

# **APPENDIX I**

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## **Interim Action Strategies Summary and Comparison**

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**FROM:** Jeanne Bowie, PE, PhD, PTOE; James Smith, PE  
**DATE:** January 10, 2019  
**SUBJECT:** SHFWY00079 – Interim Action Strategies Summary and Comparison

## Introduction

The Alaska Department of Transportation and Public Facilities (DOT&PF) is actively working on ways to improve traffic and pedestrian safety at the intersection of Egan Drive at Yandukin Drive (Egan-Yandukin) shown in Figure 1. Concepts for actions that can be taken in the interim while more permanent solutions are being developed are being considered. Interim Action (IA) Concepts meet the following criteria:

- Address crash frequency or crash severity at the intersection
- Can be in place (designed and constructed) prior to November 2020

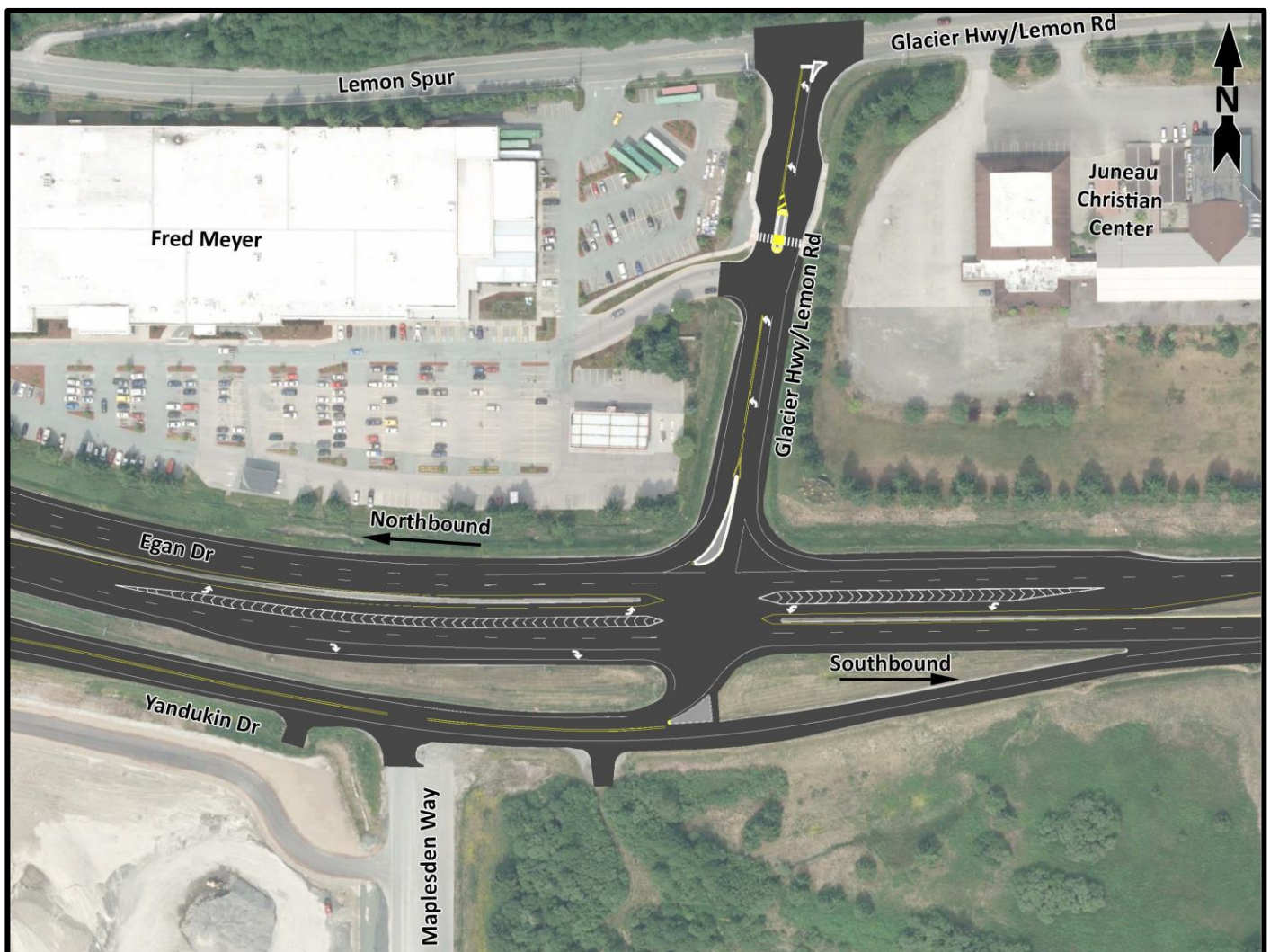


Figure 1- Intersection of Egan Drive at Yandukin Drive

Egan Drive is a controlled-access high mobility principal arterial carrying almost 30,000 vehicles per day at speeds above 55 mph. It is an important connection for every person traveling north or south, as there is no alternative route to avoid the intersection. Egan Drive serves vehicular traffic including public transit, freight traffic, and tourism, as well as crossing pedestrians and bicyclists.

The crash rate at the Egan-Yandukin intersection is not statistically above average for similar intersections across Alaska. However, it has the 8th highest crash severity rate in Juneau (Annual Traffic and Safety Report, 2013). Thus, crash severity at the intersection is of concern. Left turn crashes from Egan Drive are the predominant crash type. Darkness, pavement conditions, and difficulty judging when to take gaps in oncoming traffic appear to be factors in crashes.

## Interim Action Strategies

A charette was held on September 10, 2019 in which project team members met to discuss the intersection crash history and to develop near term strategies for addressing crash concerns. The following strategies were identified:

- Strategy A: Reduce Speeds to Reduce Crash Severity
- Strategy B: Provide More Frequent Gaps
- Strategy C: Reduce Conflicts and Improve Lane Alignment between Northbound Vehicles and Southbound Left Turn (SBLT) Vehicles
- Strategy D: Reduce Conflicts and Improve Lane Alignment between Southbound Vehicles and Northbound Left Turn (NBLT) Vehicles
- Strategy E: Eliminate Left Turn Movements

Several interim concepts were developed to implement the various strategies.

For more detailed discussions of each strategy and concept, please refer to the individual Interim Action Memos for each strategy.

### Strategy A: Reduce Speeds to Reduce Crash Severity

#### Concept IA A-1: Lower Speed Limits in Study Area to 45 mph in the Winter Months

The goal of this concept is to reduce the severity of left turn crashes at the intersection of Egan Drive and Yandukin Drive by reducing the travel speed of oncoming Egan Drive traffic. The concept would install a 45-mph speed zone between the Sunny Point interchange and the Mendenhall River Bridge. The speed zone would be active from mid-October through mid-March with information signs as drivers enter the speed zone, and speed feedback signs as drivers approach the Egan Drive intersection. Enforcement and public education would be an important aspect of this concept since speed studies show current traffic does not have a high rate of compliance with the current posted speed limits.

This concept is expected to have a negligible reduction in crash severity in the left turn related crashes at Yandukin Drive. The speed zone would increase travel time for Egan Drive through movements and would not substantially change the delay for left turn movements, which modeling shows would have the same frequency of usable gaps.

The concept would have an estimated cost of \$250,000, plus an annual cost for changing the speed zone in the fall and spring.

Figure 2 on page 3 shows the proposed layout of the concept.

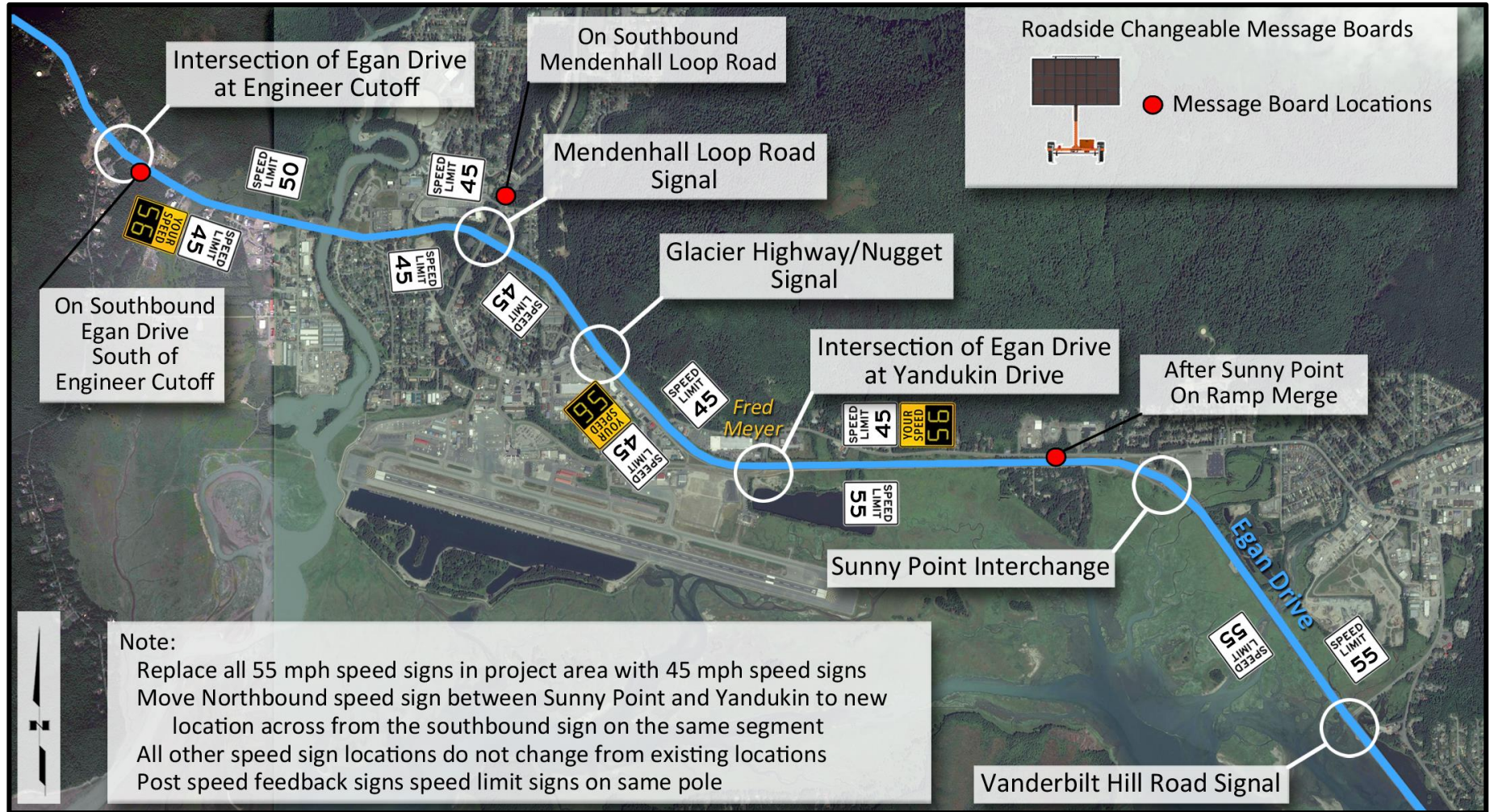


Figure 2. Concept IA A-1: Seasonal 45-mph Speed Zone

## Strategy B: Provide More Frequent Gaps

### Concept IA B-1: Adjust Signal Timing at Vanderbilt Hill Road Signal

The goal of this concept is to reduce the number of left turn crashes at the intersection of Egan Drive and Yandukin Drive by decreasing the time period between usable gaps in the Egan Drive traffic stream. This concept would shorten the cycle length of the Vanderbilt Hill signal which would theoretically have an effect on the time between usable gaps in the northbound traffic flow; however, analysis shows that changes in the cycle length does not have a significant effect on the time between usable gaps at the intersection of Egan Drive and Yandukin Drive.

This mitigation would not substantially affect the number of crashes at the Yandukin intersection. A shorter cycle length at Vanderbilt Hill would reduce overall average delay at that signal but would have no effect on the delay at Yandukin Drive.

This concept would have no construction costs.

Figure 3 below shows the proposed change to the cycle length.

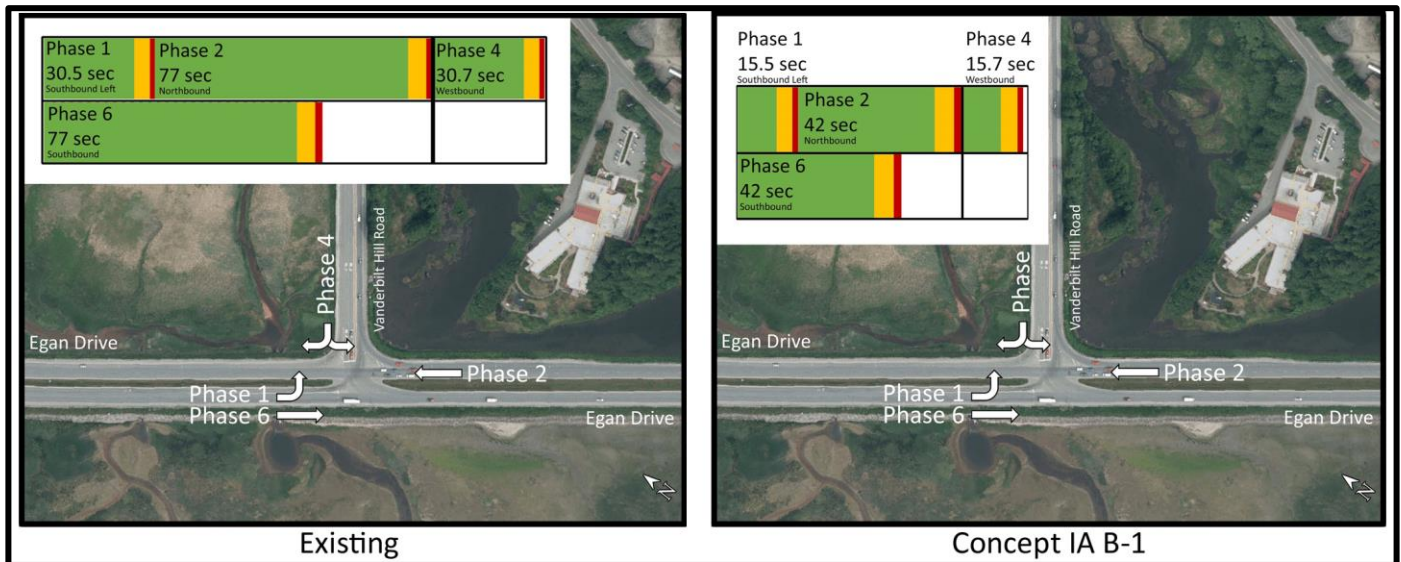


Figure 3. Concept IA B-1: Shortened Signal Cycle Length at Vanderbilt Hill Road

## Strategy C: Reduce Conflicts and Improve Lane Alignment between Northbound Vehicles and Southbound Left Turn (SBLT) Vehicles

Strategy C concepts would target a reduction in southbound left turn crashes resulting from left turn driver uncertainty about what lane the oncoming driver is in, as well as whether or not an opposing right turn driver will yield. Currently these movements meet at a right turn yield condition on Glacier Highway/Lemon Drive. It is possible that a reduction in confusion about the lane assignment of right turn traffic may improve performance and safety.

### Concept IA C-1: Improve Northbound Right Turn Yield Signs

The goal of this concept would be to reduce the number of conflicts at the northbound right turn yield by installing flashing LED warning lights to improve the compliance with the yield sign. This mitigation is expected to have a minor reduction in the crash frequency. The concept would have no effect on delay.

The cost of installing the LED flashing warning lights would be approximately \$21,000 not including the additional increase in maintenance and operation costs.

Figure 4 below shows the proposed layout of the concept.

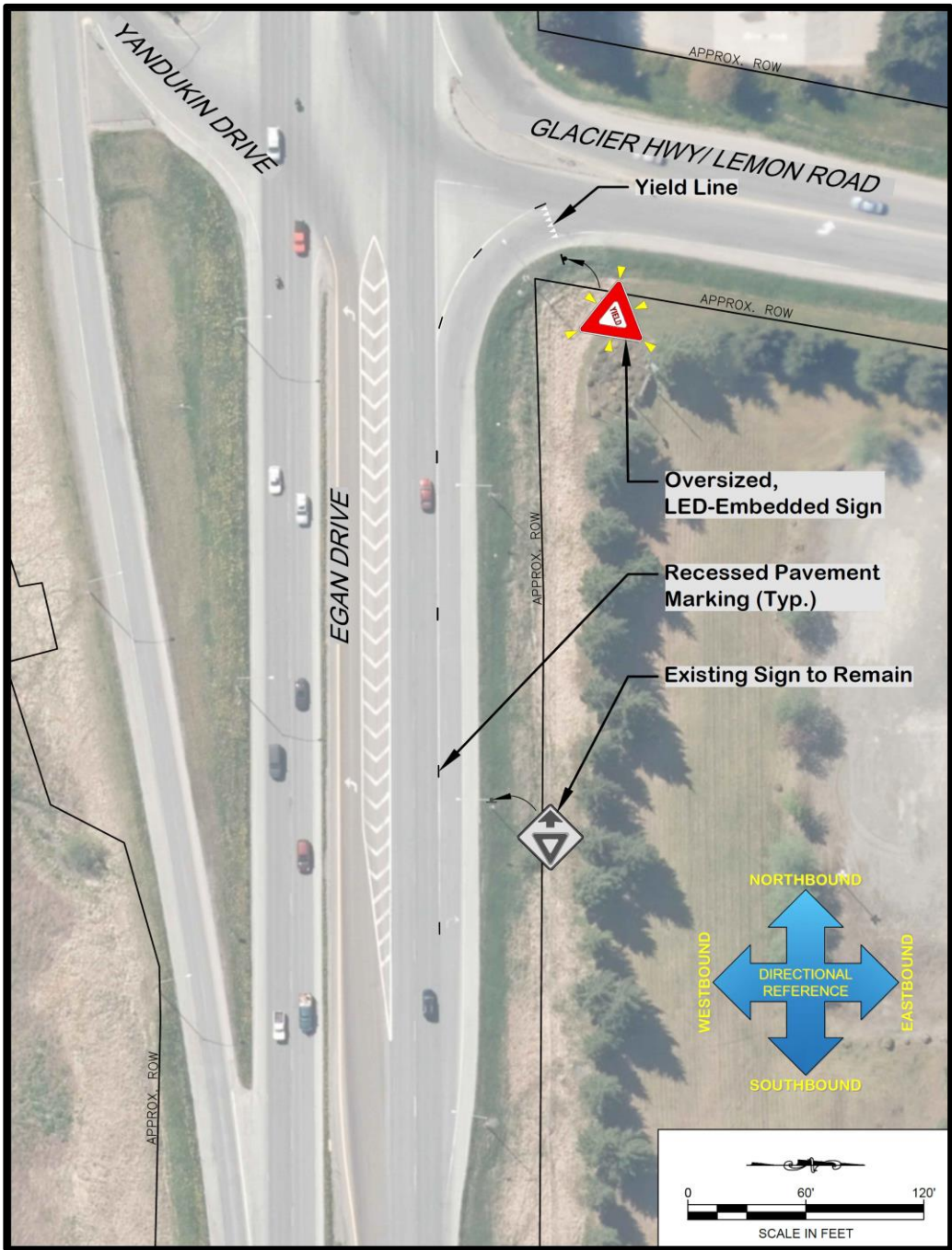


Figure 4. Concept IA C-1: Improve Northbound Right Turn Yield Signs

### Concept IA C-2: Emphasize Northbound Right Turn Yielding Through Design

The goal of this concept would be to reduce the number of conflicts at the northbound right turn yield by widening the northbound right turn lane and installing a new raised channelized island. This mitigation is expected to have a minor reduction in the crash frequency. The raised median island would provide pedestrian refuge for Egan Drive crossings and may provide some benefit for southbound left turns with a clearer indication of lane use for northbound vehicles.

The cost of installing this concept would be approximately \$1,100,000.

Figure 5 below shows the proposed layout of the concept.

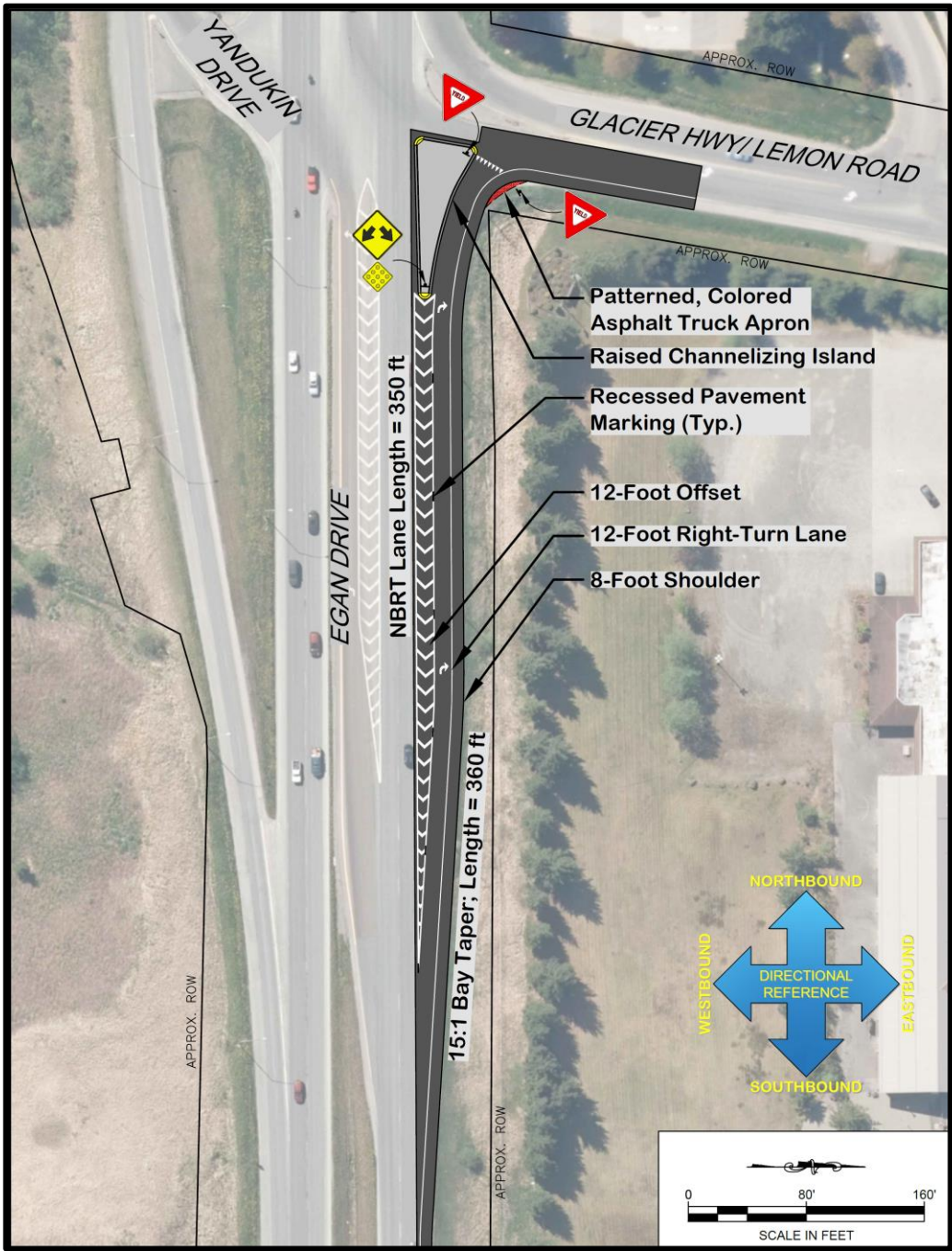


Figure 5. Concept IA C-2: Emphasize Northbound Right Turn Yielding Through Design



### Concept IA C-3: Construct Northbound Right Turn Receiving Lane (Free Movement)

The goal of this concept would be to eliminate the conflicts between the northbound right turns and the southbound left turns at Yandukin Drive by constructing a separate receiving lane on Glacier Highway/Lemon Drive for the northbound right turns. One lane would become a left turn only lane at the Fred Meyer driveway. This mitigation would likely have a minor reduction in the crashes resulting from the existing yield condition and may also provide some benefit for southbound left turns which are having trouble distinguishing between northbound right turns and northbound through movements. This concept may have the negative effect of introducing sideswipe crashes due to the short distance it would provide for lane change maneuvers. This short distance for merging would be especially difficult for busses turning southbound left which would then need to weave into the northbound right turn travel lane to reach the bus stop.

The estimated cost for this concept is \$110,000 to construct. Figure 6 below shows the proposed layout of the concept.

