APPENDIX E

Interim Improvement Concepts White Paper

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MEMORANDUM

FROM: Shelley Giraldo, EIT; James Smith, PE; Jessi Miranda, PE; Jeanne Bowie, PE, PhD, PTOE

DATE: May 29, 2020

SUBJECT: SHFWY00079 – Interim Improvements Concept White Paper

On Wednesday, April 1, 2020, the project team (which includes DOT&PF, HDR and Kinney Engineering, LLC) held an Interim Actions – HSIP Application planning meeting for the Egan Drive-Yandukin Drive/Glacier Lemon Highway (E-Y) intersection. At the meeting, interim action concepts that had been previously identified by the project team and analyzed to determine planning-level benefit and costs were presented. (See Interim Action Strategies Summary and Comparison, dated January 10, 2020.) The team discussed each concept, and also identified other concepts that could be beneficial. The project team reconvened on Friday, April 3, 2020, to identify a group of the proposed concepts that could be bundled together and included in an HSIP nomination for a project to be constructed.

Based on the crash history of the E-Y intersection, the crashes of concern were left-turn collision type. These types of crashes typically occur when the left-turning drivers misjudge one or more of the following:

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

Furthermore, the majority of crashes occurred during the winter months and road conditions were identified as a contributing factor.

Interim Action Improvement Concept

The project team recommends implementing the following interim measures to help mitigate the crash issue at this intersection:

- Seasonal speed reduction in the vicinity of the intersection
- Left-turn lane median striping with recessed pavement markers
- Offset northbound right-turn (NBRT) lane with recessed pavement markers

Table 1 presents the Crash Reduction Factors (CRFs) for the proposed improvements. Table 2 presents the cost estimates for the improvements. Figure 1 and Figure 2 present the recommended interim action improvement concepts.

Table 1. CRFs for the Proposed Improvements

Improvement	Seasonal Speed Reduction	Left-turn Lane Median Striping	Offset Northbound Right-Turn Lane	
CRF	50%	10%	20%	59%
Crashes affected	All crashes	Left-turn crashes	Left-turn crashes	Right-turn crashes

Table 2. Cost Estimates for Proposed Improvements

	Seasonal Speed Reduction	Left-turn Lane Median Striping	Offset Northbound Right-Turn Lane
Phase 2 Design	$70,000	$60,000	$50,000
Phase 3 Right-of-Way	$0	$0	$0
Phase 4 Construction	$450,000	$410,000	$330,000
Phase 7 Utilities	$0	$0	$0
TOTAL	$520,000	$470,000	$380,000

