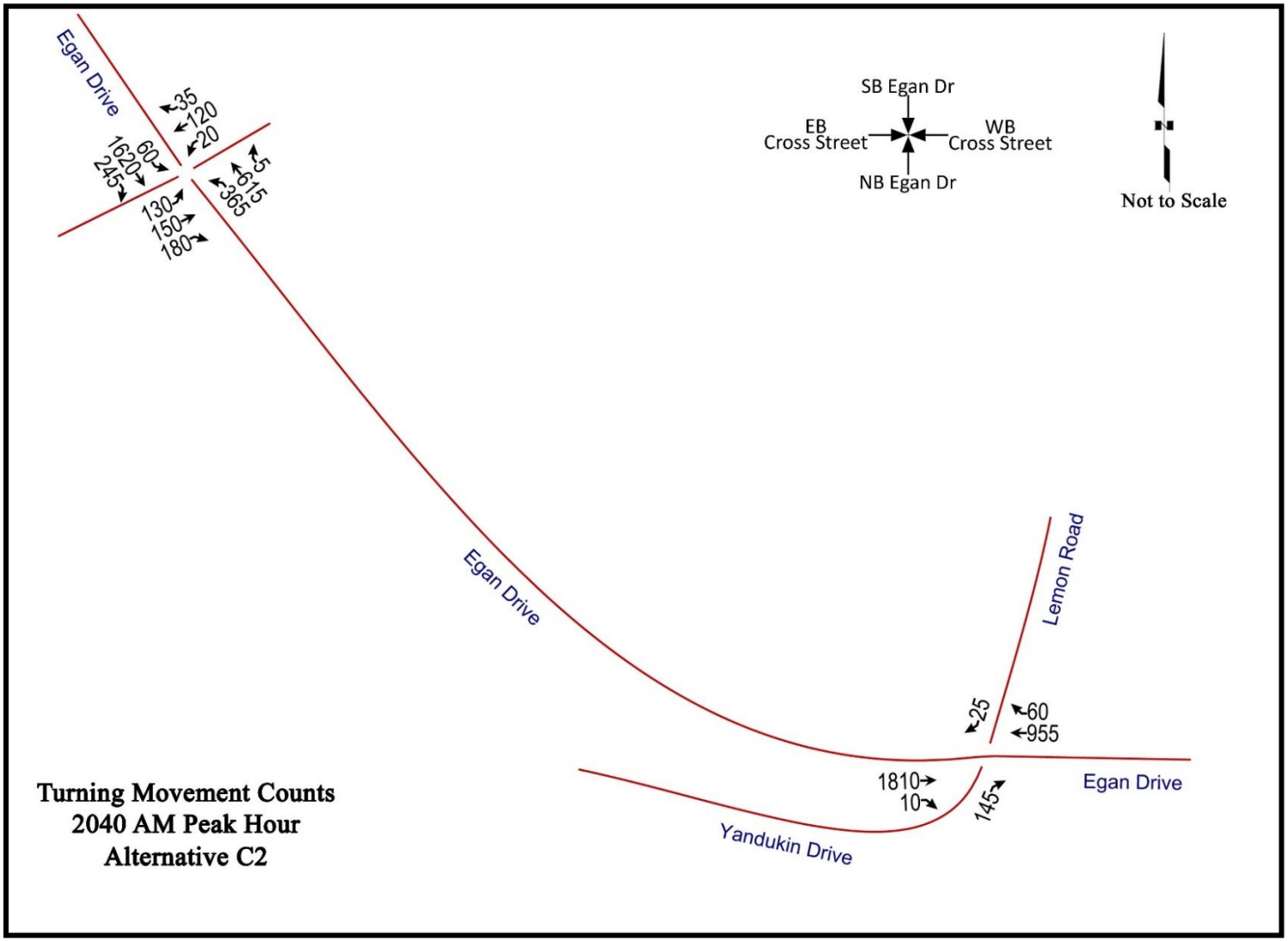


Figure 65. Turning Movement Volumes, Alternative Concept C2 (Two-Way Extension), 2040 AM Peak Hour