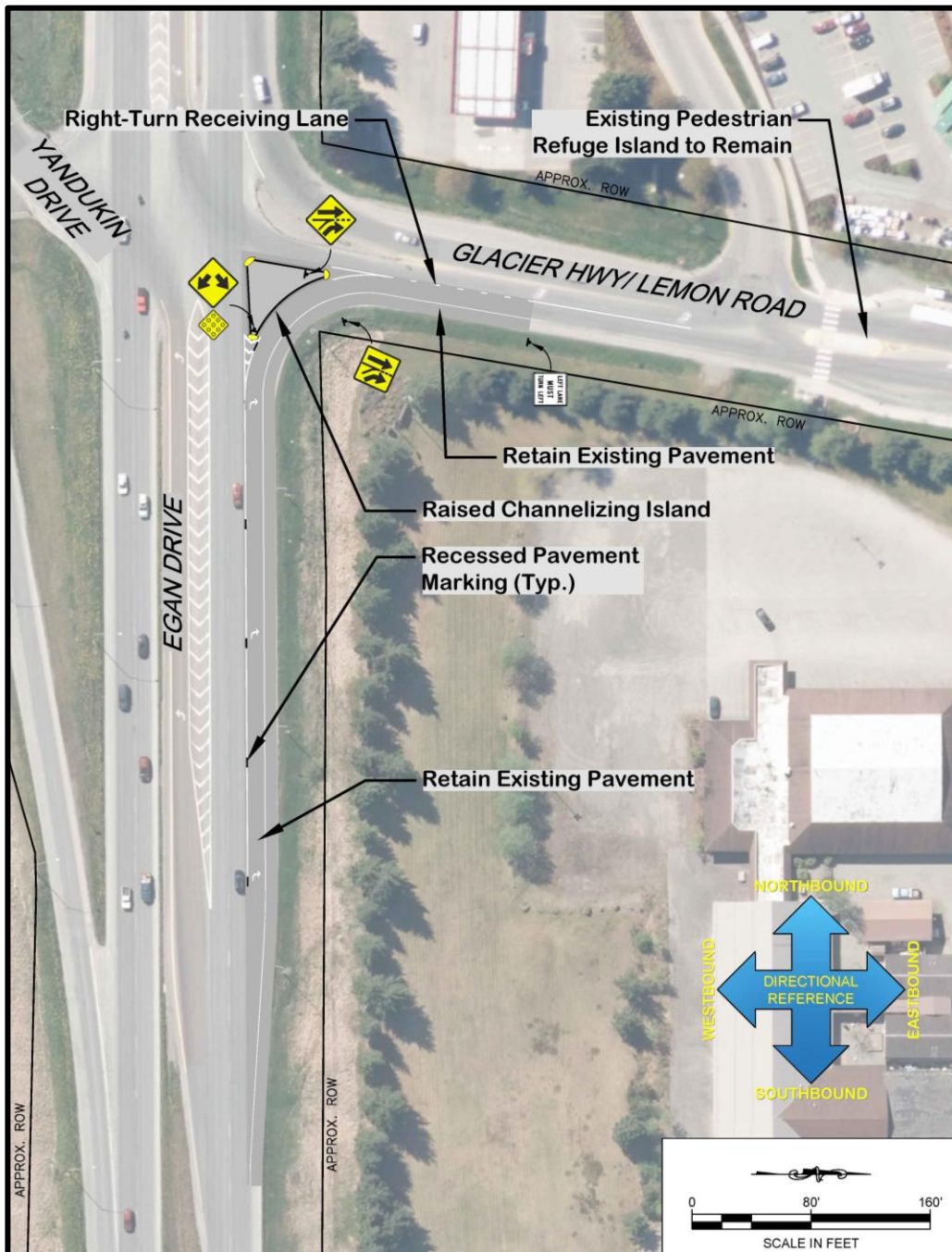


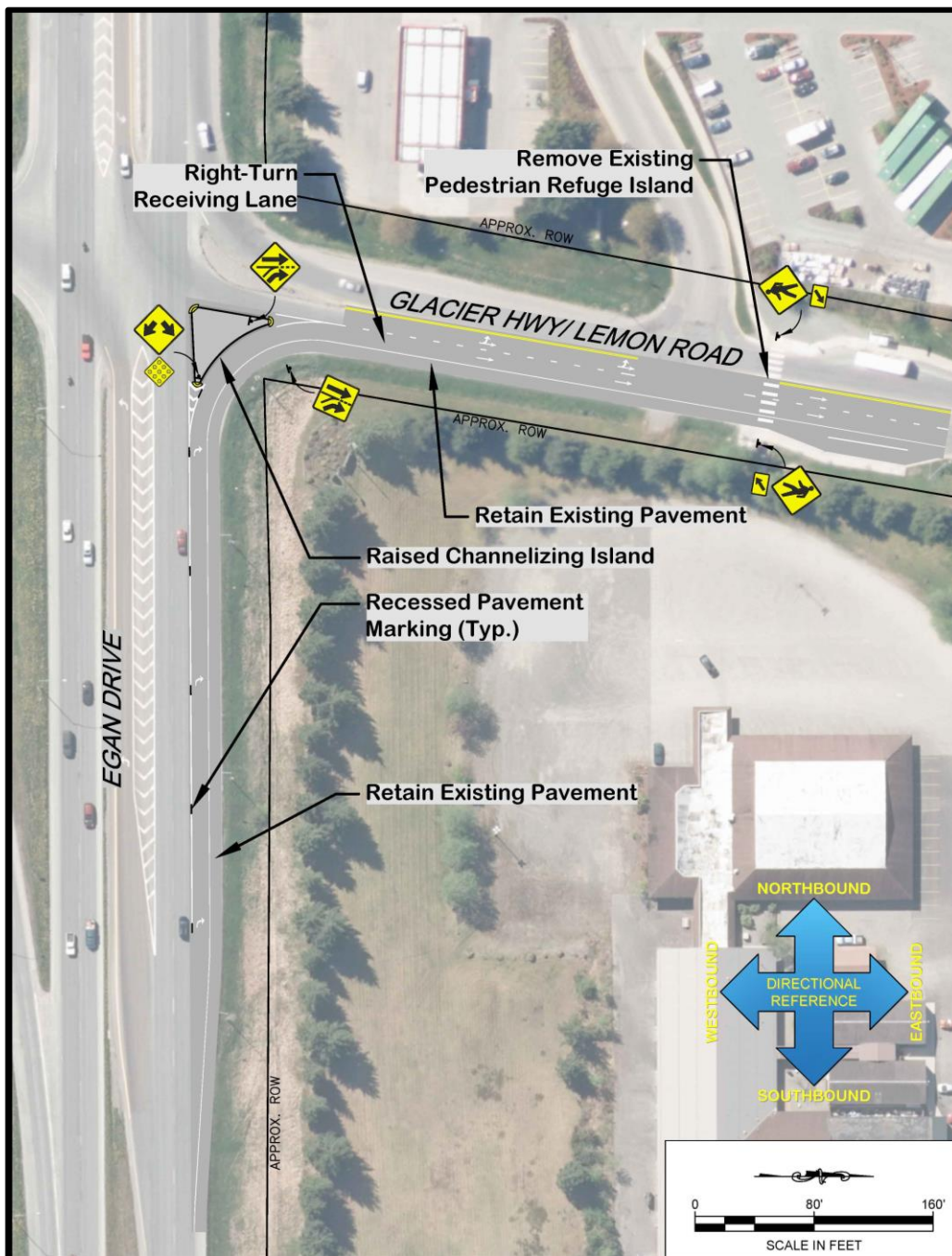
Figure 6. Concept IA C-3: Construct Northbound Right Turn Receiving Lane (Free Movement)

**Concept IA C-4: Construct Northbound Right Turn Receiving Lane (Free Movement) and Extend Weaving Area**

This concept would achieve the same goals as Concept IA C-3, above, however it would extend the weaving length on Glacier Highway/Lemon Drive to reduce the risk of merge related sideswipe crashes. This concept would improve, but not completely eliminate, the issues with the bus merging which were introduced with Concept IA C-3. Because this concept would convert the protected eastbound left-turn into Fred Meyers on Glacier Highway/Lemon Road into a shared through-left, it would introduce conflicts due to through and left turn traffic sharing the same lane.

This concept would cost approximately \$150,000 to construct.

Figure 7 below shows the proposed layout of the concept.



*Figure 7. Concept IA C-4: Construct Northbound Right Turn Receiving Lane (Free Movement) and Extend Weaving Area*

## Strategy D: Reduce Conflicts and Improve Lane Alignment between Southbound Vehicles and Northbound Left Turn (NBLT) Vehicles

### Concept IA D-1: Prohibit SBRT and Redesign West Departure Leg

This concept would target a reduction in southbound left turn crashes resulting from left turn driver uncertainty about where to aim while turning, resulting in hesitation while turning. This concept would prohibit southbound right turns and redesign the west departure leg onto Yandukin Drive. The southbound right turn demand, which is relatively low, would be redirected to a southbound right turn movement at the Nugget intersection to the north.

This concept is expected to have a small effect on the rate of crashes at the Egan Drive intersection at Yandukin Drive and is also not expected to decrease the delay at the intersection, since the displaced southbound right turn movement has such an unsubstantial demand.

The cost for this concept is approximately \$510,000.

Figure 8 below shows the proposed layout of the concept.

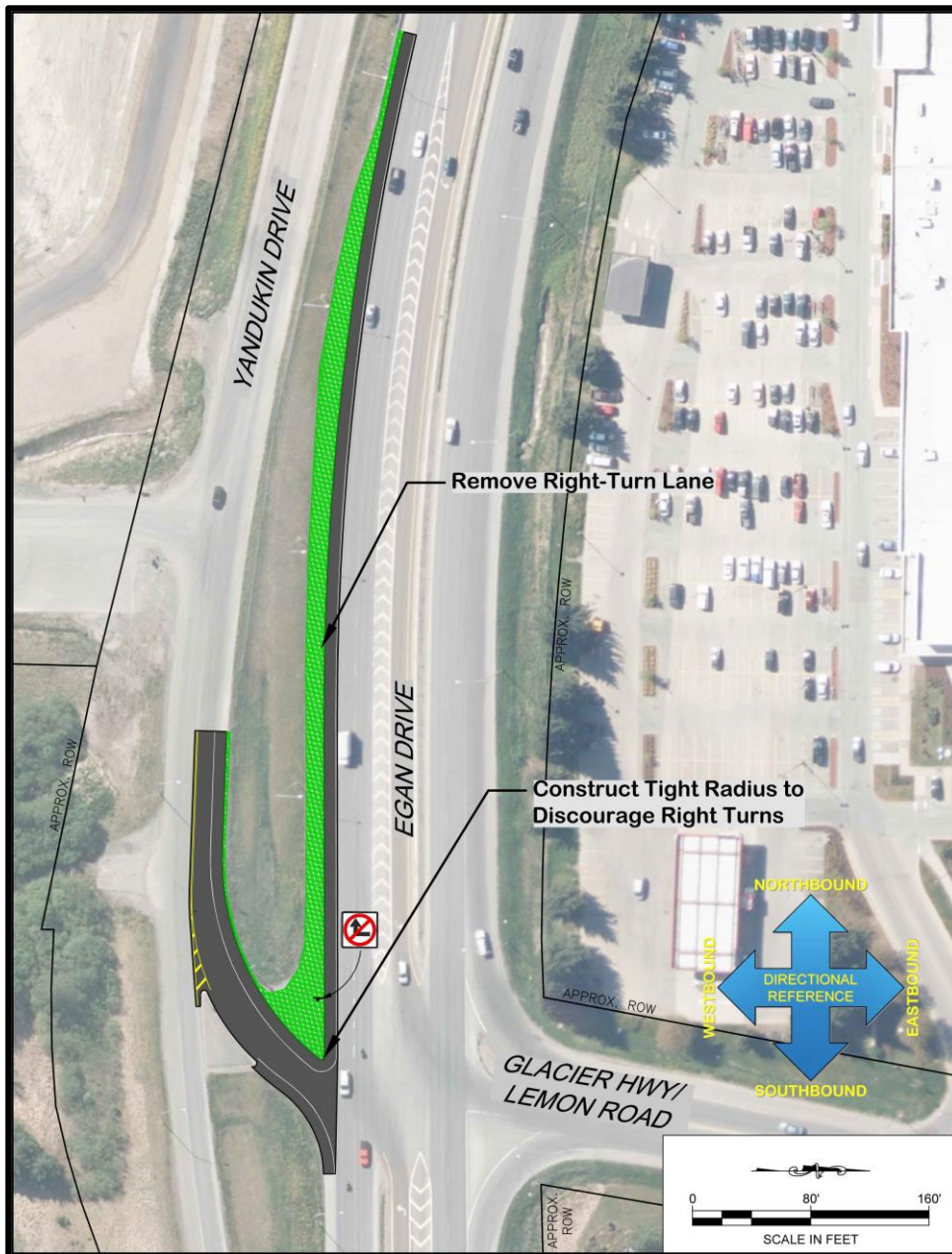


Figure 8. Concept IA D-1: Prohibit SBRT and Redesign West Departure Leg

## Strategy E: Eliminate Left Turn Movements

### Concept IA E-1: Close Median

This concept would address the left turn related crashes at Egan Drive and Yandukin Drive by eliminating the left turns at the intersection and eliminating all of the left turn related crashes. This concept would be accomplished by closing the median at Yandukin Drive. Traffic wanting to make these movements would divert southbound to the Sunny Point interchange or northbound to the Nugget traffic signal.

This concept is expected to result in a substantial reduction in the number of crashes; however it would introduce increased travel time due to out of direction travel to trips traveling to the area of Glacier Highway/Lemon Drive, as well as access to the airport on the west side of Egan Drive. Likewise, the median would lengthen several transit routes, creating increased travel time and out of direction travel for several bus lines.

The cost of installing the closed median is estimated at \$270,000.

Figure 9 below shows the proposed layout of the concept.



Figure 9. Concept IA E-1: Close Median

## Comparison of Concepts

The strategies and concepts discussed above were evaluated using criteria agreed upon by the project team.

### Safety improvement (reduction in crash frequency)

Concept A-1 is expected to reduce some of the crashes because when the oncoming traffic is slower in the winter, turning drivers will have more time to select gaps within the available sight distance.

The analysis for Concept B-1 showed no change to the length of time between gaps due to the change in signal timing, resulting in no change to the number of crashes.

While the yield sign improvements in Concept C-1 might increase yielding by northbound right turn vehicles, the improvements do not improve the ability of the southbound left turn driver to discern what lane vehicles are in or whether or not a right turn vehicle will yield.

Concept C-2 separates the northbound right turn lane from the through lanes, helping the southbound left turn driver distinguish between vehicles in the turn lane and those in the through lanes. The right turn yielding is also emphasized by the geometry and the raised island.

Both Concept C-3 and C-4 remove the need for northbound right turn vehicles and southbound left turn vehicles to yield to each other. Also, the raised island may help the southbound left turn driver distinguish between vehicles in the turn lane and those in the through lanes.

Concept D-1 removes southbound right turn vehicles from the intersection, so that northbound left turn drivers do not have to distinguish between right turn and through vehicles. In addition, the geometry makes the target trajectory for the northbound left turn more clear, reducing hesitancy.

Concept E-1 would have the largest effect on crashes by eliminating the left turn movement, and therefore all crashes related to left turns at the intersection.

### Safety improvement (reduction in crash severity)

For most of the concepts, the reduction in the frequency of crashes is expected to result in an equal portion of reduced injury crashes. (The likelihood that a crash results in an injury will not change.) However, for Concept A-1 crashes that do occur would likely be of reduced severity due to a decrease in speeds prior to the collision.

## Maintenance and Operations

The maintenance and operations impact of the various concepts will be evaluated by the DOT&PF M&O department.

### Stakeholder impacts

The definition of stakeholder for this criteria was limited to adjacent business and property owners. The project team made general evaluations as to how each concept would affect the surrounding stakeholders.

While Concept A-1 would result in travel time increases of around 40 seconds to any trip passing through the speed zone, it is unlikely that drivers would change their route or reduce their number of trips due to the lower speed limits.

Similarly, stakeholders are unlikely to be affected by the concepts for strategies B or C.

For Concept D-1, southbound right turn vehicles would be rerouted to the Nugget intersection; however, the demand for this movement is relatively low, therefore, the reroute is expected to have a small impact.

Concept E-1 could significantly impact adjacent businesses since it would increase the travel time to businesses at the intersection by about 5 minutes, which may result in drivers choosing to patronize other locations.

### Transit impacts

Impacts to transit come either from increases in travel time, increases in difficulty to maneuver to the bus stop, or impacts to how transit patrons access transit stops.

Concept A-1 would increase the travel time for the transit routes servicing the Mendenhall Valley due to decreased speeds.

Concept C-3 would require Routes 3 and 5X making a southbound left turn off of Egan Drive onto Glacier Hwy/Lemon Drive to first enter the left lane and then change lanes into the new northbound right turn receiving lane in order to stop at the bus stop across from Fred Meyer. Under Concept C-4, buses are also required to change lanes between Egan Drive and the bus stop. In addition, Concept C-4 would remove the existing pedestrian refuge island, increasing the difficulty for patrons crossing to the bus stop.

The concept with the greatest impact to transit operations would be Concept E-1, which will increase the travel time for the bus routes by around 5 minutes.

### Safety Impacts to other intersections

The safety benefits of Concept A-1 would extend through the Mendenhall Valley. Crash rates and crash severity can be expected to decrease at all intersections within the temporary speed zone, assuming that the targeted reduction in speed can be achieved through signage, education, and enforcement.

Concept C-4 could result in a small increase in crashes at the driveway to the Fred Meyer, where left turn vehicles and through vehicles will share the same lane.

Concept E-1 would result in a small increase in crashes at other intersections by increasing the traffic volumes at those other intersections. There would still likely be an overall reduction in the frequency and severity of crashes, however.

No other concept is expected to impact safety at the surrounding intersections.

### Operational Impacts to other intersections

Modeling indicates that the signal timing of the Vanderbilt Hill intersection included for Concept B-1 would improve the overall operation of that signal; however, the current performance is not failing, and the improvements would be marginal.

As discussed in the previous section, Concepts E-1 would reroute left turn traffic from the Egan and Yandukin intersection through existing intersections at Sunny Point, Lemon Drive, and Glacier Highway/Nugget. This would increase the volume in various movements and increase the delay at these intersections. The actual performance of these intersections with the additional traffic load was not analyzed.

### Environmental considerations

Concept E-1 will result in longer travel times and would send more vehicles through signalized intersections, where they are more likely to idle. This could impact air pollution.

### Ped/Bike access

This criteria looks only at the ease of crossing Egan Drive for pedestrians and bicycling. Concept A-1 would marginally improve the safety and performance of pedestrian and bicycle traffic crossing Egan Drive. When vehicles are traveling at a slower pace, those walking or biking do not have to see as far down the highway to look for available gaps.

Concept E-1 could improve the ease of crossing Egan Drive by eliminating turning traffic at the intersection, so that people walking or biking across Egan Drive would only have to yield to vehicles coming from one direction at a time.

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**FROM:** James Smith, PE; Jeanne Bowie, PE, PhD, PTOE; Jessica Miranda, PE  
**DATE:** December 13, 2019  
**SUBJECT:** SHFWY00079 – Strategy A: Reduce Speeds to Reduce Crash Severity

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## Background

The most common crash type at the intersection of Egan Drive and Yandukin Drive are left turn crashes. These are crashes where a left turning vehicle strikes or is struck by an oncoming northbound or southbound through vehicle. At this intersection, left turn crashes result in higher severity crashes as compared to other crash types. A review of the 2005 to 2017 crash history at this intersection revealed 45% (39 out of a total of 86) of the crashes were left turn related, and 28 of these resulted in at least a minor injury).

Typically, left turn crashes at unsignalized intersections occur when the left turning vehicle maneuvers into oncoming traffic when there is not an adequate gap in the traffic flow for them to clear the lane or for the oncoming vehicle to either stop or avoid the collision. This situation typically occurs when the left turn driver misjudges one of the following:

- The amount of time it will take to make the left turn movement
- The travel lane or travel path of the oncoming vehicle
- The speed of the oncoming vehicle and therefore the amount of time available for crossing

In general, these errors in judgment could be based on lack of sight distance, irregular vehicle speeds, poor road conditions, or a combination of these factors, not all of which may be present at the Egan Drive and Yandukin intersection. Sight distance at the intersection is more than adequate, but evidence suggests that irregular vehicle speeds and winter road conditions may be contributing to the crash problem.

One possible solution to reducing the rate and severity of crashes at the Egan Drive and Yandukin intersection is to reduce the speed of the oncoming traffic. This could theoretically provide larger gaps for left turn maneuvers and reduce the energy of collisions which would lower the risk of injuries.

## Existing Conditions

The proposed concept would reduce the posted speed limits on Egan Drive in an attempt to reduce the speed of traffic and in turn reduce the frequency and severity of crashes.

## Posted Speeds

Figure 1 on page 2 presents the current posted speed limits along the Egan Drive corridor.

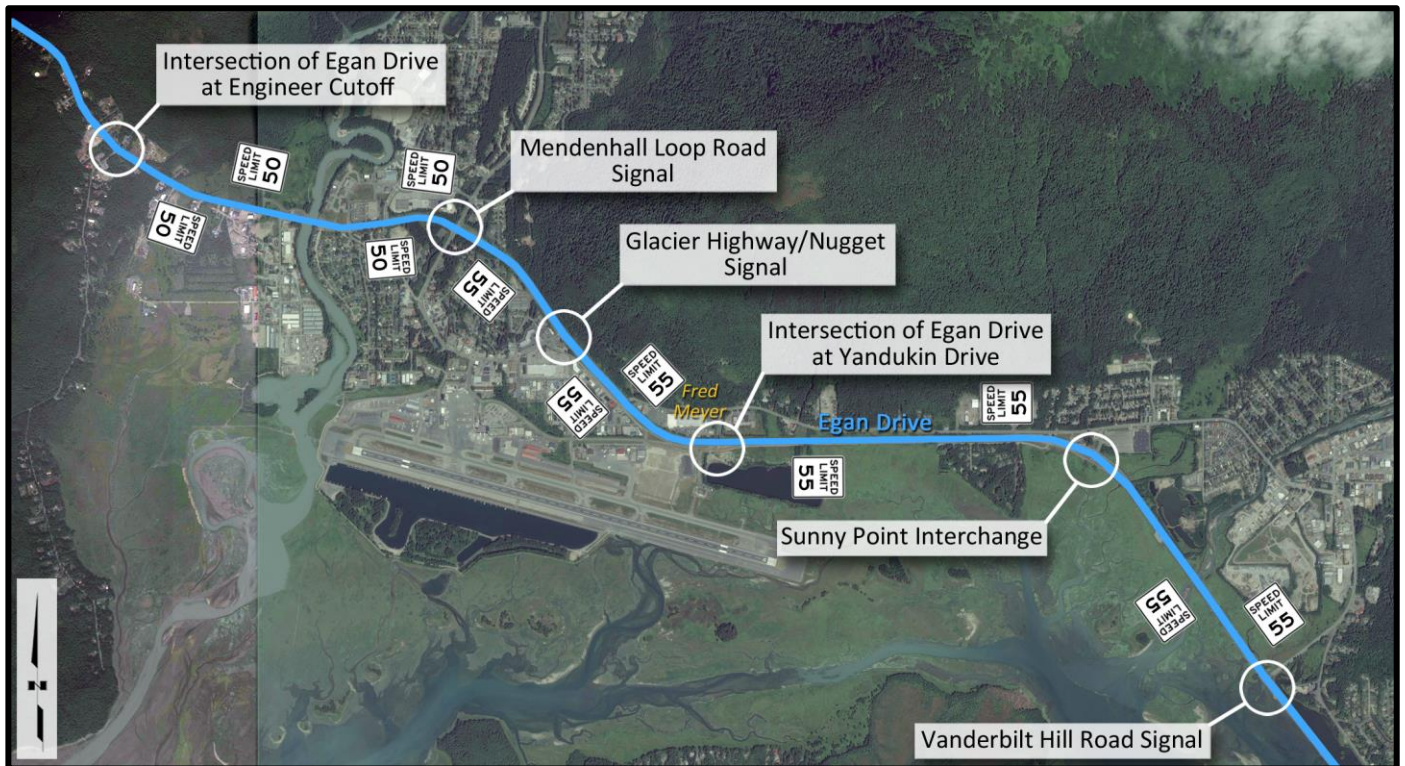


Figure 1. Existing Speed Limit Sign Locations

The Egan Drive posted speed limits at the intersection at Yandukin Drive are 55 mph in both the northbound and southbound directions. The southbound Egan Drive speed limits are posted at 50 mph until just past Mendenhall Loop Road where the speed limits increase to 55 mph as drivers approach the Glacier Highway/Nugget intersection. The 55 mph southbound speed limit continues all the way to downtown Juneau. The northbound speed limits begin 55 mph just north of downtown Juneau and are signed 55 mph all the way through the study area until after Mendenhall Loop Road, where they drop to 50 mph. The speed limits are posted in both directions between each major intersection and are positioned after the on-ramps of the Sunny Point intersection. There does not appear to be a sign northbound on Egan Drive between the Glacier Highway/Nugget intersection and the Mendenhall Loop Road intersection.