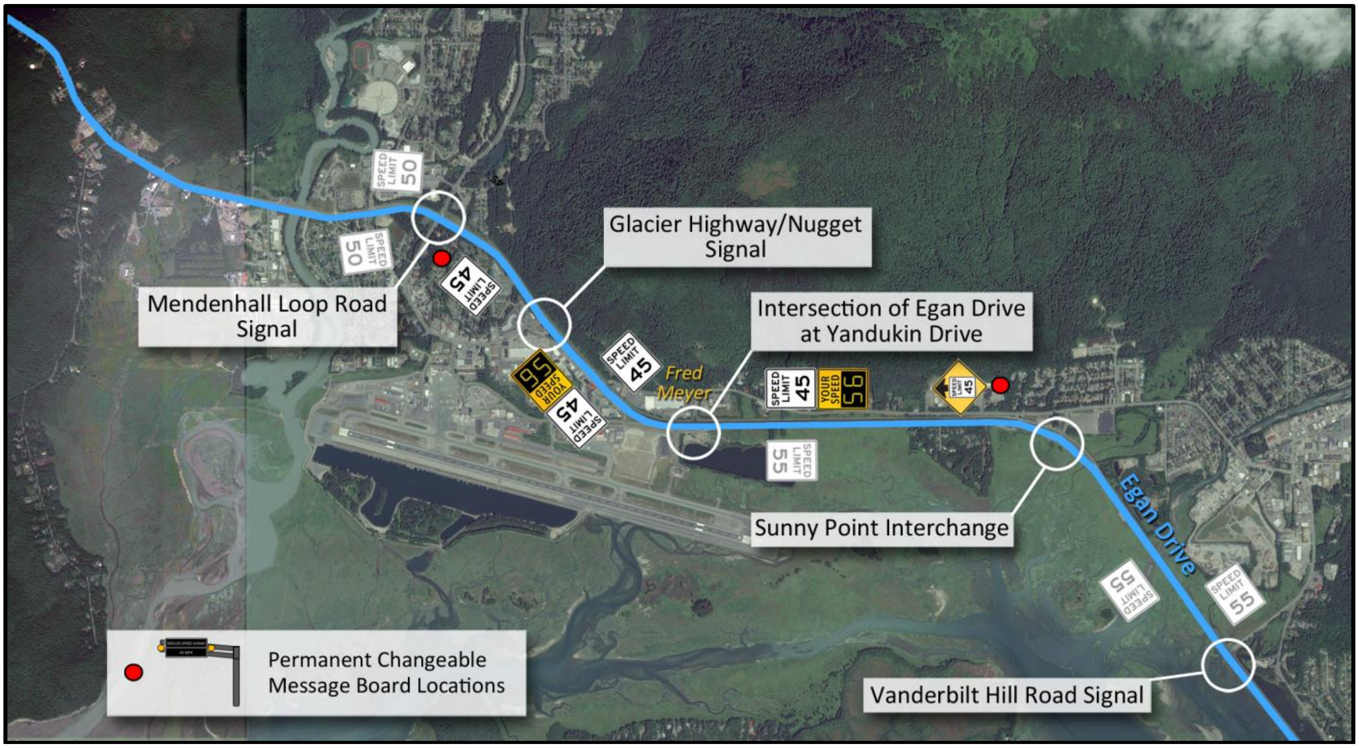

Figure 1. Seasonal Speed Reduction Concept

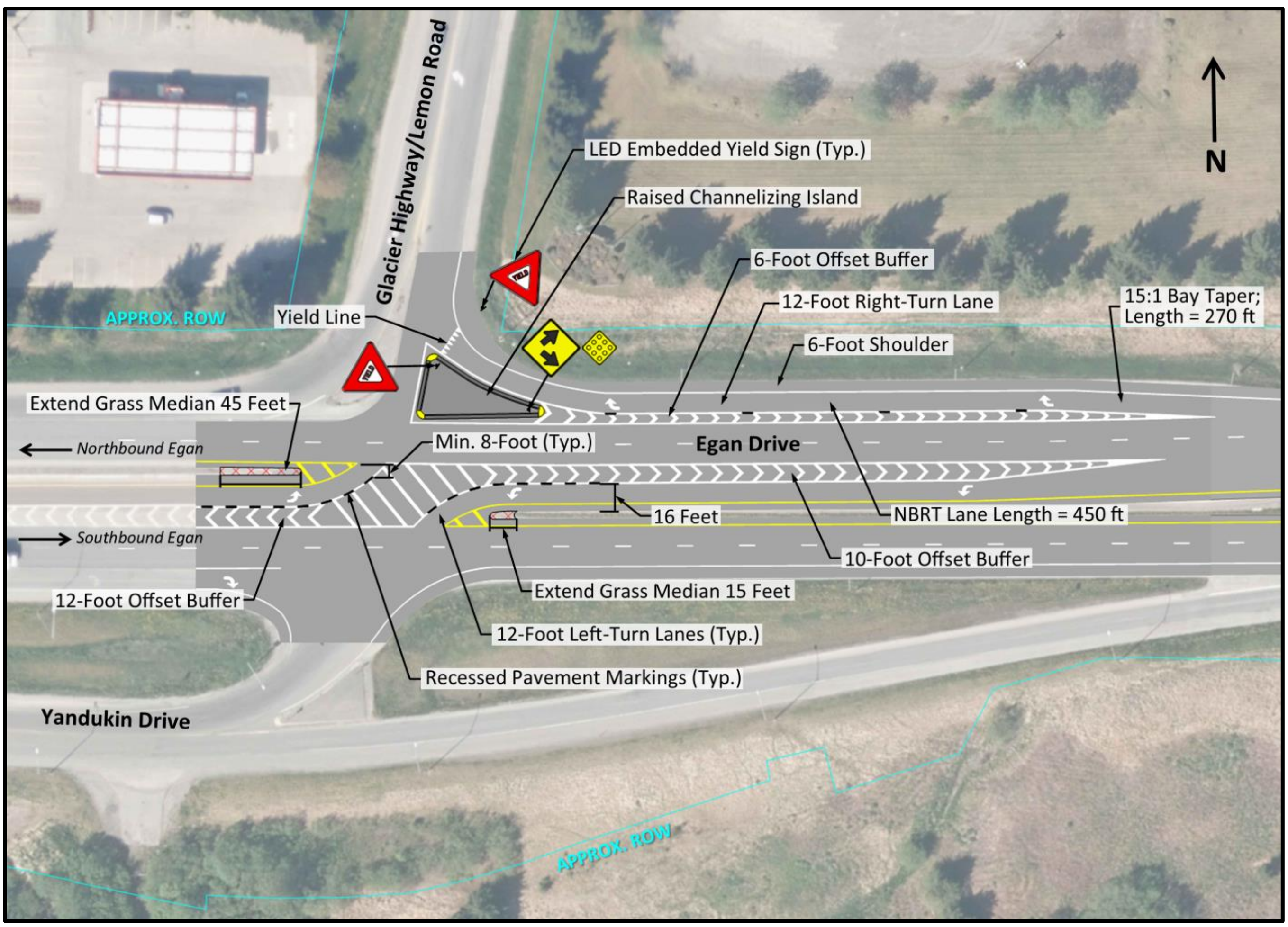

Figure 2. Intersection Improvement Concept

Design Features

Design features of the recommended interim improvement concept aid in alleviating the left-turn crash issue at the E-Y intersection. The concept assumes the existing pavement will be reused and excavation will not be required; therefore, no ROW, environmental, or utility impacts are expected. All traffic marking will be inlaid Methyl Methacrylate (MMA) paint for increased durability.

Seasonal Speed Reduction

Winter road conditions and opposing traffic speeds of 55 to 60 miles per hour (mph) affect a left-turning driver's ability to successfully navigate across the two through lanes at the intersection. Icy roads reduce the capability of a vehicle to accelerate and get across the opposing lanes in the expected timeframe. In addition, higher speeds of oncoming traffic lead to a shorter gap time between vehicles. Lowering the speed limit during winter months would increase the gap time between vehicles, making more time available for left-turning vehicles to successfully navigate through the intersection. The proposed treatment includes supplying regulatory and warning signs for seasonally changing the posted speed limit. It requires DOT&PF maintenance personnel to change the signs twice a year. It is also highly recommended to implement an educational campaign to raise awareness of and encourage compliance with this seasonal speed change. This treatment will also include purchasing two changeable message boards to remind drivers of the changed condition and aid in the educational component.

The existing speed limit through the E-Y intersection is 55 mph. The project team recommends reducing the speed to 45 mph during the winter months, from November 1st through January 31st. Reducing the speed limit provides three main benefits:

1. The time gap between oncoming vehicles becomes longer, which will provide more usable gaps.
2. The sight distance needed to judge a gap is reduced.
3. If a crash occurs, the crash is likely to be less severe.

The Alaska Department of Transportation and Public Facilities (DOT&PF) Policy and Procedure 05.05.020 states the following:

> "*As a general rule, no speed zone should be shorter than the distance traveled in 25 seconds at the posted speed limit.*"