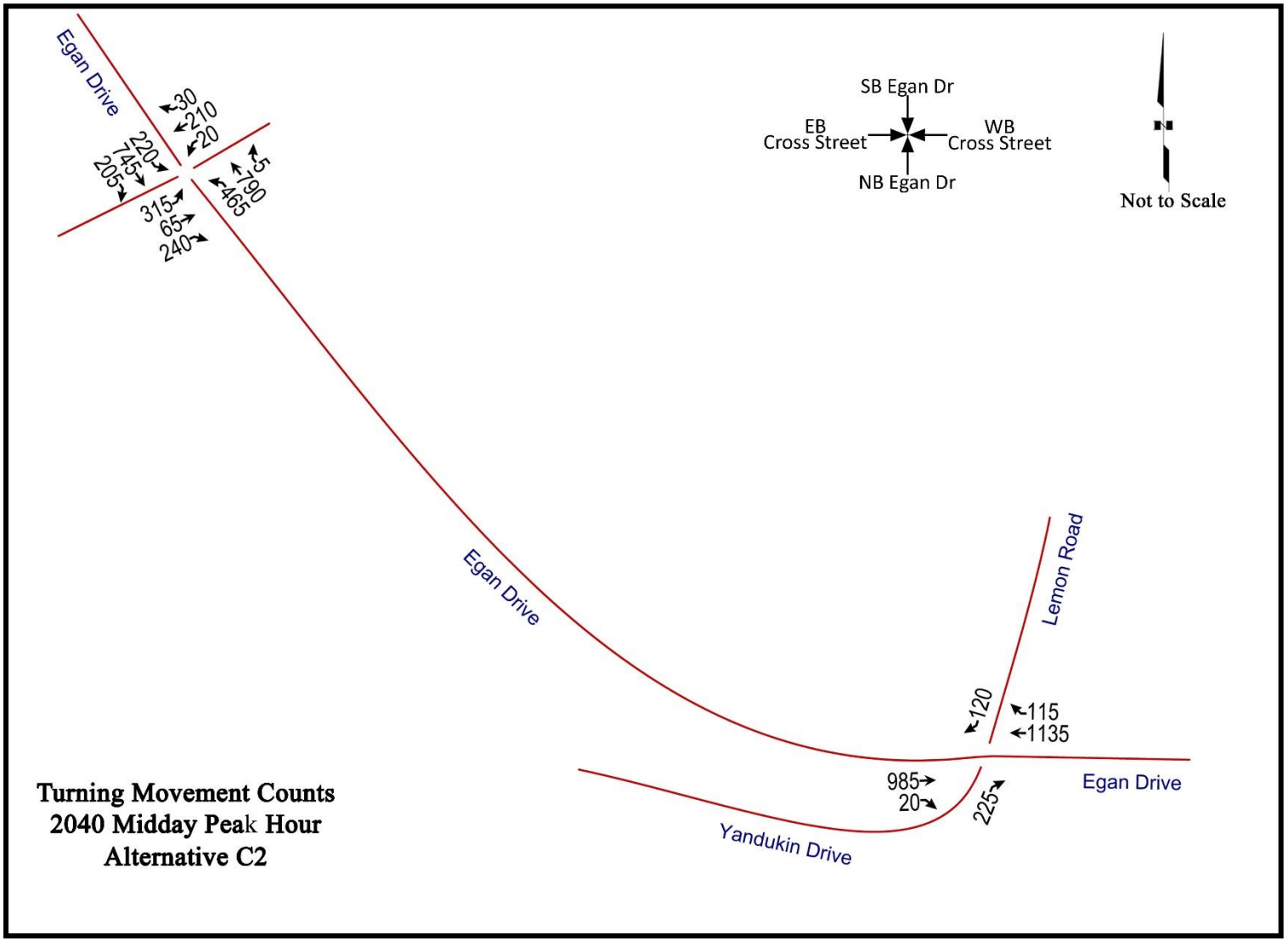


Figure 66. Turning Movement Volumes, Alternative Concept C2 (Two-Way Extension), 2040 Midday Peak Hour

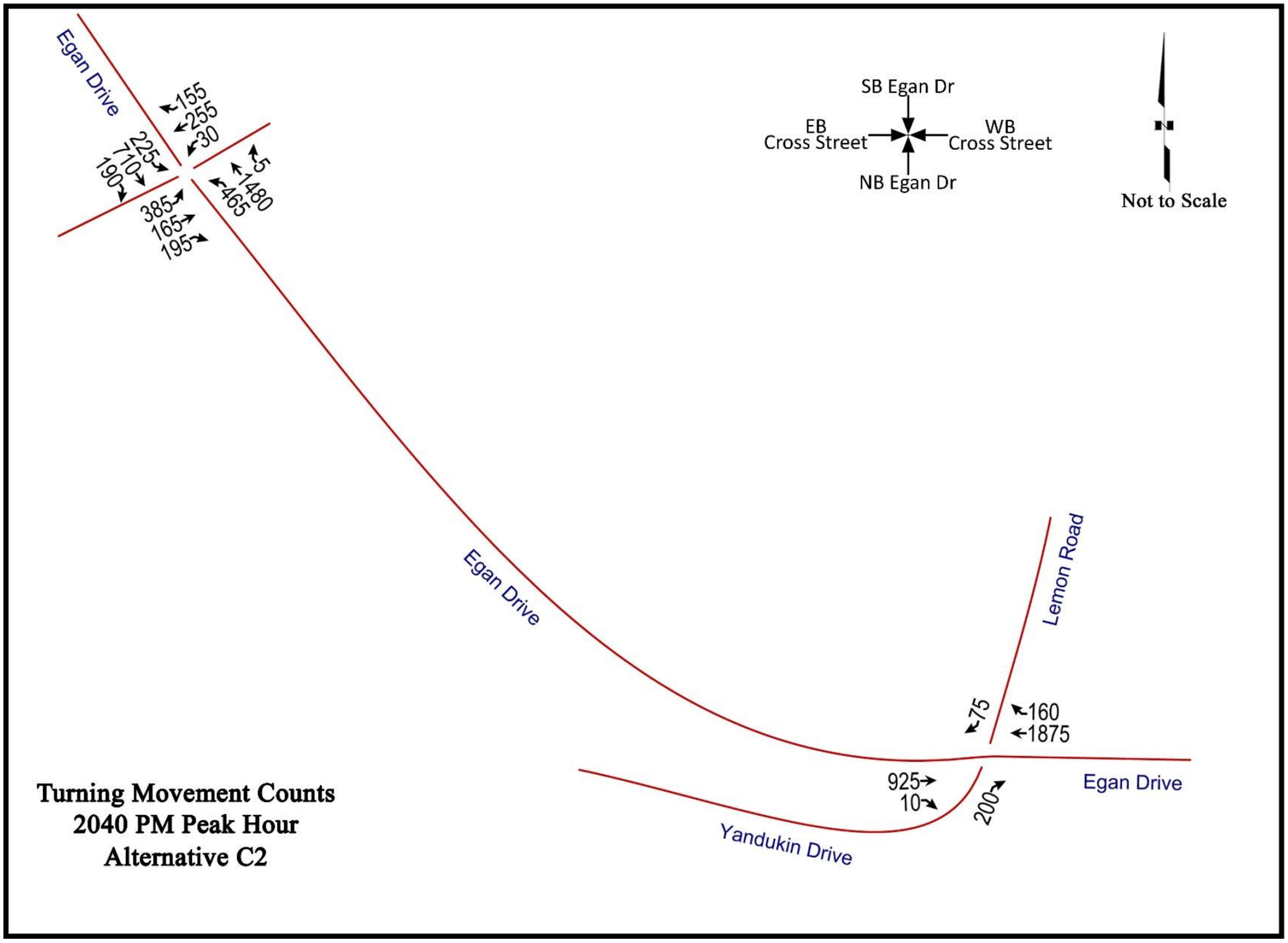


Figure 67. Turning Movement Volumes, Alternative Concept C2 (Two-Way Extension), 2040 PM Peak Hour