### Speed Studies

Speed studies were conducted for the Egan Drive and Yandukin Intersection Improvement Traffic Analysis and Alternative Concepts Report, updated in October of 2019. The speed studies were conducted in September and October of 2017. Three of the speed study locations were on Egan Drive as shown in Figure 2 on page 3.



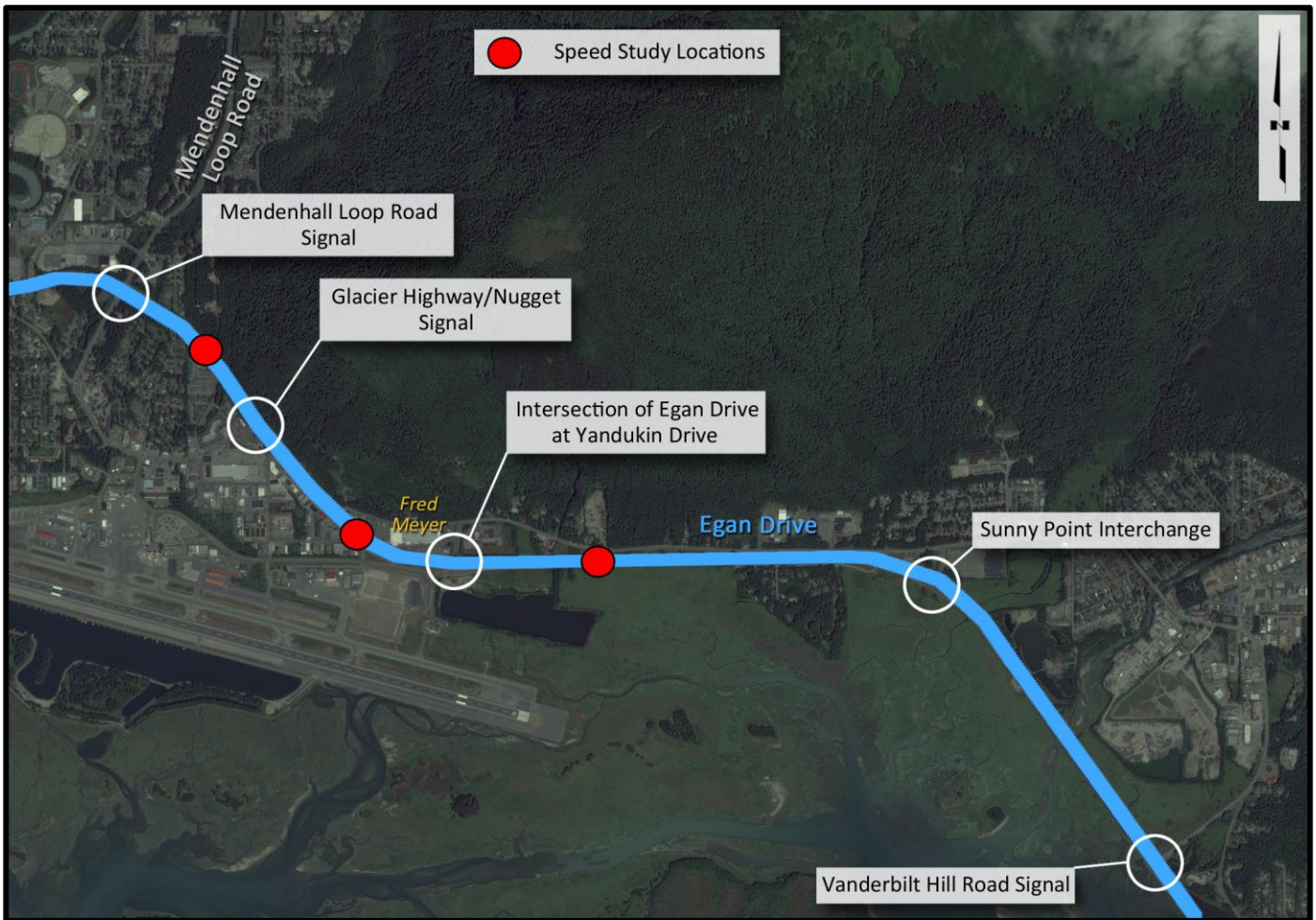


Figure 2. Speed Study Locations

The results of the speed study are shown in Table 1 below. The results include the 85<sup>th</sup> percentile speeds which typically should be at or near the posted speed limit, and the “pace” speed which is the speed range that contains more vehicles than any other 10 mph range, and the percentage of traffic that is in the pace as well as above or below the pace.

Table 1. Egan Drive Speed Study Results

Location	Direction	85% Speed (mph)	Pace Range (mph)	Percent of Vehicles Observed		
				Below Pace	In Pace	Above Pace
Mendenhall to Glacier Hwy/Nugget	Northbound	63	54-63	15	64	21
	Southbound	63	53-62	22	58	19
Glacier Hwy/Nugget to Yandukin	Northbound	57	47-56	14	68	18
	<b>Southbound</b>	<b>60</b>	<b>50-59</b>	<b>18</b>	<b>66</b>	<b>16</b>
Yandukin to Sunny Point	<b>Northbound</b>	<b>61</b>	<b>51-60</b>	<b>16</b>	<b>69</b>	<b>15</b>
	Southbound	62	52-61	11	68	21

The approaches to the Egan Drive intersection with Yandukin Drive have been highlighted in the table.

At every location, the 85<sup>th</sup> percentile speeds are greater than the posted speed limits. The 85<sup>th</sup> percentile speeds approaching Yandukin drive are each approximately 60mph.

The percent of vehicles observed in each of the columns (the pace and above and below the pace) can give an indication of the deviation of traffic speeds in the flow. According to the FHWA publication Methods and Practices

for Setting Speed Limits: An Informational Report, April 2012, the pace should typically contain 70% of the roadway traffic with 15% of the traffic above the pace and 15% below. This scenario would represent an even bell curve distribution of traffic which is familiar to drivers when predicting the speeds of oncoming traffic. On Egan Drive, the speeds are generally within this range. Of certain note is the northbound approach to Yandukin which matches the 15-70-15 distribution recommended by FHWA almost exactly. This suggests that the distribution of travel speeds on Egan Drive are not unexpected, particularly when approaching the Yandukin intersection. The data suggests that drivers are uniformly choosing to drive faster.

A gap study using this same speed study dataset also determined that the number of gaps available for turning were limited due to high traffic volumes overall (see description in Strategy B memo). The combination of these factors is likely contributing to the crash frequency at this location and the high speeds of oncoming traffic (higher than 45 mph) are likely contributing to the higher than expected severity of those crashes.

### Seasonal Crash Analysis

In addition to the high speeds on Egan Drive, crash analysis determined that road conditions may be a factor in both crash frequency and severity. Figure 3 below presents the frequency of crashes by month based on documented road conditions at the time of the crash.

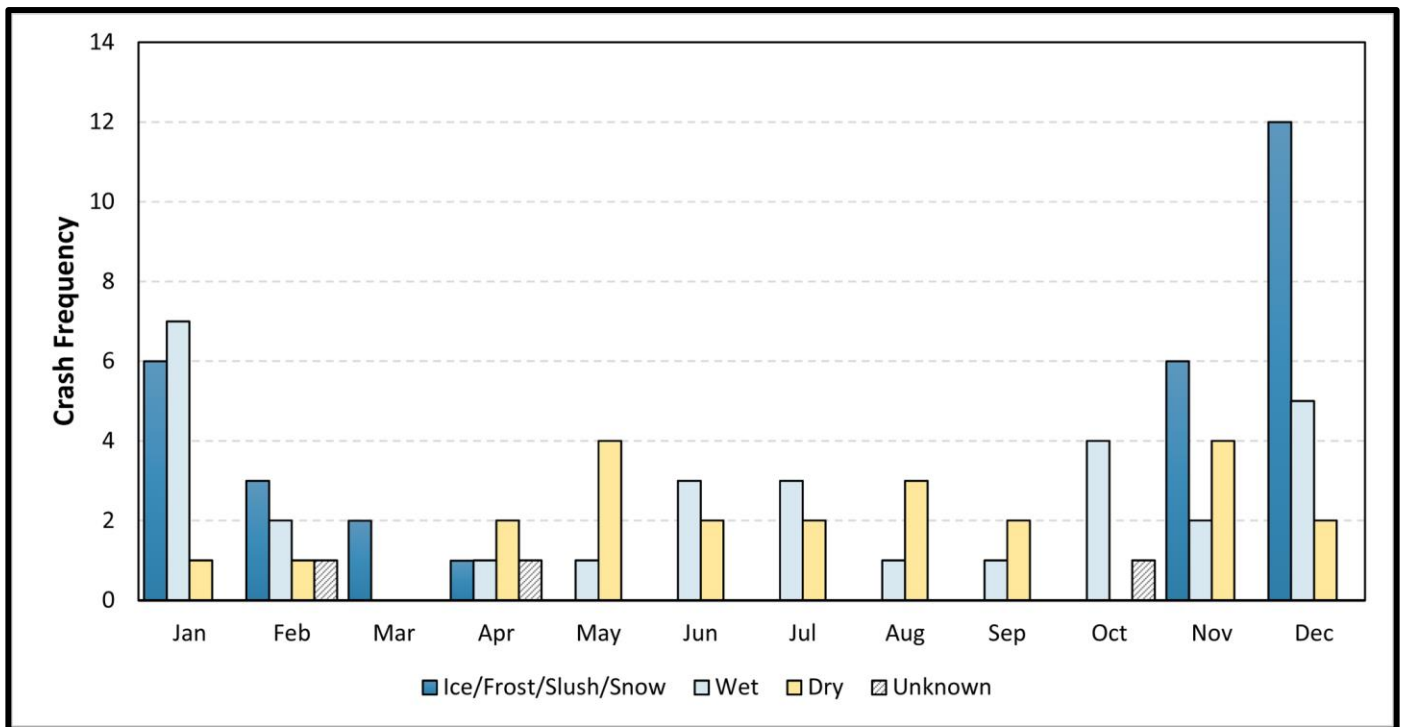


Figure 3. Crashes per Month by Road Conditions, 2013 to 2017

Crashes at the Egan Drive and Yandukin intersection increase in the winter months as the road conditions become more frequently icy. Crash frequency in the winter months during dry conditions seem to be consistent with the frequency of crashes on dry pavement in the summer.

### Concept for Strategy A: Reduce Speeds to Reduce Crash Severity

The data in the previous sections suggests that higher than normal speeds and seasonal weather conditions may be contributing to the crash history and higher than expected severity of crashes at the intersection of Egan Drive and Yandukin Drive. One strategy for reducing crash frequency and crash severity may be to reduce the speed of traffic on Egan Drive by lowering the allowable speed limit in the winter months.

### Concept IA A-1: Lower Speed Limits in Study Area to 45 mph in the Winter Months

Concept IA A-1 would temporarily lower the speeds along the Egan Drive Corridor between mid-October and mid-March. The posted speeds in the study area would be converted to 45 mph and changeable message boards would be posted at the beginning of the speed zone in either direction warning drivers of the new seasonal change in speeds. Likewise, speed feedback signs would be deployed at the entrance to the speed zones in either direction to increase compliance to the posted speeds. This concept is shown in Figure 4 below.

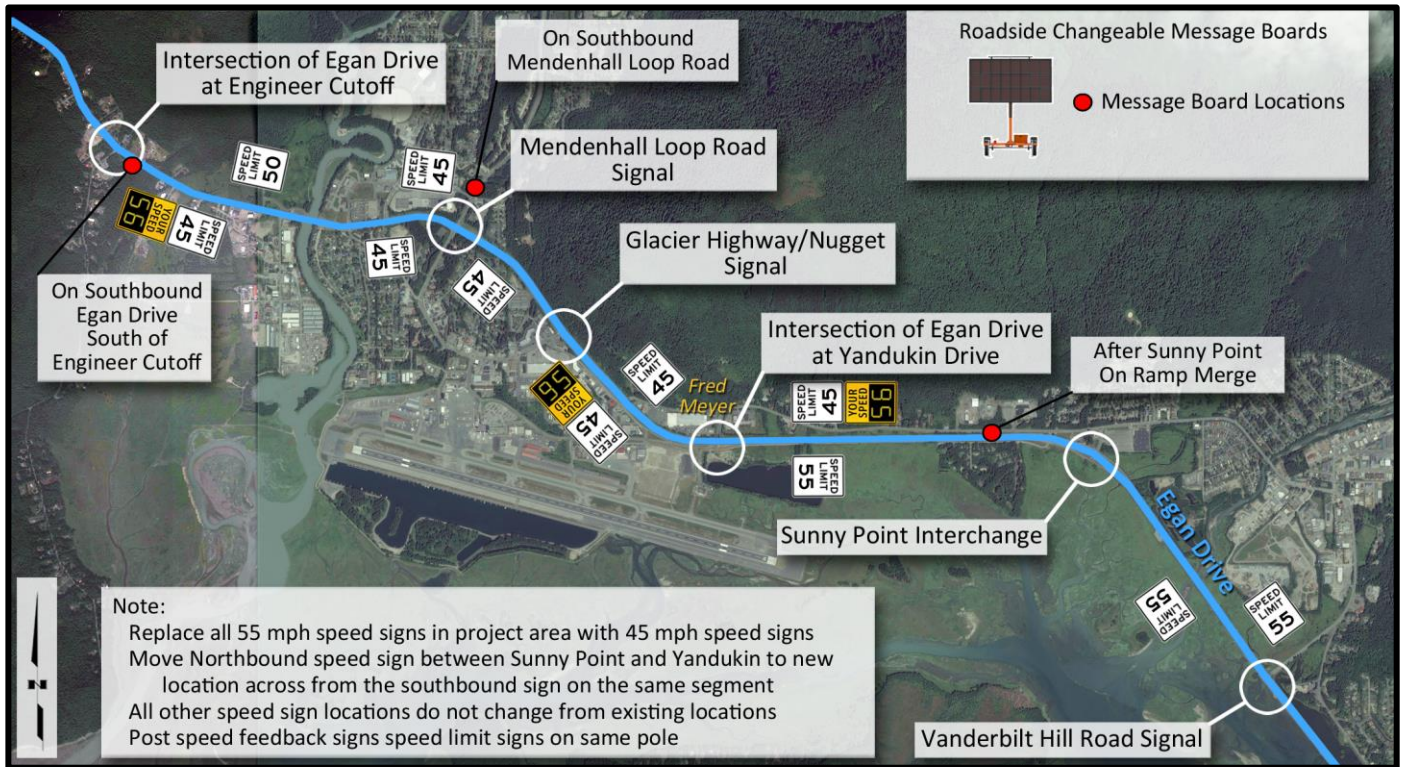


Figure 4. Concept IA A-1 Diagram

### Targeted Speed Reduction

It is recommended in this concept to reduce the posted speed limit in both the northbound and southbound directions from 55 mph to 45 mph.

The Crash Modifications Factors Clearinghouse includes studies that indicate a reduction of less than 10 mph would not have the desired effect of decreasing the crash rates in the study area. A reduction of 10 mph would have some possible effect if it is implemented along with information signs and enforcement, otherwise a reduction in speeds may have the negative effect of increasing the spread of vehicle speeds as some drivers comply with the new limits and other drivers remain at the higher speeds. This would further exacerbate the problem of left turn drivers being unable to safely anticipate the length of gaps and would increase the risk of high energy and high severity crashes.

The CMF Clearinghouse database shows that many studied locations where lower posted speed limits were used as a crash mitigation experienced no benefit or a net increase in crashes. It is recommended that enforcement and public notices be made to ensure that a true reduction in average travel speeds is achieved to avoid increasing the risk of crashes.

Severe crashes will likely be decreased in relation to the actual speed reduction that can be achieved through signage, driver education, and enforcement. The FHWA publication *Self-Enforcing Roadways: A Guidance Report*, 2018 indicates a direct correlation between vehicle speeds in a collision and the severity of the crash. Figure 5 on page 6 presents a table based on equations provided by the study. The results show that a 10 mph decrease in vehicle speeds would correlate to an approximate 50% decrease in major injury crashes and a 17% decrease in minor injury crashes.

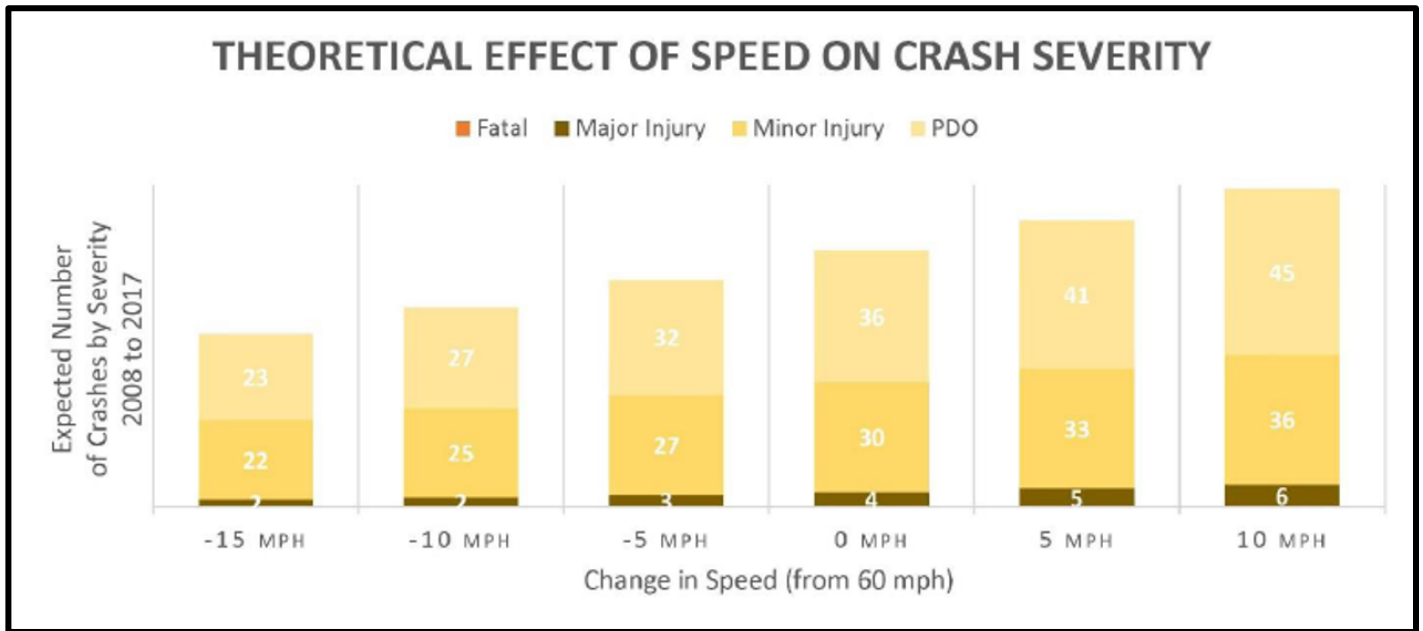


Figure 5. Theoretical Effect of Speed on Crash Severity

### Limits of Speed Zone

Given the recommended speed reduction to 45 mph, the speed zone would need to be extended through the Mendenhall Loop Road area, since posted speed limits in this area are already reduced to 50 mph, otherwise, drivers would be accelerating into this semi-urban area. Therefore, the southbound speed zone is recommended to begin at the posted speed limit sign near the bus stop south of Engineer Cutoff and then end at the speed limit sign between Yandukin and Sunny Point. The northbound speed zone is recommended to begin at the posted speed limit sign north of the Sunny Point Interchange and end at the speed limit sign north of the Mendenhall River bridge.

### Seasonal Limits

It is recommended that the reduced speed zones be active seasonally to target the crashes related to peak winter road conditions and maximize driver compliance with the reduced speed limits. Egan Drive is a high mobility corridor with a design that encourages drivers to travel at high speeds. Table 1 on page 3 showed the results of a speed study which confirmed that the 85<sup>th</sup> percentile speeds on the Egan Drive corridor are all higher than the posted speed limit of 55 mph and are, on average, greater than 60 mph. The Alaska State DOT Policy and Procedure Manual concerning establishing speed limits states that posted speed limits should be set at the nearest 5 mph interval to the 85<sup>th</sup> percentile speed. The manual states the following warning:

*“Speed limits set lower than the 85th percentile speed increase the likelihood for speed variance and hazardous conditions related to speed variation. They are generally viewed by motorists as unnecessary or objectionable, and leads to disregard and reduced effectiveness of other necessary and appropriate regulatory speed limit signs.”*

However, the policy does allow for speeds to be posted below the 85<sup>th</sup> percentile speed if there is a clear reason that can be conveyed to the public which can support compliance.

For this reason, it is recommended that the reduced speed zones be active seasonally and clearly be advertised with advance warning signs stating that the speeds are seasonal. It is likely that a year-round speed reduction would only have a temporary effect on the speeds since eventually driver behavior would rebound and the effect of the speed reduction would be lost. It would, therefore, be more effective if the speed reduction were put in place seasonally. Although severe and non-severe crashes occur year-round, a significant number of crashes are related to winter road conditions. It is recommended that this concept be implemented during the winter months (mid-October through mid-March) when conditions have been shown to be most hazardous (see Figure 3 on page 4).

This recommendation would satisfy the suggestions and requirements of the DOT Speed Zone Policy which state that speed zones should be put in place where they are most reasonable, where their need is most apparent to the public and during a time when the speed reduction has the greatest effect; however, it should be noted that the policy states that reduced speed zones should be avoided, in general.

### Information Signs

In accordance with the DOT Speed Zone Policy, it is recommended that a speed zone on Egan Drive should be supported by both Speed Feedback Signs at the entrances to the Speed Zone, and Changeable Message Signs in advance of the speed zone.

### Speed Feedback Signs

A Speed Feedback Sign is a sign that would be installed on the pole beneath the standard Speed Limit Sign. The feedback sign detects the speeds of oncoming vehicles and displays that speed in order to communicate to drivers when they are over the limit. The use of this device is allowed by the Alaska Traffic Manual and would be appropriate for use in this situation as the driver population is used to traveling at higher speeds and the posted speed would now be nearly 15 mph below the 85<sup>th</sup> percentile speed.

Speed Feedback Signs are recommended to be installed at the beginning of the speed zone in both the northbound and southbound directions as well as on the southbound approach toward the Yandukin intersection.

### Changeable Message Signs

Changeable Message Signs are typically trailer mounted boards which can be temporarily placed on the shoulder of the road to provide information to drivers. It is recommended that changeable message signs be deployed at the start of each seasonal speed zone window to inform drivers of the reasons for the speed reduction and warn them to be aware of the new limits.

One possible message to have displayed on the boards would be “REDUCE SPEEDS AHEAD – SEASONAL SPEED LIMITS – NOW IN EFFECT”. This message would inform drivers that they were approaching a temporary speed reduction zone.

It is recommended that the changeable message sign be active for the first week of the seasonal speed zone and then taken down, in accordance with DOT policy concerning message boards, since prolonged exposure has been shown to reduce compliance. The signs should be placed at least 200 feet prior to the entrance into the speed zone. Signs should be placed on Egan Drive southbound just south of Engineer Cutoff, Egan Drive northbound just north of the Sunny Point on-ramp merge, and on Mendenhall Valley southbound prior to the intersection with Egan Drive.

### Enforcement

The speed studies on Egan Drive showed that vehicles are driving well above the speed limit. Given the current disregard for the posted speed limits on Egan Drive, it is unlikely that speed zones and warning signs will have an effect without enforcement of the speed limits.

It is recommended that police enforcement of the posted speed limits be used in conjunction with the other suggestions in this concept. Enforcement is recommended to be intermittent throughout both the winter seasonal speed reduction and the summer months.

### Effect of Speeds on Gaps and Left Turn Delay

A microsimulation analysis was conducted of the corridor using VISSIM to evaluate the effect of the reduced speeds on the potential gaps in both the northbound and southbound traffic. An increase in the frequency of useable gaps would suggest that the delay for left turn movements would be reduced, which would, in turn, give greater weight to the theory that the number of crashes would be reduced as well. However, the results of the simulation indicated no difference in the frequency of gaps at the intersection of Egan Drive at Yandukin Drive in either the northbound or southbound direction. This conclusion is based on a simulation that applied a full 10 mph reduction in speeds from the speeds used in the existing conditions model. The model included the Egan Drive signalized intersections at both Nugget and Vanderbilt.

## Impacts of Concept IA A-1

### Safety improvement (Crash Frequency and Severity)

This concept would possibly result in a slight decrease in overall crash frequency as well as a possible decrease in the severity of crashes. However, reliable crash modification factors for this mitigation are not available, particularly on high-speed multilane highways.