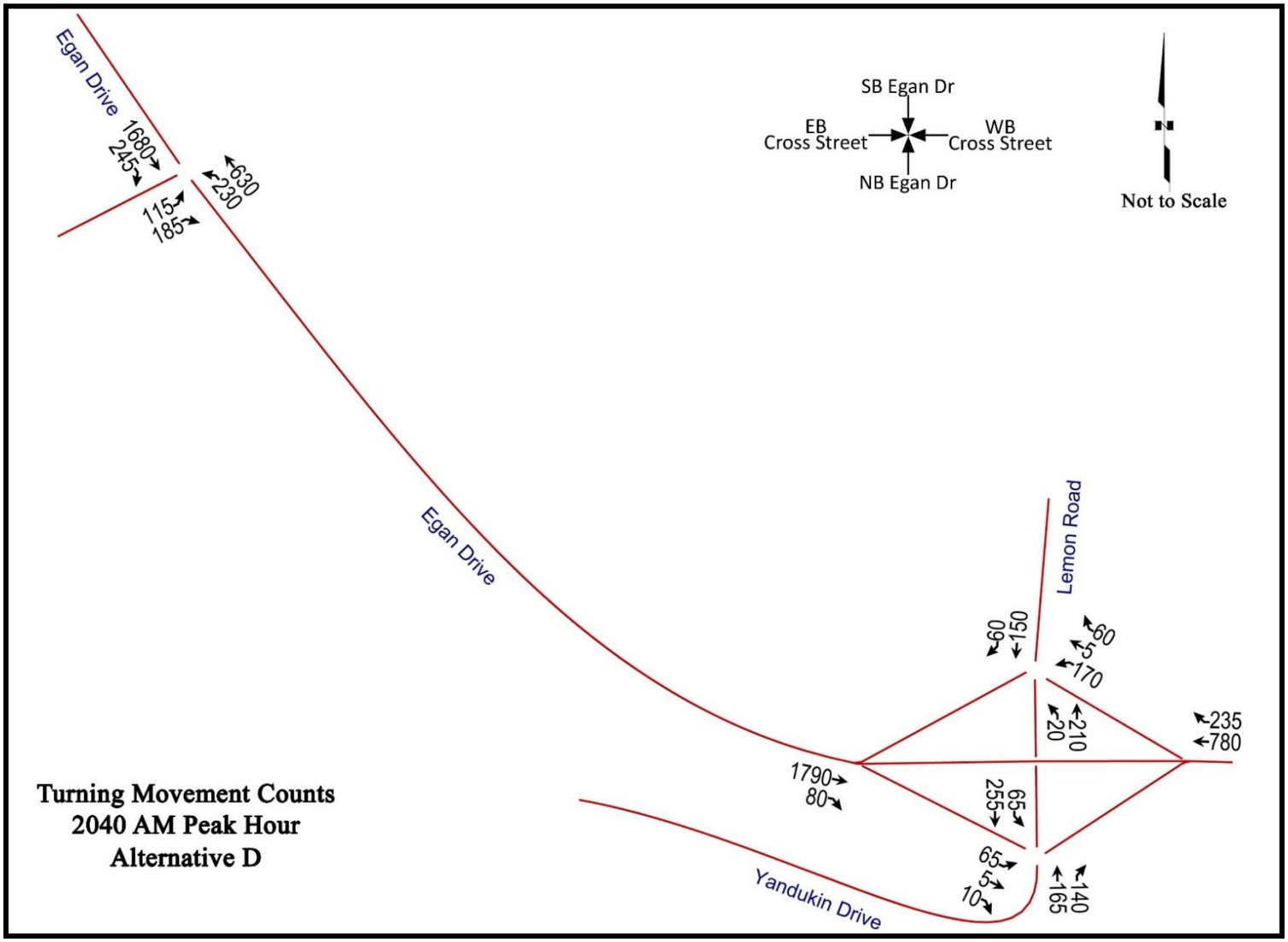


Figure 68. Turning Movement Volumes, Alternative Concept D (Interchange), 2040 AM Peak Hour