Crash severity will likely decrease in direct relation to the actual reduction in travel speeds of vehicles involved in crashes. The relationship between speed and crash severity is shown in Attachment B – The Relationship Between Speed and Crash Severity on page 10.

### Stakeholder impacts

This concept has no stakeholder impacts.

### Transit Impacts

This concept would increase the delay for all transit operations passing through the Egan Drive corridor by increasing the time between stations by a maximum of 45 seconds. This concept does not change any transit routes.

### Safety impacts to other intersections

This concept would provide a possible safety benefit at the adjacent intersections within the speed zone, particularly in decreasing the severity of crashes.

### Operational Impacts to other intersections

Delay across the speed zone will be increased as the travel speeds are decreased. The operations of signals will not be affected.

### Environmental considerations

Environmental effects, benefits, and impacts for this concept are currently being evaluated.

### Ped/Bike access

This concept has no pedestrian or bicycle access effect, benefits, or impacts.

## Attachment A – Cost Estimate for Concept IA A-1: Reduce Speeds to Reduce Crash Severity

This cost assumes replacing the entire sign assemblies (panels, posts, and foundations); salvaging and delivering the existing signs to M&O; installing 3 radar speed feedback signs; purchasing 3 portable changeable message signs; and all mobilization, demobilization, construction surveying, traffic control during construction, and other contractor expenses. This estimate is for only a single season and does not include the cost of converting at the end of the season. Long terms costs could be reduced with changeable speed limit signs.

ENGINEER'S ESTIMATE				Juneau - Egan & Yandukin Inx. Imp. PEL Study		
State of Alaska Department of Transportation & Public Facilities				IA A-1 Seasonal Speed Limit Reduction		
				AKSAS No.: 10150992		
				Federal No.:		
				Version ID:		
Item Number	2017 SSHC ITEM NO.	Description	Unit	Quantity	Unit Price	Amount
		Standard Signs	SF	84	\$ 150.00	\$ 12,600.00
		Sign Salvage	EA	7	\$ 100.00	\$ 700.00
		Portable Changeable Message Boards	EA	3	\$ 21,600.00	\$ 64,800.00
		VMS-Radar Speed Sign	EA	3	\$ 20,000.00	\$ 60,000.00
Project Summary:					Subtotal	\$ 138,100.00
		Administration Items*		40%		\$ 55,240.00
					Exc Subtotal	\$ 193,340.00
		Construction Engineering		15%		\$ 29,001.00
					Subtotal	\$ 222,341.00
		Indirect Cost Allocation Plan (ICAP)		5.64%		\$ 12,540.03
					Concept Total	\$ 234,881.03

\* Summary of Admin Items:

Mob/Demob	10%	\$ 13,810.00
Construction Surveying	5%	\$ 6,905.00
ESCP	10%	\$ 13,810.00
Traffic Maintenance	15%	\$ 20,715.00
	40%	\$ 55,240.00

## Attachment B – The Relationship Between Speed and Crash Severity

### Speed and Crash Severity

SOURCE: *Self-Enforcing Roadways: A Guidance Report*, Publication No. FHWA-HRT-17-098, 2018.

Crashes at higher speeds (or at least, with greater changes in speeds) have higher energy, and therefore can be expected to result in higher crash severity. Researchers suggested the following equation to model how speed affects severity:

$$LO_2 = LO_1 \left( \frac{v_2}{v_1} \right)^n$$

Where:

$LO_2$  = number of crashes of a given crash severity after the speed change

$LO_1$  = initial number of crashes of a given crash severity (before the speed change)

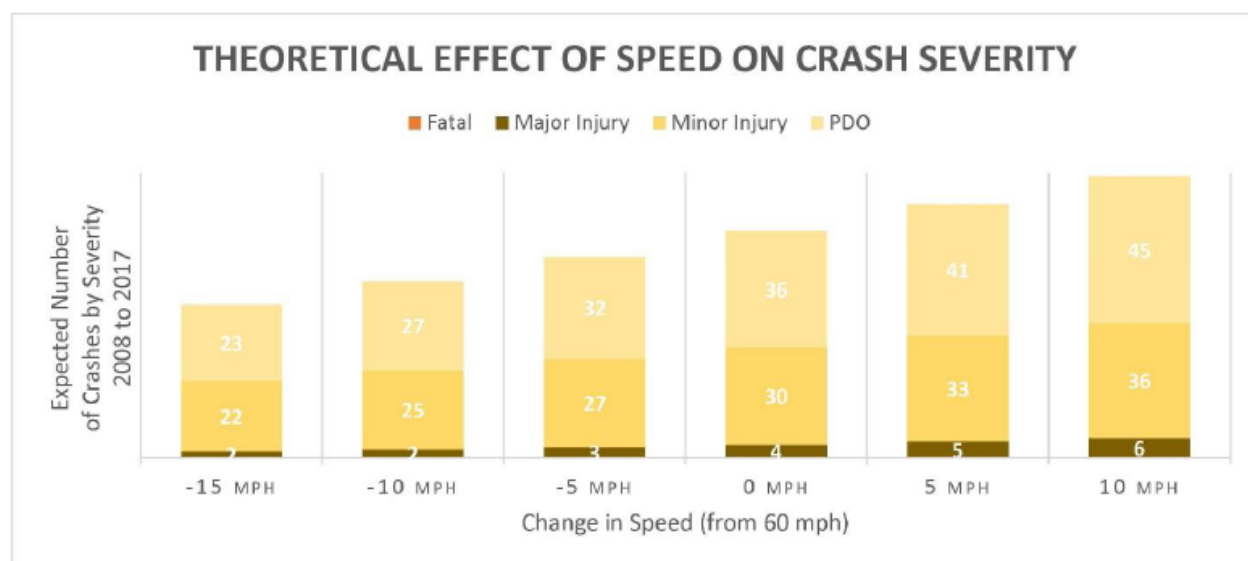
$v_2$  = average vehicle speed in after period (mph)

$v_1$  = initial average vehicle speed (mph)

$n$  = constant depending on crash severity

Researchers used historical crash data to developed values for the power function ( $n$ ) depending on the crash severity.

Crash Severity	Best Estimate Exponent	95% Confidence Interval
Fatal crashes	4.1	(2.9, 5.3)
Serious-injury crashes	2.6	(-2.7,7.9)
Slight-injury crashes	1.1	(0.0, 2.2)
Property damage only crashes	1.5	(0.1, 2.9)





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**FROM:** Jeanne Bowie, PE, PhD, PTOE; Randy Kinney, PE, PTOE; Aiza Miguel, PE

**DATE:** January 10, 2019

**SUBJECT:** SHFWY00079 – Strategy B: Provide More Frequent Gaps

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### Southbound Left Turn Delay

Data collected in October 2017 included several days of vehicle volume counts, providing information on both vehicle speeds and gap times between vehicle arrivals. A statistical analysis of this data was performed to develop an estimate of the existing delay to left turn vehicles turning at the Egan-Yandukin intersection based on the assumption of random arrivals of left turn vehicles and the observed distribution of gaps in the through vehicle traffic stream. According to the AASHTO Green Book (Table 9-16, 2018), a left turn passenger vehicle needs approximately 6.5 seconds to start moving and travel the distance to clear the median and the two oncoming through lanes. A second vehicle in the queue does not need a full 6.5 seconds to turn after the first vehicle. Based on guidance from the Highway Capacity Manual, this analysis assumed that a following vehicle could also turn if the gap is 2.2 seconds longer. (Two vehicles can turn in a 8.7 second gap.)

The southbound left turn delay is highly dependent on both the southbound left turn volume (which is around 200 to 250 vehicles per hour most of the day, but peaks to almost 400 vehicles per hour in the 5 PM hour) and the northbound through volume (which peaks in the evening, from 4 PM through 6 PM). Based on this analysis, there is minimal southbound left turn delay throughout most the day and 30 to 40 percent of southbound left turn drivers experience no delay (arrive during a gap in the northbound traffic that is long enough for the vehicle to turn immediately). However, in the evening (between 4 PM and 6 PM) the probability that a southbound left turn vehicle will experience 35 seconds or more of delay (LOS E or F) becomes significant, with about 15% of vehicles experiencing delay greater than 35 seconds between 4 and 5 PM and about 43% of vehicles experiencing greater than 35 seconds of delay between 5 and 6 PM. According to the Highway Capacity Manual, drivers experiencing LOS E or F are likely to become impatient and alter their behavior, such as turning in a gap that is too small (requiring oncoming traffic to brake) or deciding to take another route, such as leaving the turn lane and continuing south to take another route to their destination.

### Crash Experience by Time of Day

The crash experience also shows an increase in crashes during the PM peak period, as shown in Figure 1. The graph shows the number of crashes in the 13-year period from 2005 to 2017 for 3 months of the year (November through January: blue bars) compared to the other 9 months of the year (February through October) by time of day. The percentage of daily volume on Egan Drive by hour (orange line) is also shown, for comparison. As expected, crashes are more likely during higher volume periods of the day. This is especially true November through January; the Traffic Analysis Report (2019 update) showed that road conditions contribute to an increase in crashes in these three months of the year.

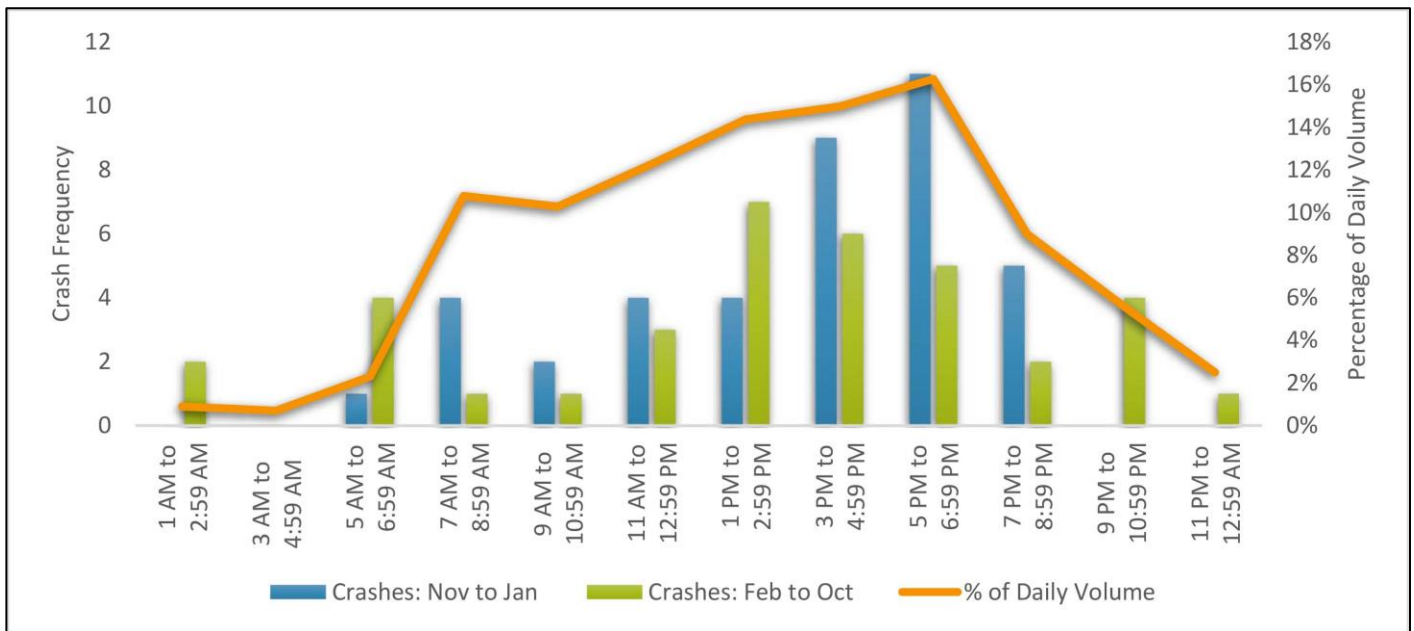


Figure 1: Crashes at Egan-Yandukin Intersection by Time of Day (2005 to 2017)

### Strategy B: Provide More Frequent Gaps

#### Concept IA B-1: Adjust Signal Timing at Vanderbilt Road Signal

One concept was reviewed to determine if changing the signal timing at the upstream intersection (Vanderbilt Hill Road) would provide acceptable gaps more frequently.

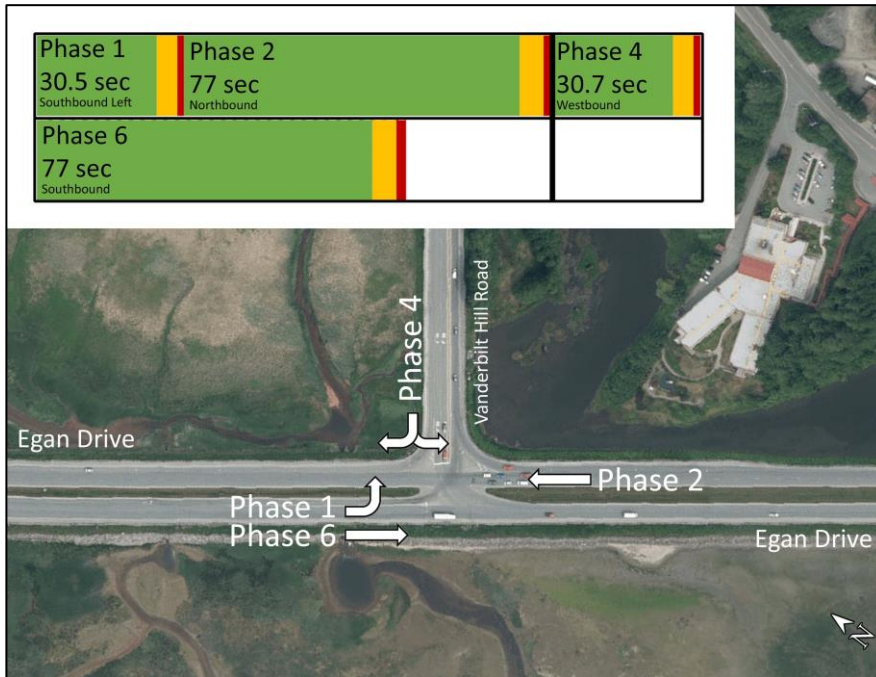
Figure 2 presents the Egan Drive corridor in the study area as a line drawing, showing the distances between intersections/interchanges and the type of signal control at each.



Figure 2: Egan Drive Approximate Spacing and Traffic Control of Access Points

Northbound traffic arriving at the Egan-Yandukin intersection either travel through the signalized intersection at Vanderbilt Hill Road or enter Egan Drive using the northbound on-ramp at the Sunny Point interchange. Traffic leaving the Vanderbilt Hill Road signal travel approximately 2.5 miles to the Yandukin intersection, starts as a denser platoon formed with the discharge of the signal queues held on red, with additional vehicles arriving on the green that may catch up to the platoon. Figure 3 presents the signal timing at Vanderbilt Hill Road during the PM peak period when northbound traffic is the heaviest. Because this signal operates actuated-uncoordinated (ending the green for each movement either when the maximum green time is met or when no more vehicles are present),

the cycle length varies each cycle. On average, the platoon from Vanderbilt Hill Road arrives at the Yandukin intersection about every 100 seconds. Once the platoon arrives, there is approximately 42 seconds during which there are few gaps of sufficient length for a southbound left turn vehicle to make a left turn.



SOURCE (Aerial): Google Earth

Figure 3: Signal Timing at Intersection of Egan Drive and Vanderbilt Hill Road

Shortening the signal cycle length at Vanderbilt Hill Road may further concentrate vehicle platoons leaving the signal, resulting in more vehicles collecting in the platoon with shorter headways, followed by more frequent periods of larger gaps, resulting in reducing the delay of southbound left-turns.

A microsimulation model was developed, calibrated, and validated to look at the effect of changing the signal timing at the Vanderbilt Hill Road signal on the gap distribution at Yandukin Drive. Volume, speed, and traffic control elements in the microsimulation were adjusted to match the observed southbound left turn delay characteristics as much as possible. Table 1 shows the values from the microsimulation.

Table 1: Microsimulation Southbound Left Turn Delay Characteristics of Egan Drive in the PM Peak

Percentage of southbound left turns with 0 delay (gap of sufficient size upon arrival)	16%
Percentage of southbound left turns with delay > 35 seconds (LOS E)	44%
Average southbound left turn delay (seconds per vehicle)	48 (LOS E)

The signal timing was then changed in the microsimulation model to reduce the cycle length at Vanderbilt Hill Road and the model was run to see if the new signal timing changed the gap distribution and left turn delay at Yandukin Drive. Figure 4 shows the new signal timing. Under this timing, the platoon from Vanderbilt Hill Road arrives at the Egan-Yandukin intersection about every 68 seconds, and there is approximately 29 seconds with few gaps of sufficient length for a left turn vehicle.

Table 2 shows the microsimulation values after the signal timing change at Vanderbilt Hill Road.

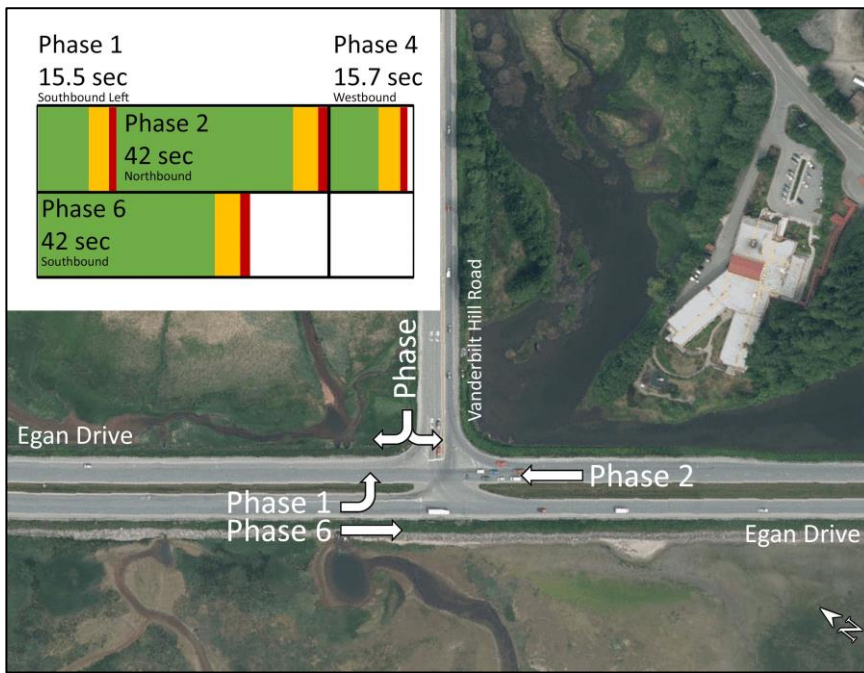


Figure 4: Altered Signal Timing at Intersection of Egan Drive and Vanderbilt Hill Road (shorter cycle length)

Table 2: Microsimulation Southbound Left Turn Delay Characteristics of Egan Drive in the PM Peak with Shorter Cycle Length at Vanderbilt Hill Road

Percentage of southbound left turns with 0 delay (gap of sufficient size upon arrival)	15%
Percentage of southbound left turns with delay > 35 seconds (LOS E)	46%
Average southbound left turn delay (seconds per vehicle)	52 (LOS F)

Thus, changing the signal timing did not provide more frequent gaps sufficient for southbound left turn vehicles to complete the left turn maneuver. This may be because of the vehicles entering Egan Drive from the Sunny Point interchange. These vehicles arrive randomly, and therefore fill in the large gaps that are created by the Vanderbilt Hill Road signal.

Concept IA B-1 Performance Measures with respect to Evaluation Criteria

*Safety improvement (reduction in crash frequency)*

Because the proposed change in signal timing did not provide more frequent gaps or reduce the delay for southbound left turn vehicles, no change in crash frequency is expected.

*Safety improvement (reduction in crash severity)*

Because the proposed change in signal timing did not provide more frequent gaps or reduce the delay for southbound left turn vehicles, no change in crash severity is expected.

*Stakeholder impacts*

There was essentially no change in vehicle delay at the Egan-Yandukin intersection; similarly, vehicle delay would remain nearly the same at the Vanderbilt Hill Road signal under a shorter cycle length. See *Operational Impacts to other intersections* below.

*Transit Impacts*

This concept would not impact transit routes or travel times.

*Safety Impacts to other intersections*

This concept has no safety effect, benefits, or impacts on other intersections.

*Operational Impacts to other intersections*

This concept would reduce the cycle length at the Vanderbilt Hill Road signal. The analysis shows a very slight decrease in overall vehicle delay with the cycle length reduction, as shown in Table 3.

*Table 3: Comparison of Cycle Length and Delay for Vanderbilt Hill Road Signal in PM Peak*

	Actuated Cycle Length (seconds)	Average Vehicle Delay (seconds)	Level of Service
Existing Cycle Length	100	20.1	C
Shorter Cycle Length	67.7	18.2	B

*Environmental considerations*

This concept has no increased or decreased environmental effects, benefits, or impacts.

*Ped/Bike access*

This concept has no pedestrian or bicycle access effect, benefits, or impacts.

**Cost Estimate for Concept IA B-1: Adjust Signal Timing at Vanderbilt Signal**

There are no construction costs associated with this concept. Costs to implement this concept include only costs for personnel to change the signal timing and verify that it is working. For the Vanderbilt signal, the needed time is approximately 0.5 person-days.

**FROM:** Jeanne Bowie, PE, PhD, PTOE; Randy Kinney, PE, PTOE; Jessi Miranda, PE

**DATE:** January 10, 2019

**SUBJECT:** SHFWY00079 – Strategy C: Reduce Conflicts and Improve Lane Alignment between Northbound Right Turn (NBRT) and Southbound Left Turn (SBLT) Vehicles

**Background**

Figure 1, below, presents the current configuration for the intersection of Egan Drive and Yandukin Drive in Juneau, Alaska. A yield sign (R1-2) for the NBRT is mounted on the highway illumination electrolier located at approximately the middle of the corner radius and turning lane. An advanced yield ahead warning sign and plaque (W3-2 and W3-2P) are mounted on a highway illumination electrolier located about 270 feet upstream of the yield sign. Figure 2 presents the approach view and shows sign locations from the driver’s perspective.



Figure 1- Existing Geometric Conditions

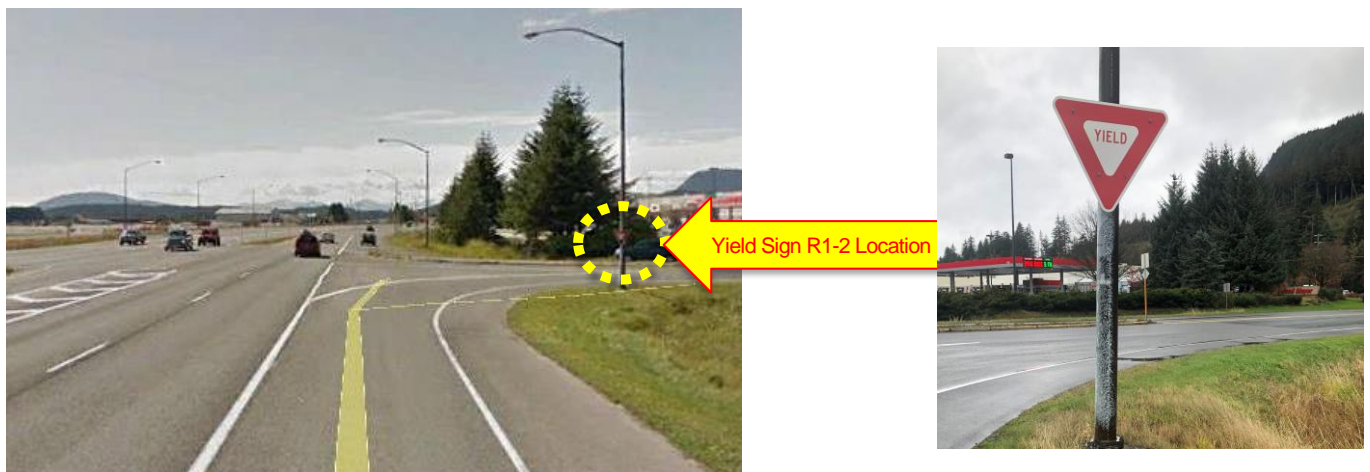


Figure 2- Approach View for NBRT Lane (source: Google Earth Street View)

## Issues

The conflict area for SBLT and NBRT is the convergence of the two traffic streams as depicted in Figure 1. These are the only two movements that enter Glacier Highway/Lemon Road in the eastbound direction. As the NBRT turns and enters Glacier Highway/Lemon Road, the trajectory angle between NBRT and SBLT flattens to produce a merging condition; however, the additional lane length required for merging maneuvers is nonexistent. As such, if one of these traffic streams do not yield, then a conflict occurs which then could result in a collision. A conflict occurs if the SBLT vehicle brakes to avoid collisions with the NBRT vehicle, or either vehicle maneuvers to evade the other.