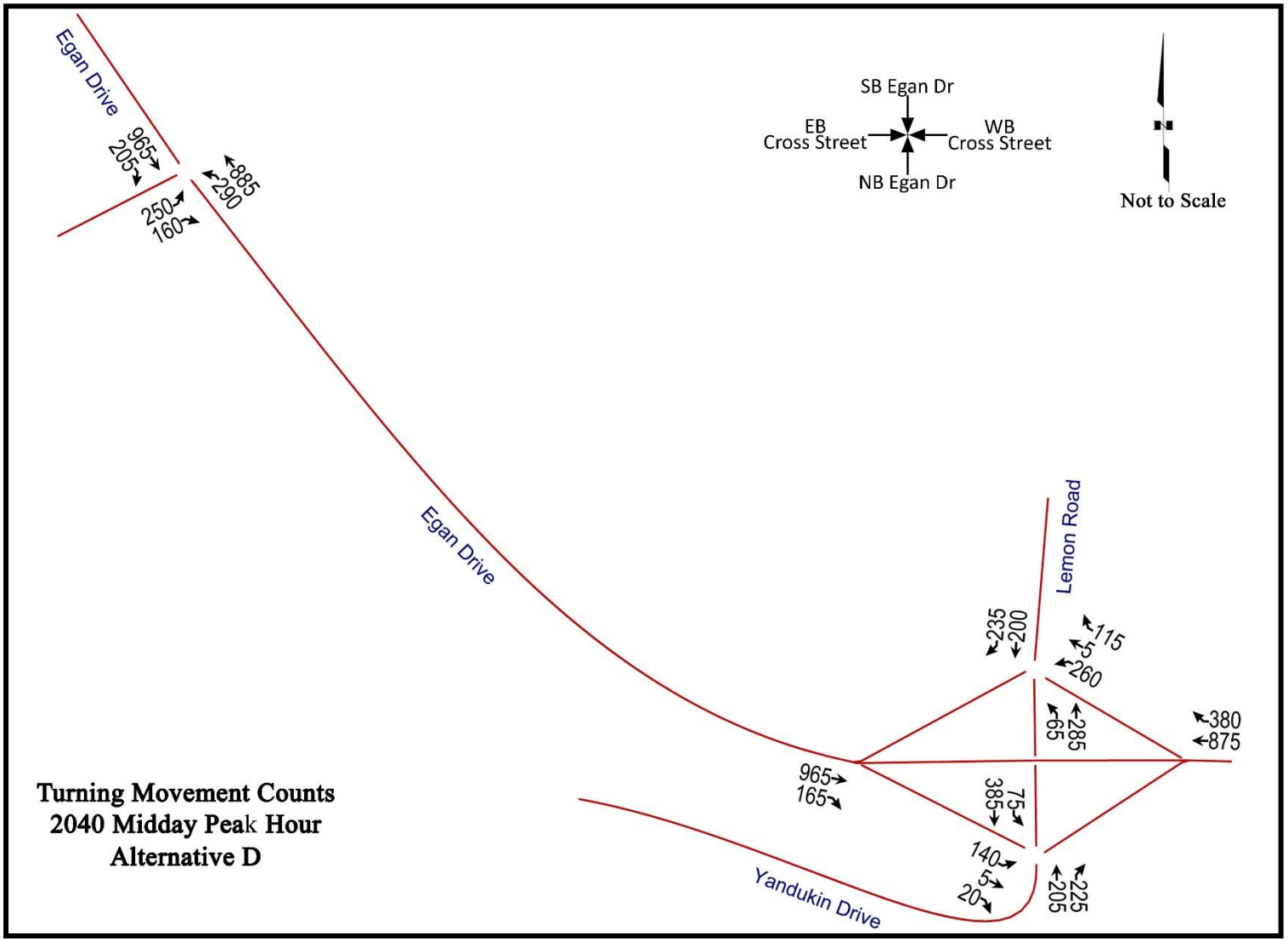


Figure 69. Turning Movement Volumes, Alternative Concept D (Interchange), 2040 Midday Peak Hour

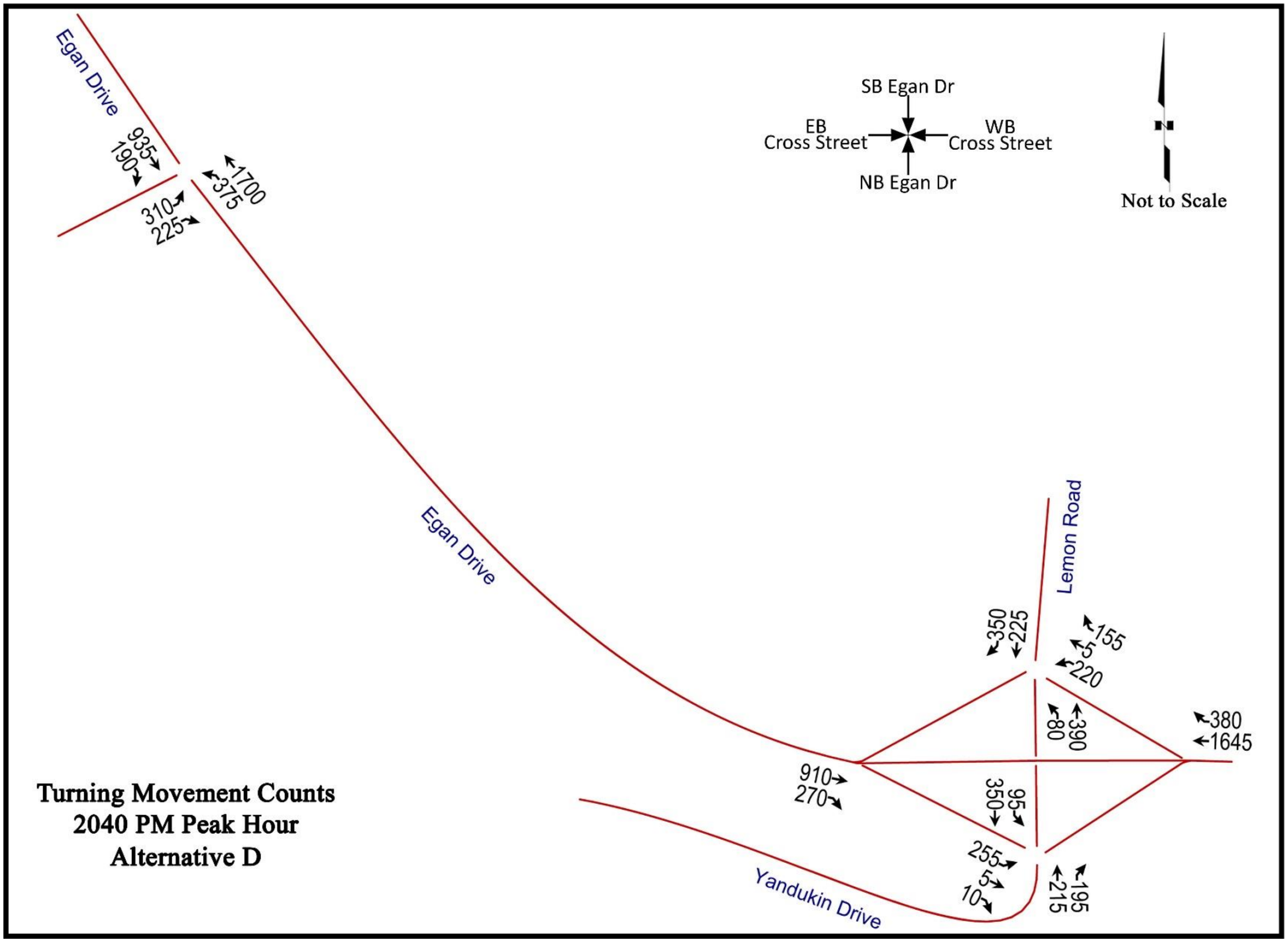


Figure 70. Turning Movement Volumes, Alternative Concept D (Interchange), 2040 PM Peak Hour

Appendix D Public Input and Involvement Summary

The public has been encouraged to provide comments on the study intersection at the official project website (http://dot.alaska.gov/sereg/projects/egan-yandukin/), which was first available on Monday, December 4, 2017. The public also provided comments at an Open House held at the Mendenhall Valley Library on December 23, 2017. The public comment period is open through Friday, January 12, 2018. The website and the Open House were advertised through a variety of different media, including newspaper ads, flyers posted in area businesses, radio public service announcements, online ads, and media interviews, as shown in Table 64.