The public has shared their concerns about the SBLT-NBRT conflicts, near misses and collision potential. The primary concern noted by the public was that southbound left turn drivers weren't sure who would yield once they made the turn. This uncertainty would cause left turn drivers to hesitate during their turning movement and potentially be at risk for getting sideswiped by oncoming traffic. They suggested having a clearer path for both the left and right turn traffic would improve the situation. As such, C strategies are primarily focused on reducing crashes between southbound left-turn crashes and northbound through vehicles that may be caused by the hesitancy in completing the turn.

The secondary crash pattern that would be reduced are the collisions between NBRT and SBLT movements at the point of conflict where the northbound turning lane intersects the eastbound lane. A review of intersection crash data between 2005 and 2017 (86 crashes in total) did not explicitly identify collisions between SBLT-NBRT vehicles, although two crashes had location coordinates within the conflict area of the northbound turning lane and eastbound lane.

## Strategy C Concepts

Strategy C Concepts were formed at the September 10, 2019 charrette. These include:

- Concept IA C-1: Improve Northbound Right Turn Yield Signs
- Concept IA C-2: Emphasize Northbound Right Turn Yielding Through Design
- Concept IA C-3: Construct Northbound Right Turn Receiving Lane (Free Movement)
- Concept IA C-4: Construct Northbound Right Turn Receiving Lane (Free Movement) and Extend Weaving Area

### Concept IA C-1: Improve Northbound Right Turn Yield Signs

Concept IA C-1 is presented in Figure 3 below. The concept has an estimated cost of \$21,000 at the conceptual design level (see Attachment C for details).

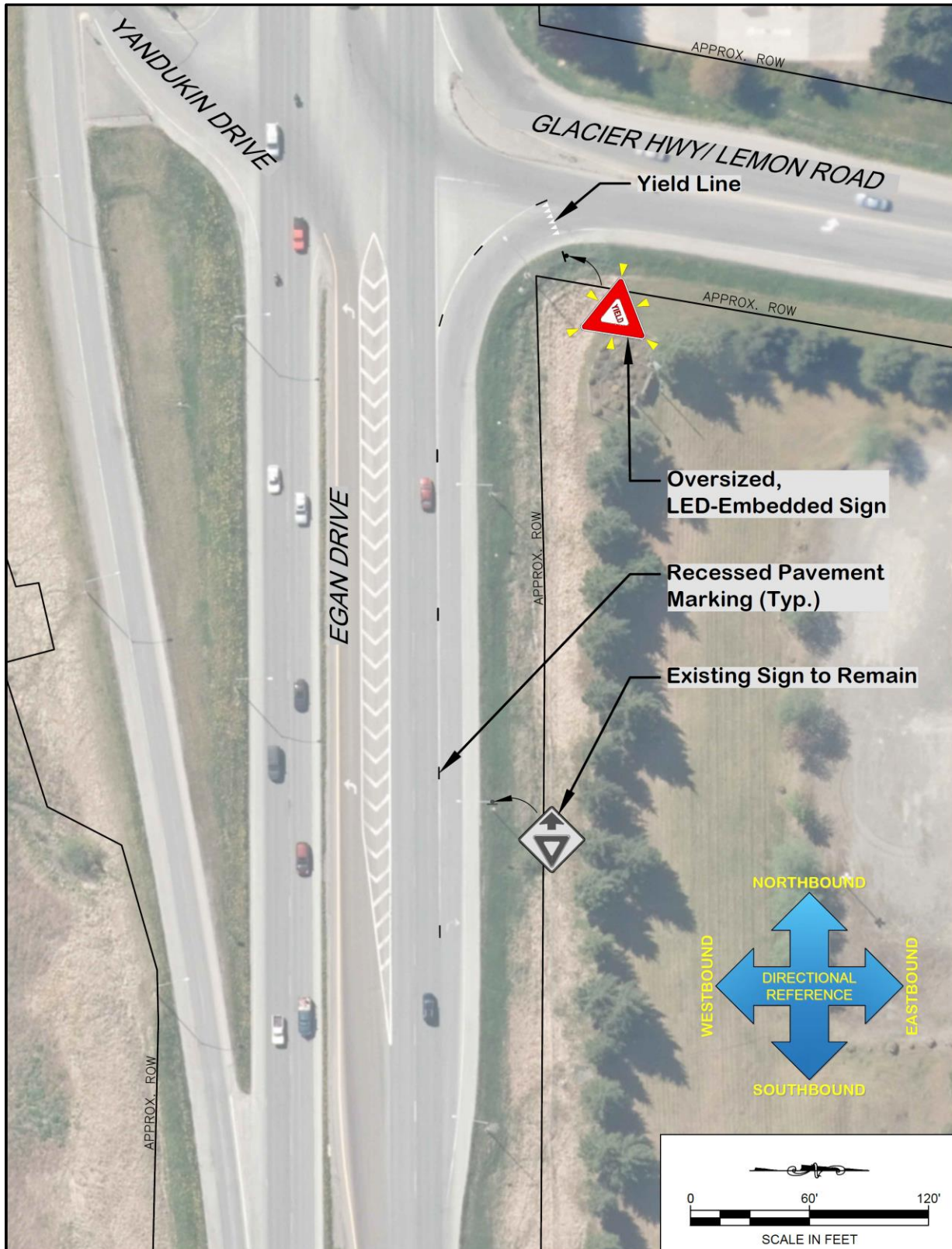


Figure 3- Concept IA C-1: Improve Northbound Right Turn Yield Signs

This concept improves the visibility of signing for the NBRT vehicles, emphasizing yielding to the SBLT entering Glacier Highway/Lemon Road. It improves awareness for NBRT vehicles on the requirement to yield to SBLT,



and provide conflict separation with improved control. This concept would retain the existing Yield Ahead sign assembly 270 feet in advance of the intersection. The yield location would be moved closer to the Glacier Highway/Lemon Road travel way. A new oversized yield sign, augmented with LED flashing lights around the sign border, would be installed along with yield pavement markings.

### Concept IA C-1 Performance Measures with respect to Evaluation Criteria

#### *Safety improvement (reduction in crash frequency)*

A survey of the Crash Modification Clearinghouse ([www.cmfclearinghouse.org](http://www.cmfclearinghouse.org)) reveals that the Concept IA C-1 or its sub-elements have no crash modification factors (CMF) in the database. However, CMF ID 4074- Replace standard stop sign with flashing LED stop sign has a CMF of 0.59, with a standard error of 0.25. This corresponds to a crash reduction factor (CRF) of 41%, and standard error of 25%. As shown in Figure 1 and Figure 2, and discussed within the Issues section, the position of the existing yield signs may contribute to driver's unawareness of the yield control. Concept IA C-1 may be considered similar to CMF ID 4074- replace standard stop sign with flashing LED stop sign because it will increase the awareness of the intersection control and right-of-way assignments. However, the high standard error also indicates that this treatment may not be effective in reducing crashes.

Moreover, the crash patterns that are treated by CMF ID 4074 would appear to be applied only to the actual collisions between NBRT-SBLT vehicles, and not to the SBLT-NBT pattern of primary concern. As such, there is no evidence that this treatment would be effective in improving the SBLT hesitancy to complete the turn because they are unsure that NBRT will yield.

#### *Safety improvement (reduction in crash severity)*

This does not reduce severity between the SBLT-NBT crashes. The SBLT-NBRT suspected crashes were property damage only, with no reported injuries. This is consistent with expectations of lower speeds of involved vehicles within the conflict area, as well as the flatten collision angle, which further reduces energy of the impact.

#### *Stakeholder impacts*

This concept has no quantifiable impacts to stakeholders, except that there may be an increased burden and responsibility added to DOTPF's M&O section to maintain the sign's LED displays.

#### *Transit Impacts*

There are six transit routes that perform the SBLT movement. Buses on these routes board and alight passengers at bus stop 479, just to the north of the Fred Meyer driveway. This alternative would have little impact to transit operations.

#### *Safety Impacts to other intersections*

This concept has no safety effect, benefits, or impacts on other intersections.

#### *Operational Impacts to other intersections*

This concept has no operational impacts on other intersections.

#### *Environmental considerations*

This concept has no increased or decreased environmental effects, benefits, or impacts.

#### *Ped/Bike access*

This concept has no pedestrian or bicycle access effect, benefits, or impacts.

### Concept IA C-2: Emphasize Northbound Right Turn Yielding Through Design

Concept IA C-2 is depicted in Figure 4 below. The concept has an estimated conceptual-level cost of \$1.1 million. (See Attachment D for details).

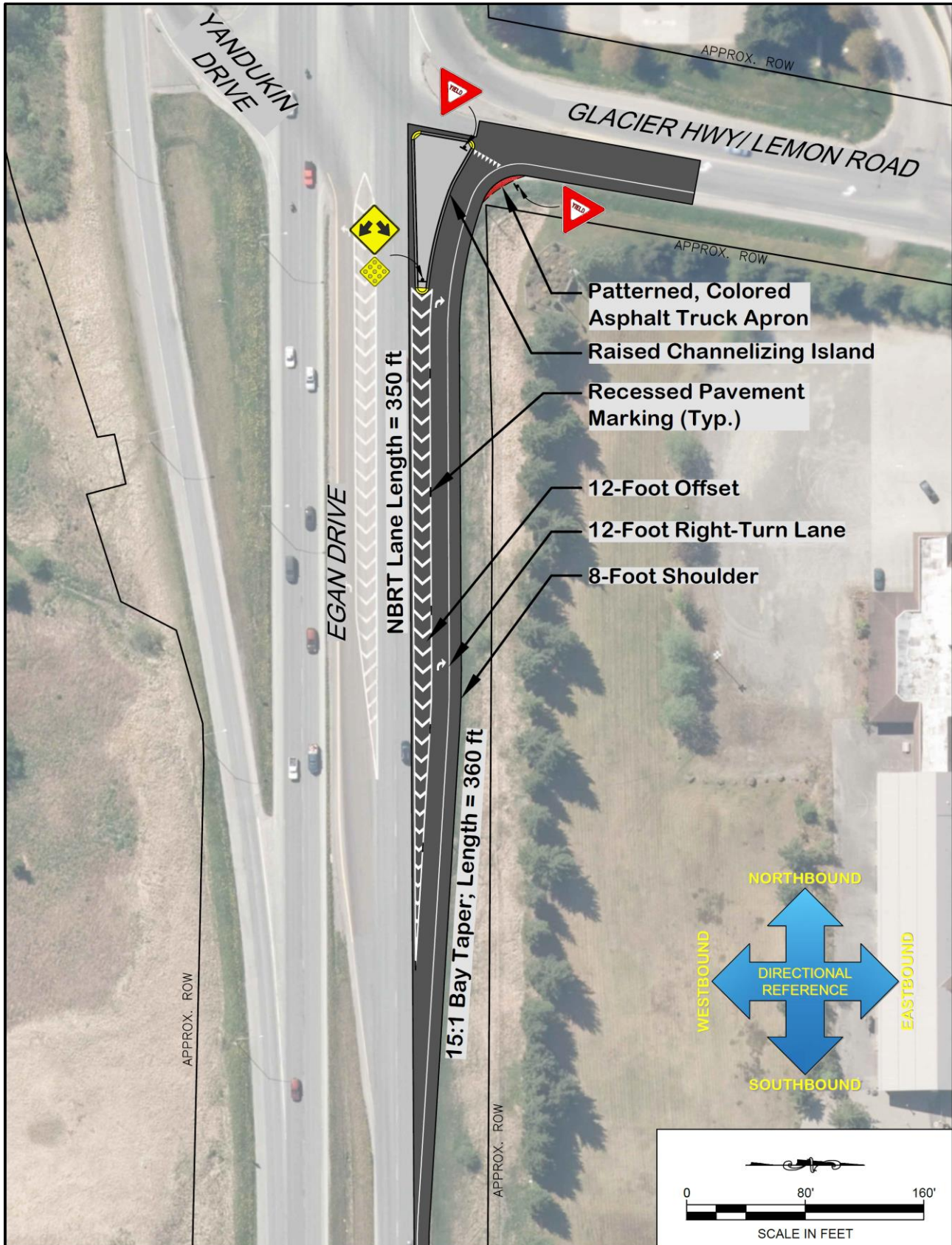


Figure 4- Concept IA C-2: Emphasize Northbound Right Turn Yielding Through Design

The concept includes a right-turn slip lane design and a separation of the right-turn lane and the adjoining through lane. This strategy improves awareness of the NBRT driver's requirement to yield to SBLT that travel eastbound after the turn, and provides conflict separation through improved control and geometrics.

The desired geometric elements of a right-turn slip lane are presented in Figure 5 below. The entry angle, between 55 degrees and 70 degrees, eliminates the flat merge with eastbound traffic and improves the NBRT driver's sight distance to the west, including an approaching SBLT vehicle. Moreover, the raised triangular median island configuration, the compound approach radii, and the slip lane angle with the cross-street reinforces yield signage on the island and shoulder to emphasize that NBRT vehicles must yield to SBLT traffic. Note that this figure contains pedestrian and bicycle elements that are not anticipated to be built with this alternative, such as cut through median and islands, a crosswalk, and a bike lane.

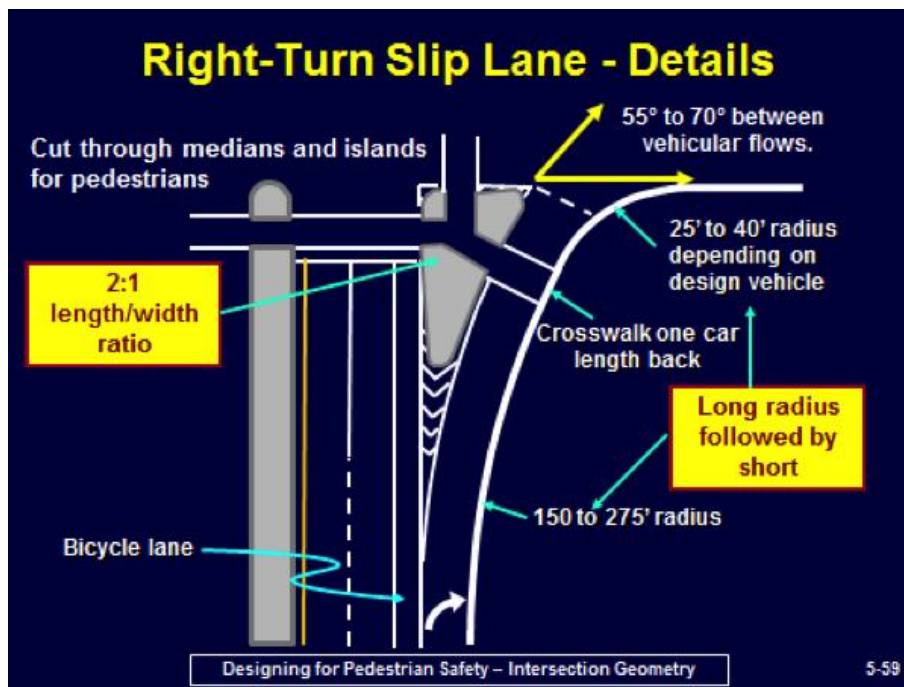


Figure 5- Right-Turn Slip Lane Geometric Elements (source:

[http://pedbikesafe.org/PEDSAFE/cm\\_images/ImpRig11.jpg](http://pedbikesafe.org/PEDSAFE/cm_images/ImpRig11.jpg)) **Note that pedestrian/bike elements are not anticipated for this alternative**

Under this concept, the right-turn lane is offset from the adjoining northbound through lane by 6 to 12 feet. The separation would be a flush painted median, that leads to the triangular raised median island. The required NBRT lane length depends on the highway speeds and queue length at the yield point. Although posted 55 mph, 2017 speed studies indicate that the 85<sup>th</sup> percentile speed is about 60 mph, which we choose as the design speed for the auxiliary lane length. Yield line queues are assumed to be 100 feet, suitable for two tractor-trailer rigs or four passenger cars.

AASHTO's 2011 A Policy on the Geometric Design of Highway and Streets *Table 9-22 Desirable Full Deceleration Lengths* provides guidance to determine lane lengths. Given the 60-mph design speed, 100-foot queues, and the bay taper rate of 15:1 (AASHTO), the length of the deceleration/storage lane should be about 350 feet, and the bay taper would be 360 feet for the separation median width of 12 feet and the auxiliary lane width of 12 feet. Attachment B- NBRT Lane Length Computations on page 14 provides computations for this lane length.

In addition to creating and emphasizing the yielding requirement for the NBRT traffic, the concept provides separation between right-turning traffic and the outside northbound through traffic lane. One of the contributing factors for crash patterns between the SBLT vehicles and the northbound through vehicles may be the added complexity in trying to judge and select adequate gaps within three oncoming lanes of 60-mph traffic. Separating the right turn lane further from the adjoining through lanes will probably reduce the complexity in gap judgement and assist the SBLT driver's discernment of through and right-turning traffic streams.

## Concept IA C-2 Performance Measures with respect to Evaluation Criteria

### *Safety improvement (reduction in crash frequency)*

Concept IA C-2 is well-represented in the Crash Modification Clearinghouse with CMF ID 8430- Improve angle of channelized right turn lane. The CMF applies to the safety effectiveness of “sharpening the approach angle typical in traditional designs, reducing the radius, adjusting the stop bar position, and modifying the corner island to increase the line of sight of approaching through traffic”. CMF ID 8430 has crash reduction factor (CRF) of 59%, and standard error of 6%, thus indicating good evidence of meaningful crash reduction for target right angle collision.

The primary benefit of Concept IA C-2 in reducing SBLT-NBT collisions is the separation of the NBRT lane from the adjoining through lane by the 12-foot median. In doing so, this might decrease the complexity for the SBLT driver in selection of adequate turning gaps. There is a crash modification factor for right-turn offsets in the CMF clearinghouse, but it is of marginal quality and is focused on sight distance for vehicles controlled by stop signs on the minor street approach. As such, we believe that there is a SBLT crash reduction benefit by separation of the NBRT lane, but it cannot be quantified.

As previously discussed, the crash history of the study conflict area indicates that there may be SBLT-NBRT crashes. If so, these crashes would be reduced by this improvement by a least 50%.

### *Safety improvement (reduction in crash severity)*

In reducing SBLT-NBT crashes, severities will be reduced as well. The SBLT-NBRT suspected crashes were property damage only, with no reported injuries. This is consistent with expectations of lower speeds of involved vehicles within the conflict area, as well as the flattened collision angle, further reducing energy of the impact. However, this concept has the highest likelihood of the NBRT vehicle stopping when a SBLT vehicle is present, thus reducing the severities.

### *Stakeholder impacts*

This concept has no quantifiable impacts to stakeholders. The NBRT enters the eastbound, single lane and from there may choose to maneuver to the lanes necessary to turn into Fred Meyer or continue eastward.

### *Transit impacts*

There are six transit routes that perform the SBLT movement. Buses on route board and alight passengers at the bus stop 479 just to the north of the Fred Meyer driveway. To access the stop, buses laterally shift through the conflict area to the through lane. The increased yielding of NBRT traffic provided by this concept increases transit safety.

### *Safety Impacts to other intersections*

This concept has no safety effect, benefits, or impacts on other intersections.

### *Operational Impacts to other intersections*

This concept has no operational effect, benefits, or impacts on other intersections.

### *Environmental considerations*

This concept has no increased or decreased environmental effect, benefits, or impacts.

### *Ped/Bike access*

This concept has no pedestrian or bicycle access effects, benefits, or impacts.

**Concept IA C-3: Construct Northbound Right Turn Receiving Lane (Free Movement)**

Concept IA C-3 is depicted in Figure 6 below. The concept has an estimated conceptual-level cost of \$110,000 (See Attachment E for details).



Figure 6- Concept IA C-3: Construct Northbound Right Turn Receiving Lane (Free Movement)

This concept would extend the NBRT lane with a turning lane into an added receiving eastbound lane on Glacier Highway/Lemon Road through pavement markings and an new raised channelization island. This treatment physically separates SBLT-NBRT conflicts by assigning them their own lane. Glacier Highway/Lemon Road will not require widening as there is sufficient width to accommodate the proposed lanes.

The turning lane is formed by a triangular raised median, and the turning lane radius is 70 to 80 feet, which accommodates turning speeds of 15 to 20 mph..

### Concept IA C-3 Performance Measures with respect to Evaluation Criteria

#### *Safety improvement (reduction in crash frequency)*

There are no published CRFs for this treatment in the CMF clearinghouse. However, the SBLT-NBRT conflict is theoretically removed if all vehicles were to maintain lane discipline through the conflict area. Knowing this, the SBLT are less likely to hesitate in their turns and thus may decrease SBLT-NBT crashes.

#### *Safety improvement (reduction in crash severity)*

With a reduction in the SBLT-NBT crashes, severities will be reduced.

#### *Stakeholder impacts*

Other than safety improvements noted above and the intersection impacts discussed below, this concept has no quantifiable impacts to stakeholders.

#### *Transit impacts*

There are six transit routes that perform the SBLT movement. With this concept, buses on these routes are required to weave from the inside lane to outside lane to access bus stop 479 just to the north of the Fred Meyer driveway. A right-side lane change for buses is more difficult because of required use of the sideview mirror and consequent right-side blind spots. The NBRT is no longer required to yield and a conflict or sideswipe collision may result if the bus operator merges into outside lane unaware of a NBRT vehicle.

#### *Safety Impacts to other intersections*

This concept requires NBRT vehicles bound for the Glacier Highway/Lemon Road Fred Meyer driveway to merge into the inside auxiliary left-turn lane within a short distance following the right turn. Similarly, the inside receiving lane for SBLT vehicles drops at the Fred Meyer driveway left-turn lane. Those SBLT vehicles that wish to travel beyond the driveway must merge to outside lane. As a result, there are merges and weaves within an approximate 150-foot segment, which might contribute to conflicts and collisions between the SBLT and NBRT vehicles downstream of the current conflict area.

#### *Operational Impacts to other intersections*

The merging and weaving maneuvers on the eastbound approach to the Fred Meyer driveway intersection may cause operational issues as well as the nominal safety issues described above.

#### *Environmental considerations*

This concept has no increased or decreased environmental effect, benefits, or impacts.

#### *Ped/Bike access*

This concept has no additional pedestrian and bicycle access benefits or impacts over what is currently in place..

### Concept IA C-4: Construct Northbound Right Turn Receiving Lane (Free Movement) and Extend Weaving Area

Concept IA C-4 is depicted in Figure 7 below. The concept has an estimated conceptual-level cost of \$150,000 (see Attachment F for details).

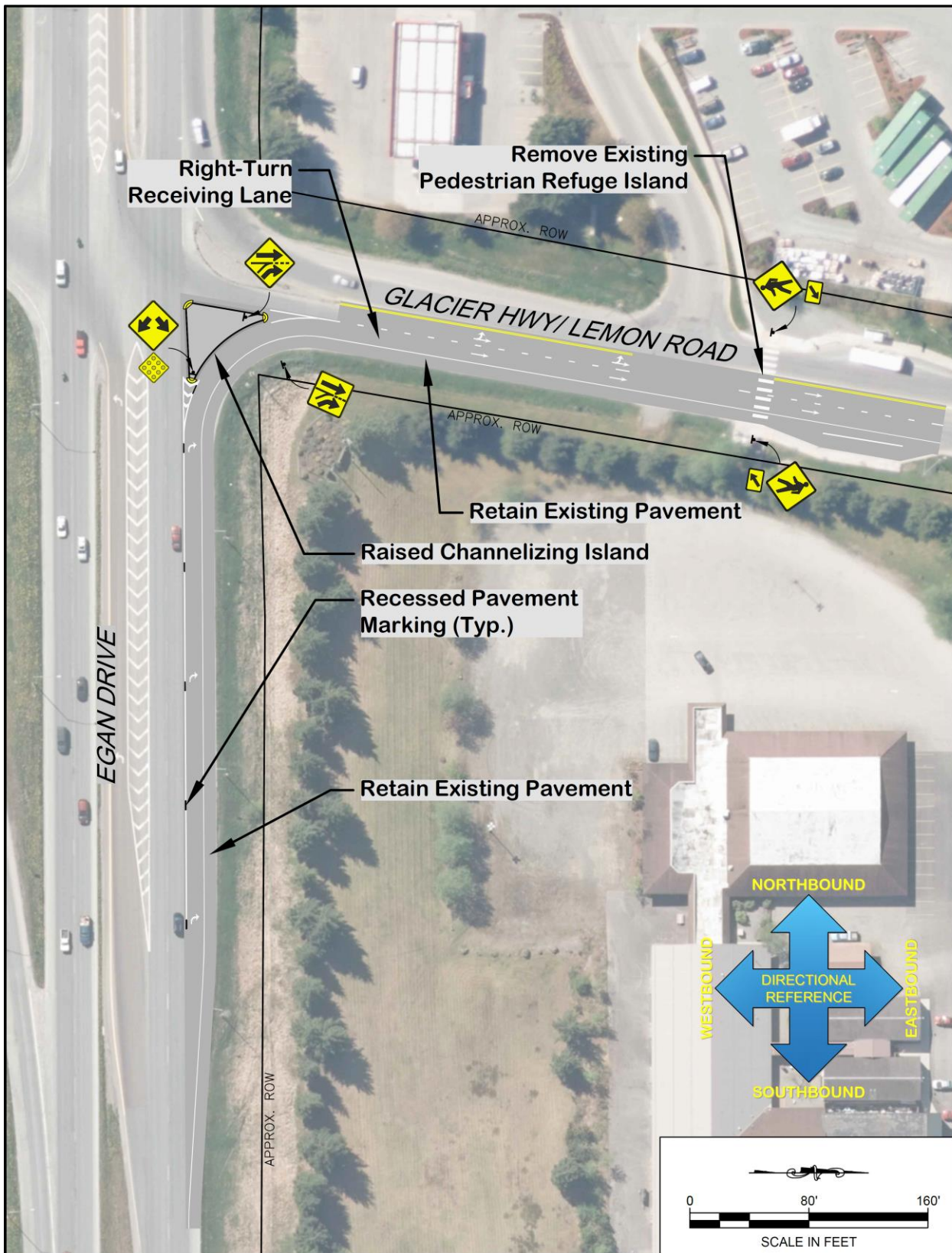


Figure 7- Concept IA C-4: Construct Northbound Right Turn Receiving Lane (Free Movement) and Extend Weaving Area

This concept would extend the NBRT lane with a turning lane into an added receiving eastbound lane on Glacier Highway/Lemon Road. This treatment physically separates SBLT-NBRT conflicts by assigning them their own lane. The two lanes extend through the Fred Meyer driveway intersection, eliminating the existing auxiliary left-lane. Left-turns into Fred Meyer will be made from the inside shared left-turn-and-through lane. It is expected that Glacier Highway/Lemon Road will not require widening as there is sufficient width to accommodate the proposed lanes.