Table 64. Public Outreach for Open House and Public Comment Period

Public Outreach Method	Dates
Juneau Empire print newspaper	Tuesday, November 28, 2017, and Tuesday, December 5, 2017
Juneau Empire online banner impressions (31,000)	Monday, December 4, 2017, to Tuesday, December 12, 2017
Radio advertisements on local station KTOO (prime time hours on weekdays and Saturday, run of schedule on Sunday, and during Juneau Afternoon program)	Thursday, December 7, 2017, to Tuesday, December 12, 2017
Public service announcements on KINY	Thursday, December 7, 2017, to Tuesday, December 12, 2017
Email notifications to elected officials and agency stakeholders	Prior to Open House
Meeting information flyers posted on approximately 40 Juneau area bulletin boards	Posted on Wednesday, December 6, 2017, or Thursday, December 7, 2017
Posted on DOT&PF Facebook Page	Unknown
Meeting advertisement on Facebook, geo-targeting Juneau users	Unknown
Online Public Notice	Tuesday, December 5, 2017
Met with media representatives on December 8, 2017, to present and answer questions in advance.	Friday, December 8, 2017
Articles ran in Juneau Empire, identifying the date, time, and place for Open House and website	Monday, December 4, 2017 Sunday, December 10, 2017

Appendix E Traffic Operations Summaries

Table 65: Intersection LOS Summary, Alternative Concept A (No Build), 2017 Volumes at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	57	-	0	77	2	-	-	22	0	**20**
LOS	E	-	Free	E	A	-	-	C	Free	**B**
v/c Ratio	0.6	-	-	0.9	0.2	-	-	0.9	-	-
Queue Length (ft)	75	-	-	350	125	-	-	1000	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	44	-	0	47	4	-	-	22	0	**19**
LOS	D	-	Free	D	A	-	-	C	Free	**B**
v/c Ratio	0.8	-	-	0.9	0.3	-	-	0.6	-	-
Queue Length (ft)	150	-	-	325	125	-	-	450	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	46	-	0	53	8	-	-	29	0	**21**
LOS	D	-	Free	D	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	1.0	0.7	-	-	0.7	-	-
Queue Length (ft)	175	-	-	400	450	-	-	550	-	-

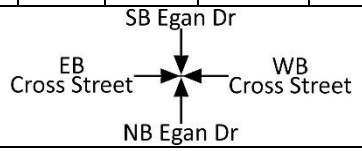


Table 66: Intersection LOS Summary, Alternative Concept A (No Build), 2040 Volumes at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	57	-	0	157	2	-	-	26	0	**32**
LOS	E	-	Free	F	A	-	-	C	Free	**C**
v/c Ratio	0.7	-	-	1.2	0.3	-	-	0.9	-	-
Queue Length (ft)	100	-	-	525	125	-	-	1025	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	44	-	0	49	5	-	-	27	0	**21**
LOS	D	-	Free	D	A	-	-	C	Free	**C**
v/c Ratio	0.8	-	-	0.9	0.4	-	-	0.7	-	-
Queue Length (ft)	150	-	-	350	175	-	-	625	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	46	-	0	54	11	-	-	41	0	**25**
LOS	D	-	Free	D	B	-	-	D	Free	**C**
v/c Ratio	0.9	-	-	1.0	0.8	-	-	0.9	-	-
Queue Length (ft)	200	-	-	475	600	-	-	650	-	-

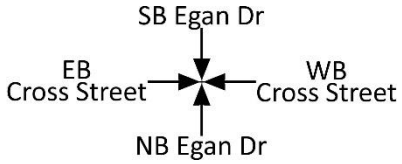


Table 67: Intersection LOS Summary, Alternative Concept B (Signal), With Existing Lanes at Egan Drive & Yandukin Drive

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	49	48	0	**56**	46	0	**75**	20	10	**72**	**103**	10	**68**
LOS	D	D	Free	**E**	D	Free	**E**	B	A	**E**	**F**	A	**E**
v/c Ratio	0.1	0.4	-	0.3	0.2	-	0.9	0.4	0.1	0.6	1.1	0.0	-
Queue Length (ft)	50	200	-	100	125	-	250	375	25	100	1,475	25	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	53	47	0	55	46	0	**86**	26	11	**82**	37	11	**35**
LOS	D	D	Free	D	D	Free	**F**	C	B	**F**	D	B	**D**
v/c Ratio	0.3	0.4	-	0.3	0.3	-	0.9	0.5	0.2	0.9	0.7	0.0	-
Queue Length (ft)	100	200	-	125	175	-	400	475	25	250	550	25	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	53	46	0	55	46	0	44	**112**	13	**197**	**57**	11	**77**
LOS	D	D	Free	D	D	Free	D	**F**	B	**F**	**E**	B	**E**
v/c Ratio	0.5	0.5	-	0.6	0.5	-	0.4	0.7	0.3	0.9	0.9	0.0	-
Queue Length (ft)	125	175	-	150	175	-	375	1,225	50	500	150	25	-

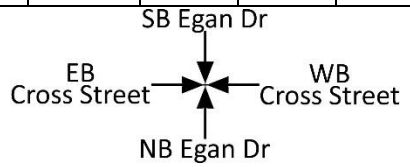


Table 68: Intersection LOS Summary, Alternative Concept B (Signal), With Existing Lanes at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**70**	-	0	**66**	2	-	-	19	0	**26**
LOS	**E**	-	Free	**E**	A	-	-	B	Free	**C**
v/c Ratio	0.7	-	-	0.9	0.2	-	-	0.8	-	**-**
Queue Length (ft)	100	-	-	350	350	-	-	1,150	-	**-**
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**68**	-	0	**73**	4	-	-	18	0	**22**
LOS	**E**	-	Free	**E**	A	-	-	B	Free	**C**
v/c Ratio	0.9	-	-	0.9	0.3	-	-	0.5	-	**-**
Queue Length (ft)	200	-	-	400	475	-	-	500	-	**-**
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**74**	-	0	**74**	8	-	-	25	0	**23**
LOS	**E**	-	Free	**E**	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	1.0	0.7	-	-	0.6	-	**-**
Queue Length (ft)	225	-	-	200	50	-	-	550	-	**-**

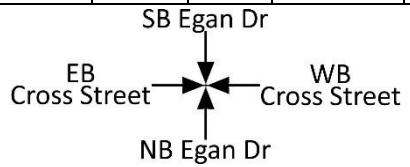


Table 69: Intersection LOS Summary, Alternative Concept B (Signal), With Additional Northbound Through Lane at Egan Drive & Yandukin Drive

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	51	50	0	**58**	48	0	**104**	19	10	**76**	**143**	10	**92**
LOS	D	D	Free	**E**	D	Free	**F**	B	A	**E**	**F**	A	**F**
v/c Ratio	0.1	0.4	-	0.3	0.2	-	0.9	0.3	0.1	0.7	1.2	0.0	-
Queue Length (ft)	50	200	-	125	125	-	375	225	25	75	1,125	25	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**56**	49	0	**58**	49	0	45	22	11	**85**	**62**	11	**39**
LOS	**E**	D	Free	**E**	D	Free	D	C	B	**F**	**E**	B	**D**
v/c Ratio	0.3	0.4	-	0.3	0.3	-	0.5	0.4	0.2	0.9	0.9	0.0	-
Queue Length (ft)	100	200	-	125	175	-	400	275	25	175	75	25	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	54	46	0	**56**	46	0	42	41	13	**87**	**59**	11	**42**
LOS	D	D	Free	**E**	D	Free	D	D	B	**F**	**E**	B	**D**
v/c Ratio	0.5	0.5	-	0.6	0.5	-	0.4	0.7	0.3	0.9	0.9	0.0	-
Queue Length (ft)	125	175	-	150	175	-	325	675	50	400	100	25	-

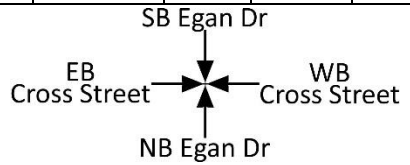


Table 70: Intersection LOS Summary, Alternative Concept B (Signal), With Additional Northbound Through Lane at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	72	-	0	167	2	-	-	20	0	**26**
LOS	E	-	Free	F	A	-	-	C	Free	**C**
v/c Ratio	0.7	-	-	1.1	0.2	-	-	0.8	-	-
Queue Length (ft)	100	-	-	475	200	-	-	250	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	69	-	0	84	3	-	-	21	0	**24**
LOS	E	-	Free	F	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	0.9	0.3	-	-	0.6	-	-
Queue Length (ft)	175	-	-	200	50	-	-	600	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	65	-	0	81	5	-	-	28	0	**23**
LOS	E	-	Free	F	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	1.0	0.5	-	-	0.6	-	-
Queue Length (ft)	200	-	-	550	75	-	-	625	-	-

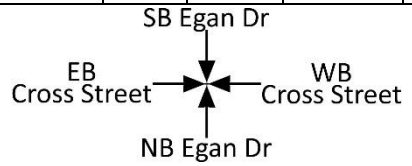


Table 71: Intersection LOS Summary, Alternative Concept B (Signal), With Additional Northbound Through Lane (Without Pedestrians) at Egan Drive & Yandukin Drive

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	68	82	0	158	64	0	110	11	10	76	45	10	**42**
LOS	E	F	Free	F	E	Free	F	B	A	E	D	A	**D**
v/c Ratio	0.2	0.8	-	1.0	0.5	-	0.9	0.3	0.1	0.7	1.0	0.0	-
Queue Length (ft)	50	275	-	175	150	-	350	150	25	75	100	25	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	58	52	0	61	51	0	35	16	11	73	50	11	**33**
LOS	E	D	Free	E	D	Free	C	B	B	E	D	B	**C**
v/c Ratio	0.4	0.5	-	0.5	0.5	-	0.5	0.3	0.2	0.9	0.9	0.0	-
Queue Length (ft)	125	200	-	125	175	-	325	200	25	150	100	25	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	65	55	0	69	55	0	35	32	13	79	56	11	**38**
LOS	E	D	Free	E	D	Free	D	C	B	E	E	B	**D**
v/c Ratio	0.5	0.5	-	0.6	0.5	-	0.4	0.7	0.3	0.9	0.9	0.0	-
Queue Length (ft)	150	200	-	175	200	-	300	625	50	250	75	25	-

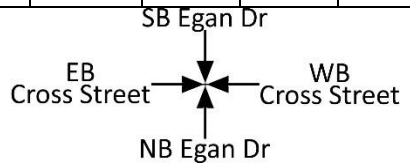


Table 72: Intersection LOS Summary, Alternative Concept B (Signal), With Additional Northbound Through Lane (Without Pedestrians) at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**72**	-	0	**167**	2	-	-	20	0	**26**
LOS	**E**	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.7	-	-	1.1	0.2	-	-	0.8	-	-
Queue Length (ft)	100	-	-	475	175	-	-	250	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**60**	-	0	**80**	3	-	-	21	0	**22**
LOS	**E**	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.8	-	-	0.9	0.3	-	-	0.6	-	-
Queue Length (ft)	150	-	-	400	75	-	-	575	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**65**	-	0	**81**	5	-	-	28	0	**23**
LOS	**E**	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	1.0	0.5	-	-	0.6	-	-
Queue Length (ft)	200	-	-	550	75	-	-	625	-	-

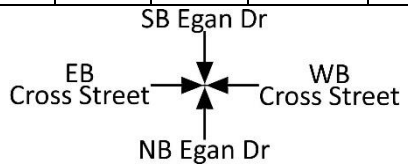


Table 73: Intersection LOS Summary, Alternative Concept B (Signal), With Additional Northbound and Southbound Through Lanes at Egan Drive & Yandukin Drive

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	50	49	0	**57.**	47	0	**61**	20	10	**76**	**55**	10	**43**
LOS	D	D	Free	**E**	D	Free	**E**	B	A	**E**	**E**	A	**D**
v/c Ratio	0.1	0.4	-	0.3	0.2	-	0.7	0.3	0.1	0.7	1.0	0.0	-
Queue Length (ft)	50	200	-	100	125	-	350	250	25	75	350	25	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	53	47	0	**55**	47	0	36	24	11	**83**	**62**	11	**38**
LOS	D	D	Free	**E**	D	Free	D	C	B	**F**	**E**	B	**D**
v/c Ratio	0.3	0.3	-	0.3	0.3	-	0.4	0.4	0.2	0.9	0.9	0.0	-
Queue Length (ft)	100	200	-	125	175	-	350	300	25	175	175	25	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	54	46	0	**55**	46	0	35	**57**	13	**58**	**60**	11	**47**
LOS	D	D	Free	**E**	D	Free	D	**E**	B	**E**	**E**	B	**D**
v/c Ratio	0.5	0.5	-	0.6	0.5	-	0.4	0.7	0.3	0.9	0.9	0.0	-
Queue Length (ft)	125	175	-	150	175	-	300	700	50	450	175	25	-