The turning lane is formed by a triangular raised median, and the turning lane radius is 70 to 80 feet, which accommodates turning speeds of 15 to 20 mph..

This concept modifies the existing pedestrian crossing. The existing raised refuge would be removed, which increases the crossing distance from two traffic lanes to three. A new pedestrian crossing with a new marked crosswalk and warning signs are proposed on the north side of the driveway to facilitate transit patrons using Capitol Transit bus stops 427 and 429 and walking to/from Fred Meyer and other generators. Since the crossing will change under this concept, conformance with Alaska Traffic Manual, given the new conditions, was reviewed.

Crosswalks should comply with the guidelines of the Alaska Traffic Manual *Table 3B-10. Recommended Practice for Crosswalk Marking on Uncontrolled Approaches or at Midblock Locations*, which are predicated on hourly peak hour pedestrian crossing volumes (20 or more pedestrians, or 15 elderly or children), AADT ranges, roadway lanes, and speed limits. The current pedestrian crossing volume is not known, but six transit routes use these stops, and it is likely that there is a crossing demand of 20 pedestrians or more during a peak hour, now or in the future. The AADT for this segment is currently 9,300 and is forecasted to be 9,600 in 2040. There is no posted speed limit on this segment of Glacier Highway/Lemon Road, but the segment that parallels Egan Drive is posted for 45 mph. If this speed limit of 45 mph is applied to the segment fronting Fred Meyer, the guidance provided in Alaska Traffic Manual indicates no crosswalks should be installed. However, given the short acceleration distance on this segment, an assumption of a reduced speed limit of 40 mph or lower on this segment is likely. Given the reduced speed limit, the 9,600 AADT, 3-lane section, and given that the pedestrian threshold is satisfied, the Alaska Traffic Manual guidance indicates the proposed marked crosswalk is acceptable. However, as discussed below, removal of the refuge will create long crossing delays and may result in risk-taking behavior by frustrated pedestrians.

## Concept IA C-4 Performance Measures with respect to Evaluation Criteria

### *Safety improvement (reduction in crash frequency)*

There are no published CRFs for this treatment in the CMF clearinghouse. However, the SBLT-NBRT conflict is theoretically removed if all vehicles were to maintain lane discipline through the conflict area. Knowing this, the SBLT may be less likely to hesitate in their turns and thus may decrease SBLT-NBT crashes.

### *Safety improvement (reduction in crash severity)*

With a reduction in the SBLT-NBT crashes, severities will be reduced.

### *Stakeholder impacts*

Other than safety improvements noted above and the intersection impacts discussed below, this concept has no quantifiable impacts to stakeholders.

### *Transit impacts*

There are six transit routes that perform the SBLT movement. With this concept, buses on these routes are required to weave from the inside lane to outside lane to access bus stop 479 just to the north of the Fred Meyer driveway. A right-side lane change for buses is more difficult because of required use of the sideview mirror and consequent right-side blind spots. The NBRT is no longer required to yield and a conflict or sideswipe collision may result if the bus operator is unaware of a NBRT in adjacent, outside lane.

Also, see the narrative below on pedestrian impacts of the proposed crossing reconfiguration. Since transit patrons comprise a large proportion of the crossing users, the reconfiguration also affects transit viability.



### *Safety Impacts to other intersections*

This concept requires NBRT vehicles bound for the Glacier Highway/Lemon Road Fred Meyer driveway to merge into the inside auxiliary left-turn lane within a short distance following the right turn. As a result, there are merges and weaves within an approximate 150-foot segment, which might contribute to conflicts and collisions between the SBLT and NBRT vehicles downstream of the current conflict area.

This concept would remove the left-turn lane into the Fred Meyer access driveway. Left-turns would occupy the inside lane shared with eastbound through vehicles while awaiting adequate turning gaps in the oncoming traffic; or would choose to continue through the driveway intersection and turn into the access on the north side of the facility off of Glacier Highway/Lemon Road/Lemon Spur Road. The 2017 Traffic Analysis Report turning movement counts at the Glacier Highway/Lemon Road- Egan Drive and Glacier Highway/Lemon Road-Glacier Highway/Lemon Road/Lemon Spur Road intersections indicate that there are at least 60 and 215 left-turning vehicles in the morning and noon peak hours at the driveway, respectively. Moreover, the PM peak hour 375 vehicles turn left in the evening peak hour.

Note that exclusive left turn lanes are installed for a variety of reasons, including:

- To remove conflicts between left turning vehicles and through vehicles traveling in the same lane
- To reduce delay to through vehicles due to turning traffic slowing or stopping in the same lane

Prior to removing the exclusive left turn lane at this location, a search of relevant documentation (such as driveway permits) should be performed to determine what factors led to the installation of the exclusive left turn lane.

### *Operational Impacts to other intersections*

A Highway Capacity Manual 7 (HCM) analysis of the Fred Meyer driveway indicates that the drivers turning left into the Fred Meyer experience 7.4 seconds of average approach delay, for an approach level of service A. This is similar to the delay and level of service that occurs with the exclusive left-turn lane and exclusive through lane, 7.3 seconds of average delay and level of service A. As such, there are no quantifiable operational impacts with this concept.

### *Environmental considerations*

This concept has no environmental impacts.

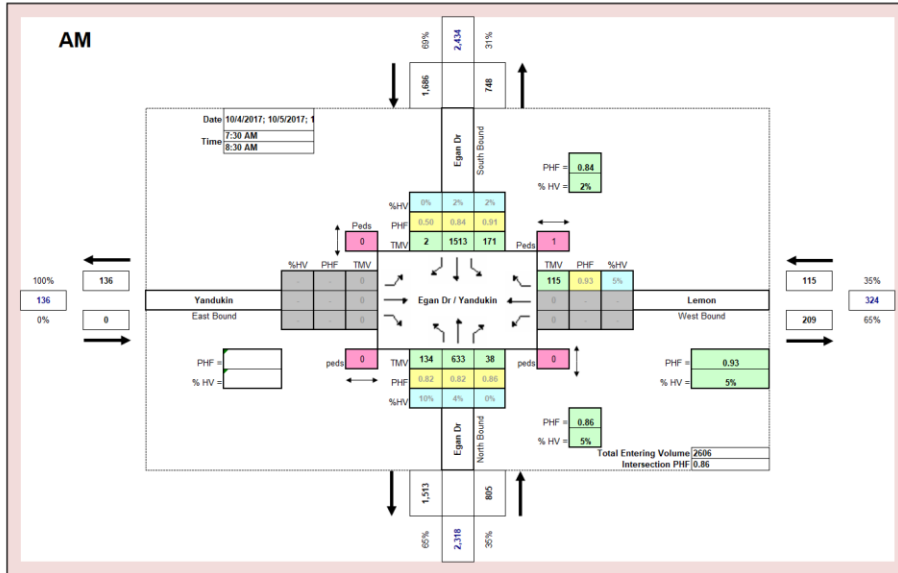
### *Ped/Bike access*

Currently, pedestrians have a two-stage crossing with the crosswalk, warning signs, and median refuge island to allow the crossing of one lane and traffic stream at a time. Pedestrian delay at the existing crossing during the current PM peak hour (see Attachment A for traffic volumes), is less than 10 seconds, which corresponds to a level of service of B and to a low likelihood that a pedestrian engages in risk-taking crossings, per the HCM.

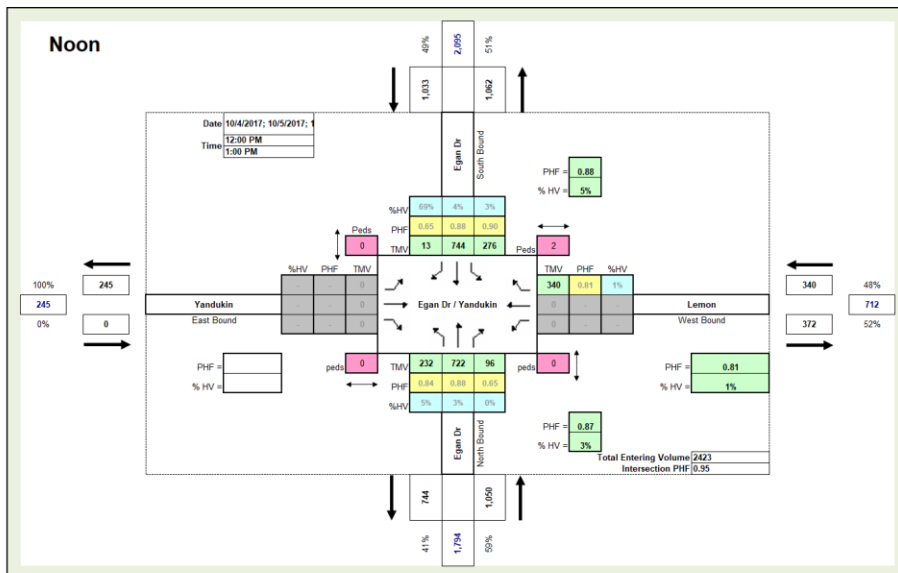
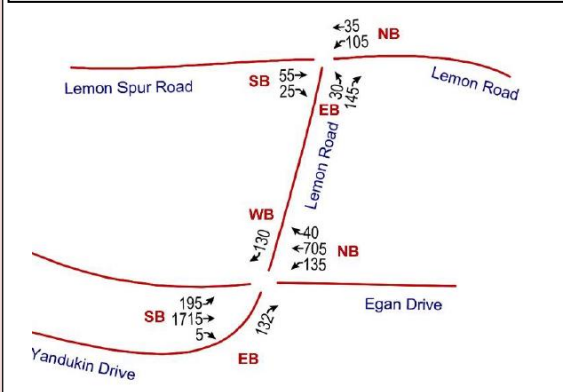
This concept removes the pedestrian refuge island and increases the critical gap by increasing crossing length to three lanes. Under this condition, the pedestrian must cross the entire roadway and seek acceptable gaps within both traffic streams at once. The delay for a crossing pedestrian with the current PM peak hour traffic under these conditions increases to over 2 minutes, which corresponds to a level of service F, and a very high likelihood of risk-taking crossings, per the HCM.

In summary, this concept adversely impacts pedestrians and transit patrons.

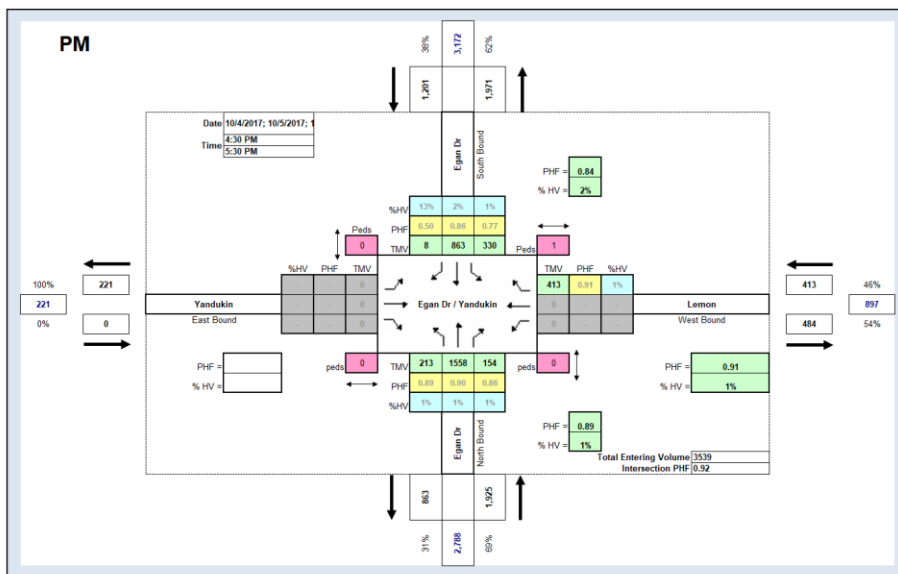
# Attachment A- Peak Hour Turning Movement Volumes



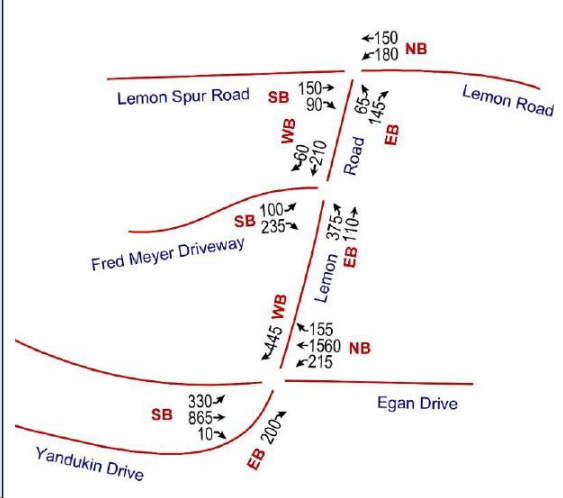
Immediate Area AM Intersection Counts: Traffic Analysis Report Figure 21



Immediate Area Noon Intersection Counts: Traffic Analysis Report Figure 22



Immediate Area PM Intersection Counts: Traffic Analysis Report Figure 23



## Attachment B- NBRT Lane Length Computations

REFERENCE: AASHTO 2011 GDHS

Intersection:	E-Y	
Approach/ Turn Bay:	NBRT; IA C-2	
Bay Lanes	1	
Lane Width	24 ft	Includes median
Approach Speed	60 mph	
Auxiliary Lane Queue (from capacity analysis)	100 ft.	2 trucks
Grade	0.0%	
Adjacent Queue	0 ft.	Not considered, Egan does not stop
Bay Taper Rate (AASHTO recommendations)	15 :1	AASHTO ranges 8: 1 to 15:1 for high speeds
Initial Decel when car is clear of through ETW	5.49 ft/sec <sup>2</sup>	
AASHTO computed Decel Rate from clear point in Bay Taper to Stop	5.82 ft/sec <sup>2</sup>	Computed from AASHTO Table 9-22
Taper Length	360 feet	
Speed after clearing shadow (15kph or 9.32 mph less than design speed)	50.68 MPH	
Total Decel Distance from 50.68 MPH to Stop	474 feet	
Lane Length (Decel+ queue storage-bay taper used for decel)	350 feet	
Lane + Taper	710 feet	

Intersection:	E-Y	
Approach/ Turn Bay:	NBRT IA C-3&C-4	
Bay Lanes	1 RT	
Lane Width	12 ft	
Approach Speed	60 mph	
Grade	0.0%	
Turning Path Radius	75 ft	
Auxiliary Lane Queue (from capacity analysis)	0 ft.	
Minimum Lane Length (Agency)	100 ft.	
Adjacent Queue	0 ft.	
Bay Taper Rate	15 :1	
Bay Taper Length	180 feet	
AASHTO Table 9-22 derived values	5.82 ft/sec <sup>2</sup>	
Estimated right turn speed	18 mph	
<b>Desirable Lane Length (form of NCHRP 279, ignores coasting deceleration)</b>		
This assumes all deceleration occurs in the auxiliary lane, none in bay taper.		
Desirable Decel	325 ft	
Queue	0 ft	
Desirable Lane	325 ft.	

## Attachment C: Cost Estimate for Concept IA C-1: Improve Northbound Right Turn Yield Signs

The preliminary estimated construction cost of this concept is approximately \$21,000. This includes installation of one LED-embedded Yield sign with electrical connection, a painted yield line at the Glacier Highway/Lemon Road-Egan Drive NBRT intersection, and seven recessed pavement markers between the existing NBRT lane and the through lane. Construction administration activities such as mobilization and demobilization, surveying, and traffic control are reflected in this estimate. The estimate does not include new lane or shoulder striping nor costs to maintain and/or operate the sign.

<b>ENGINEER'S ESTIMATE</b>				Juneau - Egan & Yandukin Inx. Imp. PEL Study		
<b>State of Alaska Department of Transportation &amp; Public Facilities</b>				IA C-1 Improve NB Right Turn Yield Signs		
				AKSAS No.: 10150992		
				Federal No.:		
				Version ID:		
<i>Item Number</i>	<i>2017 SSHC ITEM NO.</i>	<i>Description</i>	<i>Unit</i>	<i>Quantity</i>	<i>Unit Price</i>	<i>Amount</i>
		LED Sign	EA	1	\$ 5,700.00	\$ 5,700.00
		Electrical Items	LS	1	\$ 5,000.00	\$ 5,000.00
		Junction Box	EA	1	\$ 1,000.00	\$ 1,000.00
		Recessed Pavement Marker	EA	7	\$ 80.00	\$ 560.00
Project Summary:						
					Subtotal	\$ 12,260.00
					Administration Items*	40%
						\$ 4,904.00
					Exc Subtotal	\$ 17,164.00
					Construction Engineering	15%
						\$ 2,574.60
					Subtotal	\$ 19,738.60
					Indirect Cost Allocation Plan (ICAP)	5.64%
						\$ 1,113.26
					Concept Total	<b>\$ 20,851.86</b>

\* Summary of Admin Items:

<i>Mob/Demob</i>	10%	\$ 1,226.00
<i>Construction Surveying</i>	5%	\$ 613.00
<i>ESCP</i>	10%	\$ 1,226.00
<i>Traffic Maintenance</i>	15%	\$ 1,839.00
	40%	\$ 4,904.00

## Attachment D: Cost Estimate for Concept IA C-2: Emphasize Northbound Right Turn Yielding Through Design

The preliminary estimated construction cost of this concept is approximately \$1.1 million. This includes work required to offset the NBRT lane 12 feet and construct a raised concrete traffic island with curb and gutter. Work includes pavement removal, earthwork, new pavement, concrete, signing, striping, ground stabilization, and highway lighting modification. Four highway lights are assumed to require relocation. In addition, the estimate includes costs to install two new highway lights, if needed. Six recessed pavement markings along the left side of the NBRT lane is also included. The pavement structural section was assumed as two inches of hot mix asphalt, four inches of base course, and 24 inches of borrow outside the existing travel way footprint. Unclassified excavation quantities included the amount required only outside the existing asphalt area with a 6:1 foreslope to the bottom of the borrow layer. Construction administration activities such as mobilization and demobilization, surveying, and traffic control are considered in this estimate. Drainage, utility impacts, or ROW impacts were not considered for this estimate.

ENGINEER'S ESTIMATE				Juneau - Egan & Yandukin Inx. Imp. PEL Study		
State of Alaska Department of Transportation & Public Facilities				IA C-2 Emphasize Northbound Right Turn Yielding TH		
				AKSAS No.: 10150992		
				Federal No.:		
				Version ID:		
Item Number	2017 SSHC ITEM NO.	Description	Unit	Quantity	Unit Price	Amount
		Removal of Pavement	SY	2,515	\$ 15.00	\$ 37,720.83
		Clearing and Grubbing	AC	0.36	\$ 12,000.00	\$ 4,318.18
		Unclassified Excavation	CY	1,052	\$ 30.00	\$ 31,555.56
		Borrow, Type A	TON	1,155	\$ 40.00	\$ 46,200.00
		Aggregate Base Course, Grading D-1	TON	798	\$ 60.00	\$ 47,850.00
		HMA, Type II; Class B	TON	520	\$ 175.00	\$ 91,022.02
		Asphalt Binder, Grade PG 52-40	TON	29	\$ 1,500.00	\$ 42,910.38
		Colored, Patterned Asphalt	TON	4	\$ 900.00	\$ 3,795.00
		Concrete Sidewalk	SY	255	\$ 150.00	\$ 38,200.00
		Curb and Gutter, Type I	LF	282	\$ 80.00	\$ 22,528.00
		Standard Signs	SF	22	\$ 150.00	\$ 3,341.25
		Seeding	LB	35	\$ 150.00	\$ 5,201.28
		Topsoil	SY	3,669	\$ 12.00	\$ 44,032.00
		Traffic Markings	LS	1	\$ 28,539.50	\$ 28,539.50
		Recessed Pavement Markings	EA	6	\$ 80.00	\$ 480.00
		Lighting System	LS	1	\$ 176,443.78	\$ 176,443.78
Project Summary:					Subtotal	\$ 624,137.78
					Administration Items*	40% \$ 249,655.11
					Exc Subtotal	\$ 873,792.89
					Construction Engineering	15% \$ 131,068.93
					Subtotal	\$ 1,004,861.82
					Indirect Cost Allocation Plan (ICAP)	5.64% \$ 56,674.21
					Concept Total	\$ 1,061,536.03

## \* Summary of Admin Items:

Mob/Demob	10%	\$ 62,413.78
Construction Surveying	5%	\$ 31,206.89
ESCP	10%	\$ 62,413.78
Traffic Maintenance	15%	\$ 93,620.67
	40%	\$ 249,655.11

## Attachment E: Cost Estimate for Concept IA C-3: Construct Northbound Right Turn Receiving Lane (Free Movement)

The preliminary estimated construction cost of this concept is approximately \$110,000. This includes work required to construct a raised concrete traffic island with curb and gutter, and provide a right-turn receiving lane (free movement) along Glacier Highway/Lemon Road to the Fred Meyer's driveway. Work includes pavement removal, earthwork, new pavement, signing, and striping. Construction administration activities such as mobilization and demobilization, surveying, and traffic control are considered in this estimate. No additional right-of-way is expected to be required.

<b>ENGINEER'S ESTIMATE</b>				Juneau - Egan & Yandukin Inx. Imp. PEL Study		
<b>State of Alaska Department of Transportation &amp; Public Facilities</b>				IA C-3 Construct Northbound Right Turn Receiving Lane (Free Movement)		
				AKSAS No.: 10150992		
				Federal No.:		
				Version ID:		
<i>Item Number</i>	<i>2017 SSHC ITEM NO.</i>	<i>Description</i>	<i>Unit</i>	<i>Quantity</i>	<i>Unit Price</i>	<i>Amount</i>
		Removal of Pavement	SY	188	\$ 15.00	\$ 2,823.33
		Unclassified Excavation	CY	23	\$ 30.00	\$ 684.44
		Aggregate Base Course, Grading D-1	TON	42	\$ 60.00	\$ 2,541.00
		Concrete Sidewalk	SY	160	\$ 150.00	\$ 24,000.00
		Curb and Gutter, Type I	LF	193	\$ 80.00	\$ 15,400.00
		Standard Signs	SF	39	\$ 150.00	\$ 5,857.50
		Traffic Markings	LS	1	\$ 13,183.50	\$ 13,183.50
		Recessed Pavement Markings	EA	6	\$ 80.00	\$ 480.00
Project Summary:					Subtotal	\$ 64,969.78
				Administration Items*	40%	\$ 25,987.91
					Exc Subtotal	\$ 90,957.69
				Construction Engineering	15%	\$ 13,643.65
					Subtotal	\$ 104,601.34
				Indirect Cost Allocation Plan (ICAP)	5.64%	\$ 5,899.52
					Concept Total	\$ <b>110,500.86</b>

\* Summary of Admin Items:

<i>Mob/Demob</i>	10%	\$ 6,496.98
<i>Construction Surveying</i>	5%	\$ 3,248.49
<i>ESCP</i>	10%	\$ 6,496.98
<i>Traffic Maintenance</i>	15%	\$ 9,745.47
	40%	\$ 25,987.91

## Attachment F: Cost Estimate for Concept IA C-4: Construct Northbound Right Turn Receiving Lane (Free Movement) and Extend Weaving Area

The preliminary estimated construction cost of this concept is approximately \$150,000. This includes work required for Concept IA C-3 and also for extending the right-turn receiving lane to the Glacier Highway/Lemon Road-Lemon Spur Road intersection. In addition to the included work for Concept IA C-3, the existing pedestrian refuge on Glacier Highway/Lemon Road will be removed. A marked crosswalk and pedestrian crossings signs are included in the estimated cost. Construction administration activities such as mobilization and demobilization, surveying, and traffic control is considered in this estimate. No additional right-of-way is expected to be required.