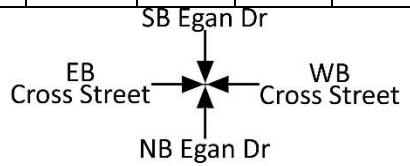


Table 74: Intersection LOS Summary, Alternative Concept B (Signal), With Additional Northbound and Southbound Through Lanes at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**72**	-	0	**167**	2	-	-	20	0	**27**
LOS	**E**	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.7	-	-	1.1	0.2	-	-	0.8	-	-
Queue Length (ft)	100	-	-	475	50	-	-	1,250	-	-
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**69**	-	0	**84**	3	-	-	21	0	**24**
LOS	**E**	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	0.9	0.3	-	-	0.6	-	-
Queue Length (ft)	175	-	-	300	50	-	-	600	-	-
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**68**	-	0	**82**	5	-	-	28	0	**23**
LOS	**E**	-	Free	**F**	A	-	-	C	Free	**C**
v/c Ratio	0.9	-	-	1.0	0.5	-	-	0.6	-	-
Queue Length (ft)	200	-	-	550	550	-	-	600	-	-

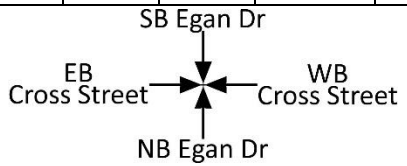


Table 75: Intersection LOS Summary, Alternative Concept C1 (One-Way Extension) (with 1 SB LT Lane), at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**67**	**75**	**51**				**80**	10	0	**78**	31	13	38
LOS	**E**	**E**	**F**				**F**	A	0	**E**	C	B	D
v/c Ratio	0.4	0.85	0.75				**0.95**	0.3	0	0.65	0.85	0.4	
Queue Length (ft)	100	225	150				425	250	0	125	1225	50	
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	49	45	16				**65**	17	0	**80**	21	14	35
LOS	D	D	B				**E**	B	0	**F**	C	B	D
v/c Ratio	0.8	0.3	0.45				**0.95**	0.45	0	0.9	0.5	0.35	
Queue Length (ft)	125	75	50				375	375	0	300	400	50	
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**63**	61	14				**68**	33	14	**91**	26	14	43
LOS	**E**	E	B				**E**	C	B	**F**	C	B	D
v/c Ratio	0.85	0.7	0.35				**0.95**	0.85	0	0.9	0.45	0.3	
Queue Length (ft)	225	200	50				400	1150	0	350	400	25	

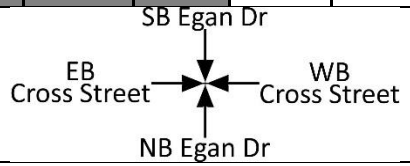


Table 76: Intersection LOS Summary, Alternative Concept C1 (One-Way Extension) (with 2 SB LT lanes), at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	65	72	51				78	10	0	70	31	13	37
LOS	E	E	F				E	A	0	E	C	B	D
v/c Ratio	0.4	0.85	0.75				0.95	0.3	0	0.35	0.9	0.4	
Queue Length (ft)	100	225	150				325	250	0	50	1325	50	
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	49	45	16				65	13	0	59	21	14	33
LOS	D	D	B				E	B	0	E	C	B	C
v/c Ratio	0.8	0.3	0.45				0.95	0.4	0	0.75	0.5	0.35	
Queue Length (ft)	125	75	50				375	325	0	125	400	50	
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	57	55	14				66	26	11	77	25	14	38
LOS	E	D	B				E	C	B	E	C	B	D
v/c Ratio	0.85	0.7	0.35				0.95	0.85	0	0.85	0.45	0.3	
Queue Length (ft)	200	175	50				400	1025	0	200	375	25	

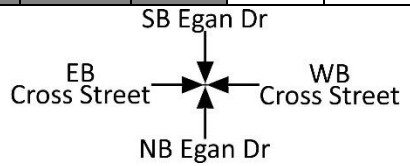


Table 77: Intersection LOS Summary, Alternative Concept C2 (Two-Way Extension), at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**164**	52	0	**85**	51	10	**118**	20	10	**69**	**91**	12	**71**
LOS	**F**	D	Free	**F**	D	B	**F**	C	A	**E**	**F**	B	**E**
v/c Ratio	1.1	0.5	-	0.6	0.2	0.1	1.0	0.4	0.0	0.6	1.1	0.4	-
Queue Length (ft)	175	225	-	75	100	25	350	300	25	125	1225	50	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**70**	29	0	**67**	39	11	48	**59**	10	**82**	**57**	13	50
LOS	**E**	C	Free	**E**	D	B	D	**E**	A	**F**	**E**	B	D
v/c Ratio	0.9	0.1	-	0.6	0.3	0.1	0.8	1.0	0.0	0.9	0.9	0.3	-
Queue Length (ft)	250	75	-	50	125	25	325	525	25	375	450	50	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**209**	45	0	**94**	54	20	43	**168**	11	**189**	**65**	13	**110**
LOS	**F**	D	Free	**F**	D	C	D	**F**	B	**F**	**E**	B	**F**
v/c Ratio	1.3	0.4	-	0.8	0.5	0.4	0.5	1.3	0.0	1.2	0.9	0.3	-
Queue Length (ft)	400	225	-	75	175	75	325	1300	25	500	450	50	-

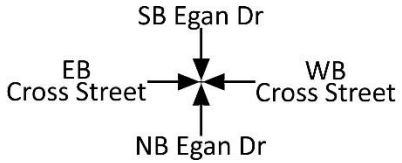


Table 78: Intersection LOS Summary, Alternative Concept C2 (Two-Way Extension) (Without Pedestrians), at Egan Drive & Glacier Highway