ENGINEER'S ESTIMATE				Juneau - Egan & Yandukin Inx. Imp. PEL Study IA C-4 Construct Northbound Right Turn Receiving Lane (Free Movement) Extended AKSAS No.: 10150992 Federal No.: Version ID:		
State of Alaska Department of Transportation & Public Facilities						
Item Number	2017 SSHC ITEM NO.	Description	Unit	Quantity	Unit Price	Amount
		Removal of Ped Island	LS	1	\$ 8,000.00	\$ 8,000.00
		Removal of Pavement	SY	37	\$ 15.00	\$ 550.00
		Unclassified Excavation	CY	36	\$ 30.00	\$ 1,084.44
		Aggregate Base Course, Grading D-1	TON	67	\$ 60.00	\$ 4,026.00
		HMA, Type II; Class B	TON	13	\$ 175.00	\$ 2,213.75
		Asphalt Binder, Grade PG 52-40	TON	1	\$ 1,500.00	\$ 1,095.81
		Concrete Sidewalk	SY	160	\$ 150.00	\$ 24,000.00
		Curb and Gutter, Type I	LF	193	\$ 80.00	\$ 15,400.00
		Standard Signs	SF	50	\$ 150.00	\$ 7,548.75
		Traffic Markings	LS	1	\$ 21,824.00	\$ 21,824.00
		Recessed Pavement Markings	EA	6	\$ 80.00	\$ 480.00
Project Summary:					Subtotal	\$ 86,222.75
					Administration Items*	40% \$ 34,489.10
					Exc Subtotal	\$ 120,711.85
					Construction Engineering	15% \$ 18,106.78
					Subtotal	\$ 138,818.63
					Indirect Cost Allocation Plan (ICAP)	5.64% \$ 7,829.37
					Concept Total	\$ 146,648.00

\* Summary of Admin Items:

Mob/Demob	10%	\$ 8,622.28
Construction Surveying	5%	\$ 4,311.14
ESCP	10%	\$ 8,622.28
Traffic Maintenance	15%	\$ 12,933.41
	40%	\$ 34,489.10



**FROM:** Aiza Miguel, PE; Jeanne Bowie, PE, PhD, PTOE; Jessica Miranda, PE  
**DATE:** December 13, 2019  
**SUBJECT:** SHFWY00079 – Strategy D: Reduce Conflicts and Improve Lane Alignment between Southbound Vehicles and Northbound Left Turn (NBLT) Vehicles

## Background

Figure 1 presents the current allowable turning movements at the Egan-Yandukin intersection.

NBLT and SBRT are the only two movements allowed to enter Yandukin Drive. The west leg is designed to accommodate both of these movements, resulting in a wide receiving lane that could make it difficult for NBLT vehicles to visually determine where to aim while turning. Thus, the wide receiving lane could be a contributing factor to northbound left turn crashes at the intersection.

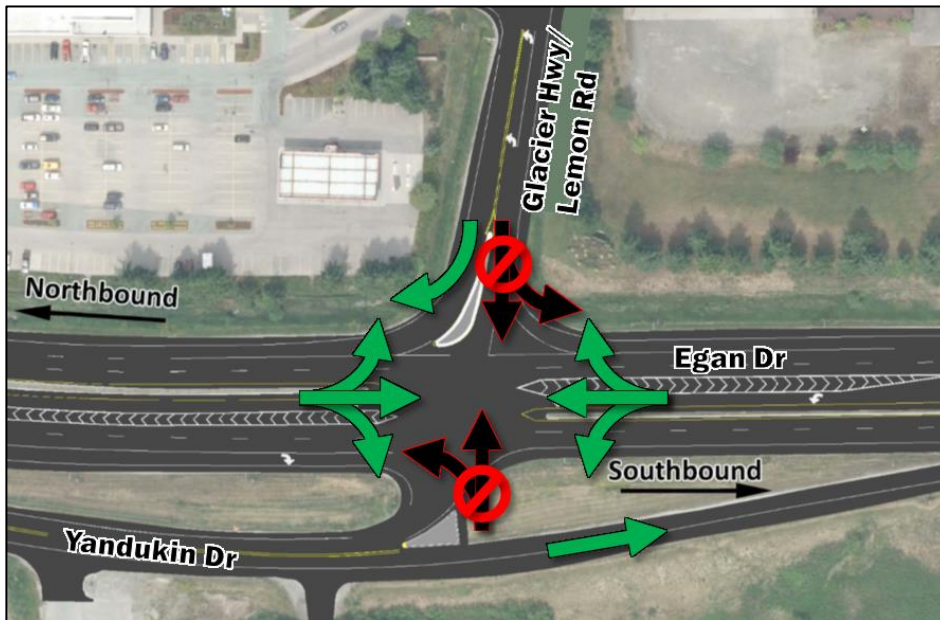


Figure 1- Allowable Turning Movements

## NBLT-SB Vehicle Conflicts

There is a low volume of SBRT at the Egan-Yandukin intersection; less than 15 SBRT vehicles were observed in 2017 during the morning, noon, and evening peak hour periods (see Attachment A). Furthermore, the roadway network is robust; there are other routes available for drivers to reach destinations on the airport side of Egan Drive.

Egan-Yandukin intersection crash data from 2005 to 2017 (86 crashes) was reviewed for NBLT-SB collisions. There were 15 crashes involving NBLT vehicles.

## Concept for Strategy D: Reduce Conflicts and Improve Lane Alignment between Southbound Vehicles and Northbound Left Turn (NBLT) Vehicles

This concept strategy reduces conflicts between SBRT and NBLT vehicles to remove confusion for NBLT drivers.

### Concept IA D-1: Prohibit SBRT and Redesign West Departure Leg

Concept IA D-1 is presented in Figure 2. The concept has an estimated cost of \$510,000 at the conceptual design level (see Attachment D for details).

Concept IA D-1 would restrict the west leg to receiving NBLT vehicles only and removes the SBRT lane on Egan Drive. This would remove conflicts between NBLT and SBRT vehicles. The receiving lane would be redesigned with a tighter radius to make it easier for the NBLT to turn left, as well as control the restricted SBRT. This could reduce conflicts between NBLT and southbound through vehicles because it would remove the confusion of where to turn into the receiving lane and NBLT drivers would not be as hesitant to turn. The prohibited SBRT movement would turn right at the Glacier Highway/Nugget signal to get to the desired destinations.

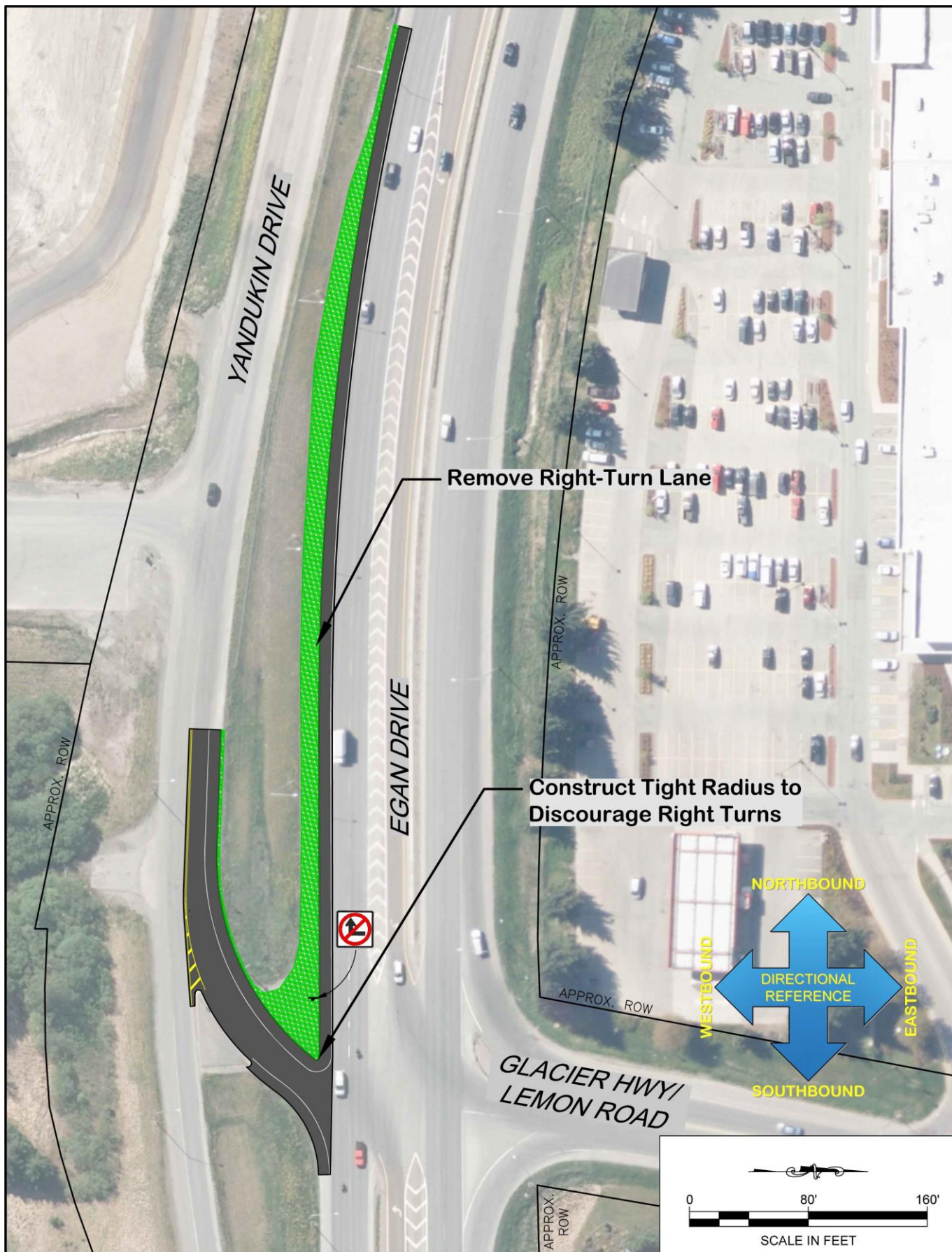


Figure 2- Concept IA D-1: Prohibit SBRT and Redesign West Departure Leg

## Impacts of Concept IA D-1

### *Safety improvement (Crash Frequency and Severity)*

This concept has no safety effect, benefits, or impacts. A survey of the Crash Modification Clearinghouse ([www.cmfclearinghouse.org](http://www.cmfclearinghouse.org)) reveals that the concept has no crash modification factors (CMF) in the database. Furthermore, there is no evidence of a history of SBRT-NBLT crashes occurring at the Egan-Yandukin Intersection.

### *Stakeholder impacts*

The SBRT would make right turns at the Glacier Highway/Nugget signal, prior to the Egan-Yandukin intersection, and continue westward to their desired destination. The diverted route would impact a small number of SBRT vehicles and could impact industrial stakeholders.

### *Transit Impacts*

This concept has no transit effect, benefits, or impacts.

### *Safety impacts to other intersections*

Prohibiting the SBRT at the Egan-Yandukin intersection would increase SBRT volumes at the Glacier Highway/Nugget signal by an estimated 150 vehicles per day. The signal has an intersection crash rate of 0.89 crashes per million entering vehicles, which suggests that less than one crash (0.63 crashes) could be expected to move to this location.

### *Operational Impacts to other intersections*

SBRT vehicles will be turning right at the Glacier Highway/Nugget signal; however, with low SBRT volumes, no operational impacts are expected.

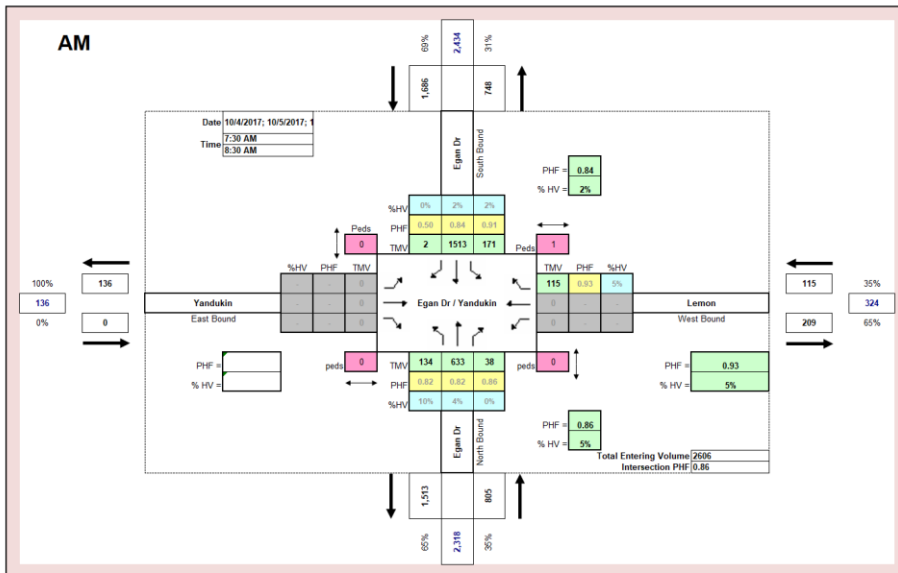
### *Environmental considerations*

Environmental effects, benefits, and impacts for this concept are currently being evaluated.

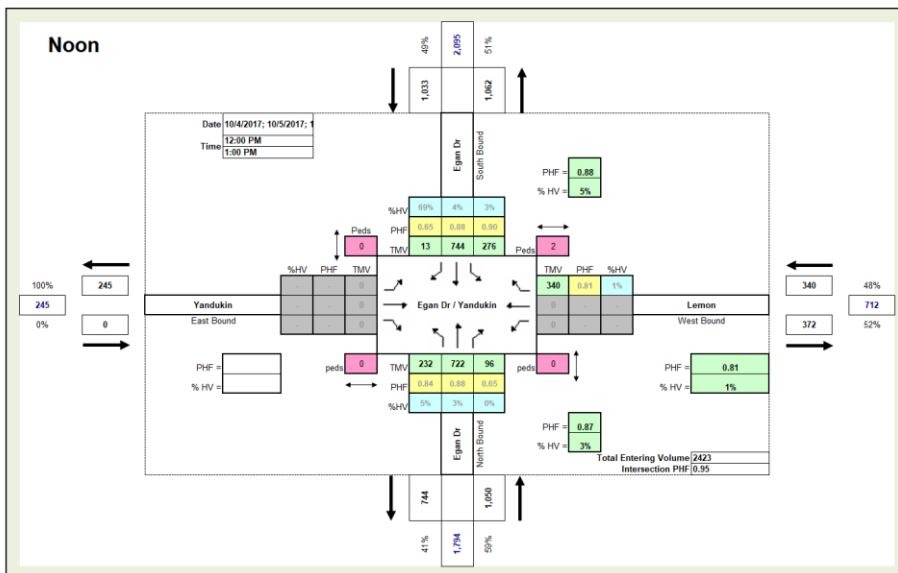
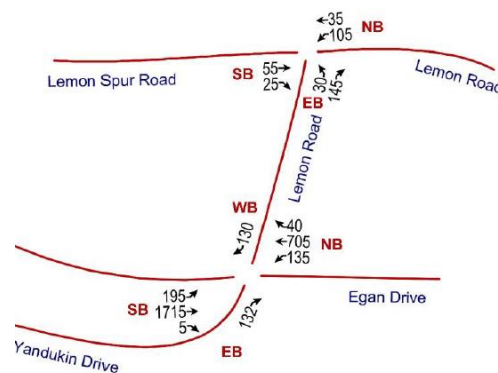
### *Ped/Bike access*

This concept has no pedestrian or bicycle access effect, benefits, or impacts.

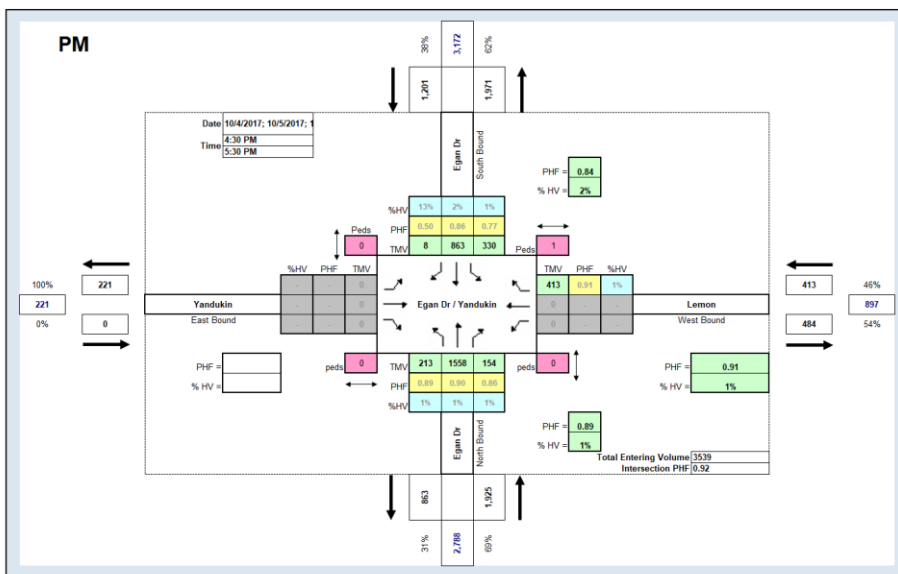
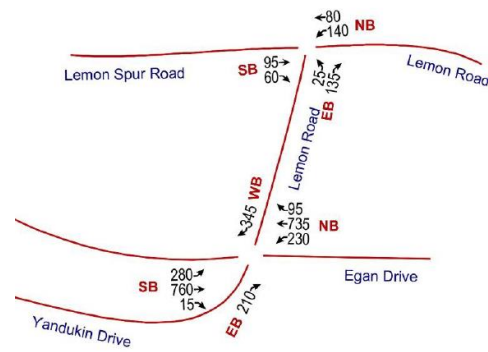
# Attachment A – Peak Hour Turning Movement Volumes



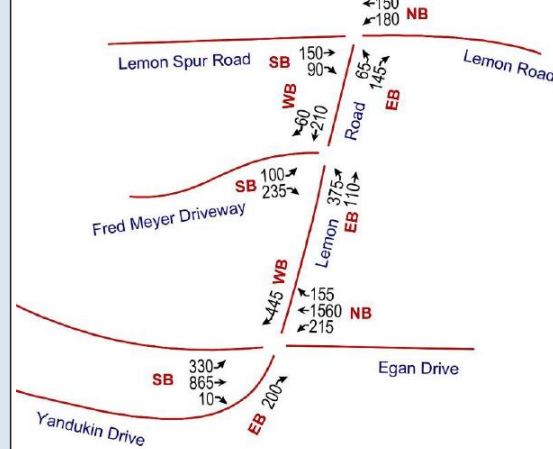
Immediate Area AM Intersection Counts: Traffic Analysis Report Figure 21



Immediate Area Noon Intersection Counts: Traffic Analysis Report Figure 22



Immediate Area PM Intersection Counts: Traffic Analysis Report Figure 23



## Attachment B – Cost Estimate for Concept IA D-1: Prohibit SBRT and Redesign West Departure Leg

The preliminary estimated construction cost of this concept is approximately \$510,000. This includes work required to remove the SBRT lane and reconstruct the Egan Drive-Yandukin Drive intersection. Work includes pavement removal, earthwork, signing, striping, ground stabilization, and highway lighting modification. One highway light on Yandukin Drive is assumed to require relocation. The existing highway lights along the existing SBRT lane of Egan Drive were assumed to remain in place; however, they may require relocation due to the increased distance to the new edge of travel way. Pavement structural design was assumed as two inches of hot mix asphalt and four inches of base course. Thirty inches of borrow was included in a small area of new pavement that encroaches outside the existing travel way footprint. Assumed unclassified excavation quantities included the amount required for base course installation, as well as the amount required to regrade the roadside to a 6:1 slope. Construction administration activities such as mobilization and demobilization, surveying, and traffic control is considered in this estimate. Drainage, utility impacts, or ROW impacts were not considered for this estimate.

ENGINEER'S ESTIMATE				Juneau - Egan & Yandukin Inx. Imp. PEL Study			
State of Alaska Department of Transportation & Public Facilities				IA D-1: Prohibit Southbound Right Turn and Redesign			
				AKSAS No.: 10150992			
				Federal No.:			
				Version ID:			
Item Number	2017 SSHC ITEM NO.	Description	Unit	Quantity	Unit Price	Amount	
		Removal of Pavement	SY	2,209	\$ 15.00	\$ 33,128.33	
		Clearing and Grubbing	LS	1.00	\$ 5,000.00	\$ 5,000.00	
		Unclassified Excavation	CY	226	\$ 30.00	\$ 6,773.33	
		Borrow, Type A	TON	130	\$ 40.00	\$ 5,214.00	
		Aggregate Base Course, Grading D-1	TON	289	\$ 60.00	\$ 17,325.00	
		HMA, Type II; Class B	TON	121	\$ 175.00	\$ 21,202.81	
		Asphalt Binder, Grade PG 52-40	TON	7	\$ 1,500.00	\$ 10,495.39	
		Standard Signs	SF	10	\$ 150.00	\$ 1,485.00	
		Seeding	LB	13	\$ 150.00	\$ 1,899.45	
		Topsoil	SY	1,340	\$ 12.00	\$ 16,080.00	
		Traffic Markings	LS	1	\$ 6,022.50	\$ 6,022.50	
		Lighting System	LS	1	\$ 18,830.21	\$ 176,443.78	
Project Summary:						Subtotal	\$ 301,069.59
						Administration Items*	40% \$ 120,427.83
						Exc Subtotal	\$ 421,497.42
						Construction Engineering	15% \$ 63,224.61
						Subtotal	\$ 484,722.03
						Indirect Cost Allocation Plan (ICAP)	5.64% \$ 27,338.32
						Concept Total	\$ <b>512,060.36</b>

## \* Summary of Admin Items:

Mob/Demob	10%	\$ 30,106.96
Construction Surveying	5%	\$ 15,053.48
ESCP	10%	\$ 30,106.96
Traffic Maintenance	15%	\$ 45,160.44
	40%	\$ 120,427.83

**FROM:** Aiza Miguel, PE; Jeanne Bowie, PE, PhD, PTOE; Jessica Miranda, PE  
**DATE:** December 13, 2019  
**SUBJECT:** SHFWY00079 – Strategy E: Eliminate Left Turn Movements

## Background

Figure 1 presents the current allowable turning movements at the Egan-Yandukin intersection. Right, through, and left turns are allowed in the northbound and southbound directions on Egan Drive. Only right turns are allowed in the westbound direction on Glacier Highway/Lemon Road; left turns are prohibited and controlled through a raised median. Motorists wishing to travel southbound on Egan Drive, leaving Glacier Highway/Lemon Road currently take Lemon Road, east of the intersection, to the Sunny Point interchange. The west leg of the intersection, Yandukin Drive, is one-way westbound that connects to the two-way section of Yandukin Drive.

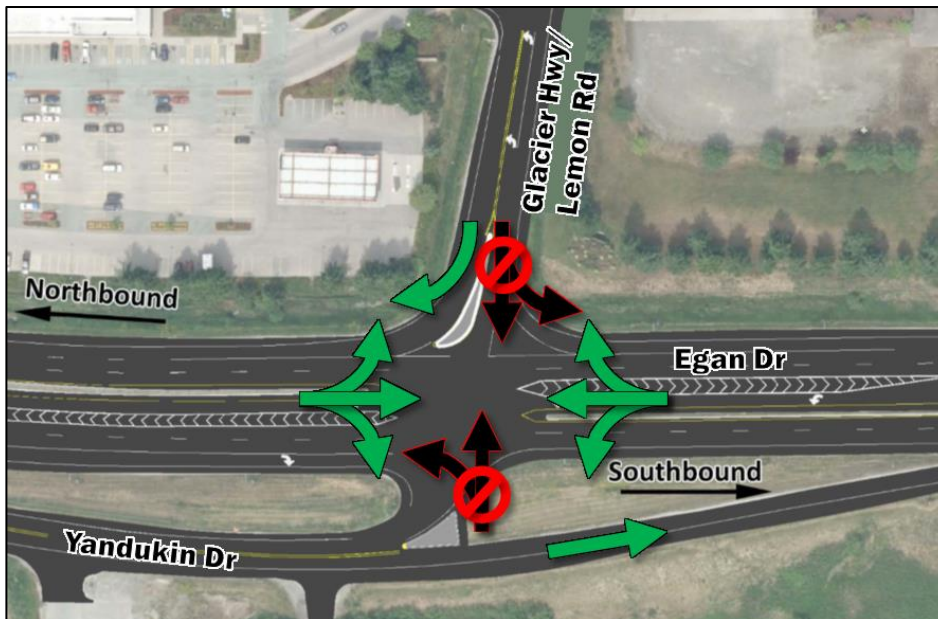


Figure 1 - Allowable Turning Movements

In 2012, in an effort to reduce left turn crashes, the left-turn auxiliary lanes on Egan Drive in both directions were shifted to provide a zero offset to the opposing left-turn lane. Crash analysis before and after the improvement indicated there is no evidence of a change in the number or severity of crashes.