AM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**75**	**91**	0	**84**	**65**	10	**79**	14	10	**68**	45	12	43
LOS	**E**	**F**	Free	**F**	**E**	B	**E**	B	A	**E**	D	B	D
v/c Ratio	0.8	0.9	-	0.6	0.6	0.1	0.9	0.4	0.0	0.6	1.0	0.4	-
Queue Length (ft)	125	325	-	75	125	25	325	225	25	125	1050	50	-
Midday Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	40	30	0	53	41	11	32	33	10	43	33	13	31
LOS	D	C	Free	D	D	B	C	C	A	D	C	B	C
v/c Ratio	0.8	0.2	-	0.5	0.7	0.1	0.7	0.9	0.0	0.9	0.9	0.3	-
Queue Length (ft)	200	100	-	50	150	25	250	425	25	275	375	50	-
PM Peak	**Eastbound**			**Westbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**123**	**59**	0	**109**	**135**	20	35	**83**	11	**144**	**63**	132	**80**
LOS	**F**	**E**	Free	**F**	**F**	C	C	**F**	B	**F**	**E**	B	**E**
v/c Ratio	1.0	0.6	-	0.8	1.0	0.4	0.4	1.1	0.0	1.1	0.9	0.3	-
Queue Length (ft)	350	275	-	100	275	75	275	1,125	25	450	450	50	-

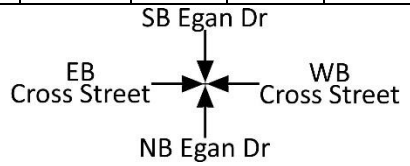
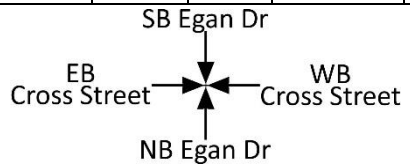


Table 79. Intersection LOS, Alternative Concept D (Interchange) at Egan Drive & Glacier Highway

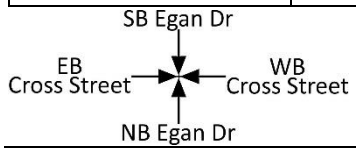
AM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	**58**	-	0	**76**	2	-	-	22	0	**20**
LOS	**E**	-	Free	**E**	A	-	-	C	Free	**C**
v/c Ratio	0.7	-	-	0.9	0.3	-	-	0.9	-	**-**
Queue Length (ft)	75	-	-	325	125	-	-	1000	-	**-**
Midday Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	45	-	0	42	4	-	-	18	0	**16**
LOS	D	-	Free	D	A	-	-	B	Free	**B**
v/c Ratio	0.8	-	-	0.9	0.4	-	-	0.6	-	**-**
Queue Length (ft)	125	-	-	250	175	-	-	500	-	**-**
PM Peak	**Eastbound**			**Northbound**			**Southbound**			**Intersection Average**
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through*	*Right*	
Delay (sec/veh)	45	-	0	49	8	-	-	23	0	**18**
LOS	D	-	Free	D	A	-	-	C	Free	**B**
v/c Ratio	0.8	-	-	0.9	0.7	-	-	0.7	-	**-**
Queue Length (ft)	215	-	-	325	500	-	-	550	-	**-**



Appendix F Old Dairy Road at Glacier Highway/Nugget Operations

Table 80. Intersection LOS, Alternative Concept A No Build at Glacier Highway & Old Dairy Road/Trout Street, 2040

AM Peak	**Eastbound**			**Westbound**			**Northbound**		**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	0	8	0	0	23	12	**96**	13
LOS	A	Free	Free	A	Free	Free	C	B	**F**	B
v/c Ratio	0.05	-	-	0.10	-	-	0.05	0.15	0.90	0.20
Queue Length (ft)	< 25	-	-	< 25	-	-	< 25	25	175	25
Midday Peak	**Eastbound**			**Westbound**			**Northbound**		**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	0	9	0	0	**88**	19	**459**	19
LOS	A	Free	Free	A	Free	Free	**F**	C	**F**	C
v/c Ratio	0.10	-	-	0.15	-	-	0.45	0.45	1.70	0.50
Queue Length (ft)	< 25	-	-	25	-	-	50	50	275	75
PM Peak	**Eastbound**			**Westbound**			**Northbound**		**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	0	10	0	0	**78**	19	**328**	18
LOS	A	Free	Free	A	Free	Free	**F**	C	**F**	C
v/c Ratio	0.05	-	-	0.20			0.25	0.50	1.25	0.35
Queue Length (ft)	< 25	-	-	25			25	75	150	50



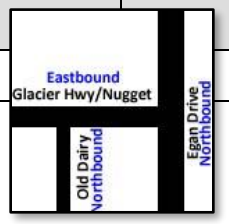


Table 81. Intersection LOS, Alternative Concept C1 or C2 Extension at Glacier Highway & Old Dairy Road/Trout Street, 2040

AM Peak	**Eastbound**			**Westbound**			**Northbound**		**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	0	8	0	0	34	14	**319**	16
LOS	A	Free	Free	A	Free	Free	D	B	**F**	C
v/c Ratio	0.05	-	-	0.15	-	-	0.10	0.15	**1.45**	0.25
Queue Length (ft)	< 25	-	-	25	-	-	< 25	25	400	25
Midday Peak	**Eastbound**			**Westbound**			**Northbound**		**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	0	9	0	0	**376**	**37**	**1867**	39
LOS	A	Free	Free	A	Free	Free	**F**	**E**	**F**	E
v/c Ratio	0.10	-	-	0.25	-	-	**1.05**	0.65	**4.55**	0.70
Queue Length (ft)	< 25	-	-	25	-	-	100	100	400	125
PM Peak	**Eastbound**			**Westbound**			**Northbound**		**Southbound**	
	Left	*Through*	*Right*	*Left*	*Through*	*Right*	*Left*	*Through/Right*	*Left*	*Through/Right*
Delay (sec/veh)	9	0	0	9	0	0	**376**	**37**	**1867**	39
LOS	A	Free	Free	A	Free	Free	**F**	**E**	**F**	E
v/c Ratio	0.10	-	-	0.25			**1.05**	0.65	**4.55**	0.70
Queue Length (ft)	< 25	-	-	25			100	100	400	125