## Issues

The most predominant crash type at the Egan-Yandukin intersection are left turn crashes, where a left turning vehicle strikes or is struck by an oncoming through vehicle traveling at high speeds. At this intersection, left turn crashes result in higher severity crashes as compared to other crash types. A review of the 2005 to 2017 crash history at this intersection revealed 45% (39 out of a total of 86) of the crashes were left-turning vehicles, and 6 of which were major injury crashes.

## Contributing Factors

Darkness, pavement conditions, and difficulty judging when to take gaps in oncoming traffic appear to be factors in crashes. Public input indicates that some drivers have trouble determining if an oncoming vehicle is in the through lane or the right-turn only lane, which leads to conflicts.



## Concept for Strategy E: Eliminate Left Turn Movements

One strategy to prevent left turn crashes is to eliminate the left turn movements at the Egan-Yandukin intersection and relocate them to other intersections where the conflicts occur at lower speeds or at reduced volumes (Strategy E).

### Concept IA E-1: Close Median

IA E-1 would completely close the median opening at the intersection, prohibiting vehicles from turning left from Egan Drive onto Yandukin (towards the airport) or onto Glacier Highway/Lemon Road (towards Fred Meyer). Right turn movements from the side streets onto Egan Drive would still be allowed. Note that vehicles are currently prohibited from turning left from the side streets onto Egan Drive. Northbound traffic turning from Egan Drive toward the airport would travel to the Glacier Highway/Nugget signalized intersection, approximately 0.8 miles north of the study intersection. Southbound traffic turning from Egan Drive towards the Fred Meyer would travel to the Sunny Point interchange, approximately 1.3 miles south of the study intersection.

Concept IA E-1a is presented in Figure 2. This is a low-cost way to close the median, involving only restriping and the installation of bollards. Concept IA E-1b is presented in Figure 3. Concept IA E-1b has an estimated cost of \$270,000 at the conceptual design level (see Attachment A for details). This method of closing the median would involve by constructing a vegetated median between the opposing traffic lanes. Concept IA E-1b has an estimated cost of \$770,000 at the conceptual design level (see Attachment A for details).

IA E-1 would completely close the median opening at the intersection by constructing a vegetated median between the opposing traffic lanes. Closing the median would prohibit vehicles from

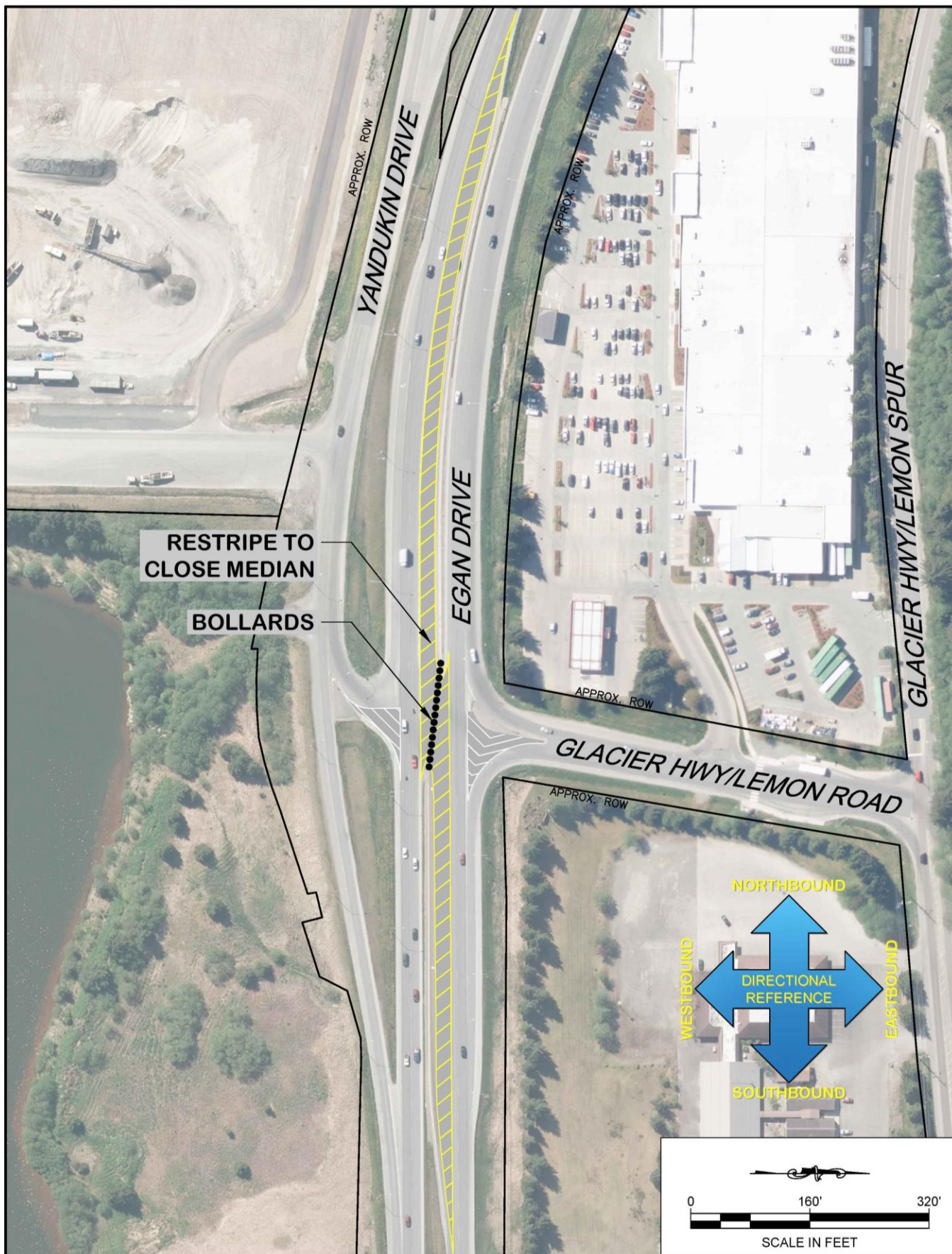


Figure 2- Concept IA E-1a: Close Median (Low Cost)

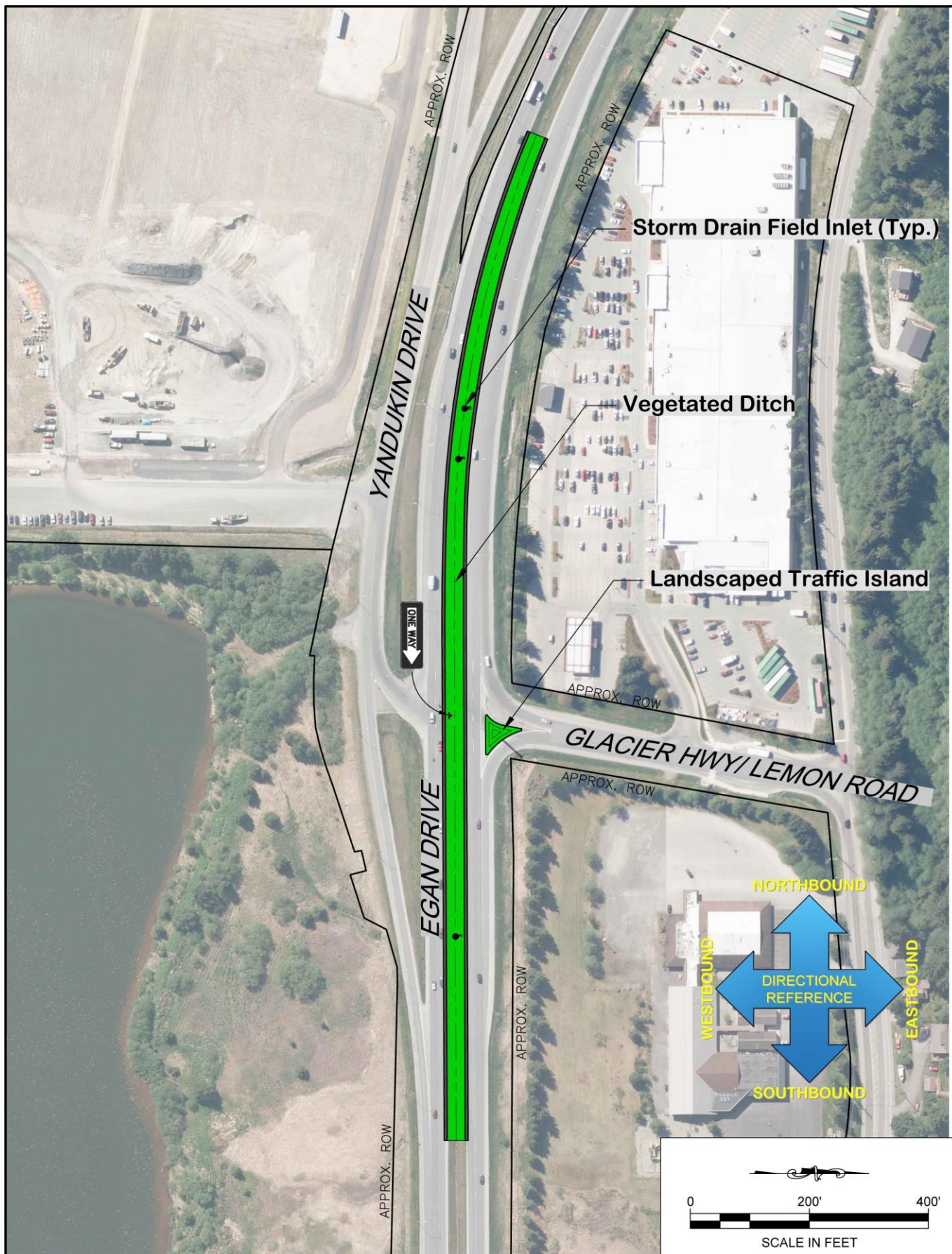


Figure 3- Concept IA E-1b: Close Median (Longer Term)

## Impacts of Concept IA E-1

### *Safety improvement (Crash Frequency and Severity)*

As previously stated, from 2005 to 2017, 45% of all crashes that occurred at the Egan- Yandukin intersection were left turn crashes (39 out of 86 crashes). The median closure would prohibit left turn movements, eliminating all left crashes at the intersection. High severity crashes are also of concern at the intersection; the left turn crashes predominantly result in higher severity crashes. Eliminating the crash type is expected to result in a decrease in crashes with high severity at this intersection. The number of crashes that would have been removed from the intersection crash history between 2005 through 2017 if the median closure had been implemented by severity are as follows:

- 5 out of 6 (83%) major injury crashes
- 23 out of 35 (66%) minor injury crashes
- 11 out of 45 (24%) property damage only crashes

Other crash types could also decrease with the closed median such as rear end or sideswipe crashes occurring in the left turn lane pockets or run-off-road crashes involving a vehicle avoiding a left turn driver.

### *Stakeholder impacts*

Patrons of the businesses and churches on Lemon Spur regularly use this intersection to access their destination. Closing the southbound left turn maneuver could have impacts on the businesses and customers, especially during the AM peak hours where customers stop in on their way to work. The southbound left turning traffic would be required to perform out-of-direction travel to the Sunny Point interchange (about 5 minutes of additional travel time). Some commuters on their way to work may divert to another store, rather than go the extra travel distance.

This intersection is also used for northbound traffic heading to the airport and the industrial/commercial area surrounding the airport. Closing the northbound left turn movement would add a little more travel time (about 2.5 minutes) for drivers traveling to this area.

### *Transit Impacts*

Northbound bus routes will not be affected by the median closure; however, southbound bus routes will be impacted. Three bus routes currently make southbound left turn movements to serve Bus Stop 479 at the Egan-Yandukin intersection:

- Route 3 – Mendenhall Loop Counterclockwise
- Route 4 – Mendenhall Loop Clockwise
- Route 14 – Mendenhall/Riverside Commuter

Buses on these routes would be required to travel to the Sunny Point interchange; complete a turnaround at the interchange to head northbound on Egan Drive, as depicted in Figure 4; and make a northbound right turn to Glacier Highway/Lemon Road to reach the Bus Stop 479 on the correct side. Traveling south to Sunny Point and then back northbound to Bus Stop 479 is an out-of-direction travel movement, increasing the travel time to reach the bus stop and impacting bus schedules. The new route would increase travel times by 3 to 5 minutes. Transit vehicle patrons are very sensitive to travel time increases, and this is a significant increase in travel time.

### *Safety impacts to other intersections*

While crashes would decrease at the Egan-Yandukin intersection, crash frequencies could increase at nearby intersections due to an increase of diverted traffic volumes. At the Glacier Highway/Nugget signal, the northbound left volume is estimated to increase by 1300 vehicles per day, which suggests 5 crashes are expected to move to this location (with an intersection crash rate of 0.89 crashes per million entering vehicles).

Southbound left turn vehicles will increase traffic at the Sunny Point interchange and at the Glacier Highway/Lemon Road-Egan Drive Access signal. While crashes could increase at these locations, the speeds of the vehicles approaching these intersections are significantly lower and the number of conflicting vehicles is significantly reduced when compared to the Yandukin intersection.

#### *Operational Impacts to other intersections*

The median closure would divert left turning traffic to other intersections to get to their desired destinations.

#### *Egan Drive at Glacier Highway/Nugget Signal (Northbound Lefts)*

Northbound left turn traffic would travel to the Glacier Highway/Nugget signal to make left turns. The northbound left turn movement is expected to have long delays and operate over or near capacity due to an increase in movement volumes. Operating at capacity indicates that vehicles will be waiting through more than one signal cycle to make their turn during the peak hours. However, the intersection as a whole is expected to operate with AM peak delays of 38 seconds per vehicle (level of service [LOS] D), Noon peak delays of 31 seconds per vehicle (LOS C), and PM peak delays of 45 seconds per vehicle (LOS D).

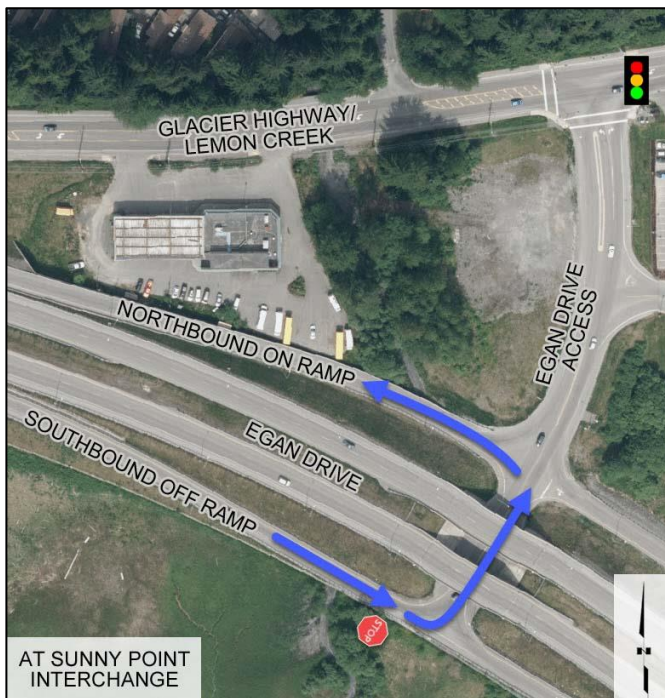
Adjusting the signal timing at Glacier Highway/Nugget would slightly decrease northbound left turn delays but would not result in any significant changes. The signal runs uncoordinated during the midday peak and is more flexible to timing changes compared to the signal running coordinated during the AM and PM peaks with the Mendenhall Loop Road signal on Egan Drive. The intersection as a whole is expected to operate between LOS C and LOS D (over 30 second delays per vehicle during the peak hours), which is considered acceptable based on the American Association of State Highway and Transportation Official's *A Policy on the Geometric Design of Highways and Streets* (2011 AASHTO Green Book).

#### *Sunny Point Interchange and Glacier Highway/Lemon Road at Egan Drive Access Signal (Southbound Lefts)*

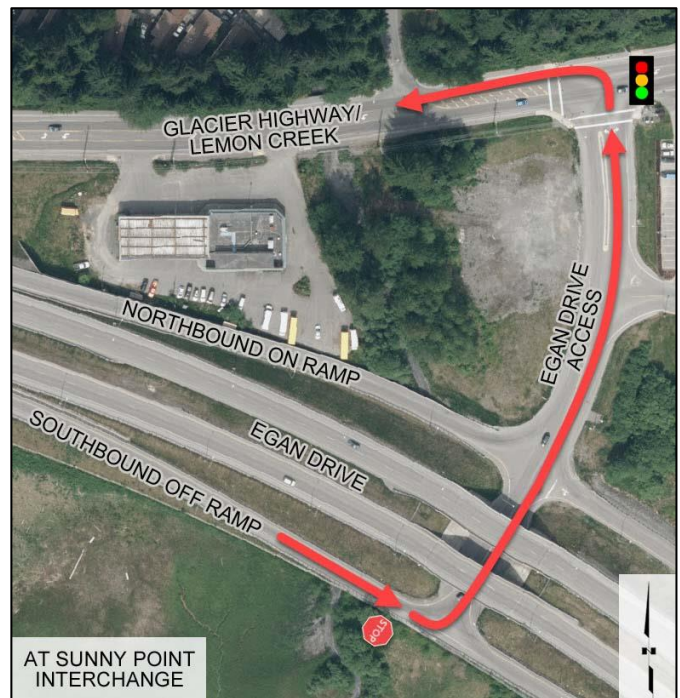
Southbound left turn traffic would travel to the Sunny Point interchange. Vehicles would exit on the southbound Egan Drive off-ramp at Sunny Point and reach a stop sign before turning left on to the Egan Drive Access road. Vehicles are expected to have long delays at the stop sign because of the high volume of diverted southbound left turn vehicles fully stopping at the intersection and waiting for sufficient gaps in cross traffic before proceeding through the intersection. The nearby signal may help provide long gaps of traffic between conflicting vehicle platoons.

Drivers will have two choices on the access road as follows:

- Complete a turnaround at the interchange and enter the northbound on-ramp onto Egan Drive (Figure 4).
- Continue straight to the signal and turn left at Glacier Highway/Lemon Road (Figure 5).



*Figure 4: Turnaround Movement at Sunny Point Interchange*



*Figure 5: Continue to Glacier Highway/Lemon Road Movement at Sunny Point Interchange*

Vehicles turning around at the Sunny Point Interchange back to Egan Drive are required to yield to any oncoming through or right turning vehicles before entering the northbound on-ramp. Short delays are expected for these vehicles while yielding to opposing traffic. A short queue would likely form behind yielding left turn vehicles.

Vehicles continuing straight to the signal will turn left to enter Glacier Highway/Lemon Road. The signal is expected to handle the increase in left turning traffic. The intersection as a whole is expected to operate at LOS C or better throughout the day, with the longest delay in the PM peak of 20 seconds per vehicle.

#### *Environmental considerations*

Longer travel distances and travel through more signals could result in an increase in air pollution.

#### *Ped/Bike access*

Volumes on Glacier Highway/Lemon Road are expected to increase due to detoured southbound left turn traffic who choose this route to access Fred Meyer. This could have an affect on the walking and biking experience for those using Glacier Highway/Lemon Road.

At the signalized intersections, pedestrian crossings are controlled; therefore, no impacts are expected unless signal timings are adjusted to longer cycle lengths.

## Attachment A – Cost Estimate for Concept IA E-1: Close Median

Two preliminary estimated construction costs were prepared for this concept. The first estimate (E-1a) assumes that the median closure involves only pavement restriping and installation of bollards. The cost for Concept IA E-1a is \$270,000.

The preliminary estimated construction cost of the E-1b concept is approximately \$770,000. This includes work required to remove the southbound and northbound left-turn only lanes, construct a vegetated ditch between the northbound and southbound through lanes of Egan Drive, and construct a vegetated traffic island at the northbound right-turn only lane intersection of Egan Drive and Glacier Highway/Lemon Road. Work includes pavement removal, earthwork, signing, striping, ground stabilization, and drainage structures. The inside four-foot wide shoulders along the proposed ditch will be reconstructed with two inches of hot mix asphalt and four inches of base course. Assumed unclassified excavation quantities included the amount required to regrade the new ditch and traffic island to 6:1 slopes away from the edge of new pavement. Three field inlet drainage structures and one culvert with end sections are assumed to be required to tie-into the existing drainage system. Construction administration activities such as mobilization and demobilization, surveying, and traffic control is considered in this estimate. In depth drainage, utility impacts, or ROW impacts were not considered for this estimate.

### E-1a:

ENGINEER'S ESTIMATE				Juneau - Egan & Yandukin Inx. Imp. PEL Study		
State of Alaska Department of Transportation & Public Facilities				IA E-1 Close Median AKSAS No.: 10150992 Federal No.: Version ID:		
Item Number	2017 SSHHC ITEM NO.	Description	Unit	Quantity	Unit Price	Amount
		Bollard	EA	35	\$ 1,500.00	\$ 52,500.00
		Traffic Markings	LS	1	\$ 106,557.00	\$ 106,557.00
Project Summary:					Subtotal	\$ 159,057.00
					Administration Items*	40% \$ 63,622.80
					Exc Subtotal	\$ 222,679.80
					Construction Engineering	15% \$ 33,401.97
					Subtotal	\$ 256,081.77
					Indirect Cost Allocation Plan (ICAP)	5.64% \$ 14,443.01
					Concept Total	\$ 270,524.78

\* Summary of Admin Items:

Mob/Demob	10%	\$ 15,905.70
Construction Surveying	5%	\$ 7,952.85
ESCP	10%	\$ 15,905.70
Traffic Maintenance	15%	\$ 23,858.55
	40%	\$ 63,622.80

E-1b:

<b>ENGINEER'S ESTIMATE</b>				Juneau - Egan & Yandukin Inx. Imp. PEL Study		
<b>State of Alaska Department of Transportation &amp; Public Facilities</b>				IA E-1 Close Median		
				AKSAS No.: 10150992		
				Federal No.:		
				Version ID:		
<i>Item Number</i>	<i>2017 SSHC ITEM NO.</i>	<i>Description</i>	<i>Unit</i>	<i>Quantity</i>	<i>Unit Price</i>	<i>Amount</i>
		Removal of Pavement	SY	6,233	\$ 15.00	\$ 93,500.00
		Remove manhole	EA	1	\$ 2,000.00	\$ 2,000.00
		Unclassified Excavation	CY	2,875	\$ 30.00	\$ 86,250.00
		Aggregate Base Course, Grading D-1	TON	657	\$ 60.00	\$ 39,435.00
		HMA, Type II; Class B	TON	240	\$ 175.00	\$ 42,061.25
		Asphalt Binder, Grade PG 52-40	TON	14	\$ 1,500.00	\$ 20,820.32
		36" Pipe	LF	110	\$ 300.00	\$ 33,000.00
		End Section for 36" Pipe	EA	2	\$ 2,000.00	\$ 4,000.00
		Standard Signs	SF	7	\$ 150.00	\$ 1,113.75
		Seeding	LB	67	\$ 150.00	\$ 10,017.00
		Topsoil	SY	7,067	\$ 12.00	\$ 84,800.00
		Field Inlet	EA	3	\$ 5,000.00	\$ 15,000.00
		Traffic Markings	LS	1	\$ 22,808.50	\$ 22,808.50
Project Summary:					Subtotal	\$ 454,805.82
					Administration Items*	40% \$ 181,922.33
					Exc Subtotal	\$ 636,728.15
					Construction Engineering	15% \$ 95,509.22
					Subtotal	\$ 732,237.37
					Indirect Cost Allocation Plan (ICAP)	5.64% \$ 41,298.19
					Concept Total	\$ <b>773,535.56</b>

## \* Summary of Admin Items:

<i>Mob/Demob</i>	10%	\$ 45,480.58
<i>Construction Surveying</i>	5%	\$ 22,740.29
<i>ESCP</i>	10%	\$ 45,480.58
<i>Traffic Maintenance</i>	15%	\$ 68,220.87
	40%	\$ 181,922.33