With this guidance and using a 45-mph speed, the minimum reduced speed zone length is 1,650 feet. Centering this length on the E-Y intersection would optimize the reduced speed benefits for left-turning traffic in both northbound (NB) and southbound (SB) directions. Changing the speed limit 825 feet south of the intersection works well, since in the NB direction the speed change would occur after the on-ramps from the Sunny Point interchange, and in the SB direction the speed change would occur prior to the Sunny Point off-ramps. However, changing the speed limit 825 feet north of the E-Y intersection is not ideal. Ending the speed zone 825 feet north of the E-Y intersection would leave a 1-mile long stretch of roadway with a 55-mph speed limit between this proposed 45-mph section and the existing 50-mph section, north of Mendenhall Loop Road. To remedy this situation, it is recommended the seasonally reduced 45-mph speed zone be extended to Mendenhall Loop Road to avoid numerous speed transitions within a relatively short length of highway.

In the northbound direction, a "Reduced Speed Limit Ahead" warning sign would be placed in advance of the first 45-mph speed limit sign south of the intersection. However, based on the MUTCD[1] guidance stating "Reduced Speed Ahead" signs are only needed for speed differentials of 10 mph or greater, this warning sign will not be installed for the SB traffic north of the intersection. Additionally, the proposed speed change will occur right after a signalized intersection, where it is not uncommon to have speed changes. Electronic speed feedback signs will be installed at the speed limit signs just before the E-Y intersection as a reminder to drivers to be cognizant of their speed. Changeable message signs will be placed before each end of the reduced speed

[1] Section 2B.13 Guidance 09 and Section 2C.38 Guidance 01

zone during the winter months to inform drivers of the change. Figure 1 shows the proposed location of the reduced speed zone and the general location of the proposed signs.

Left-Turn Lane Median Striping with Recessed Pavement Markers

The existing geometry of the left-turn lanes at the E-Y intersection gives the perception that left turn vehicles should pause at the end of the existing median to wait for a gap in oncoming traffic. Median geometry and striping modifications at this opening could encourage turning vehicles to travel farther into the median before waiting for a gap, thus lining vehicles up better with the receiving lanes, reducing crossing distance, and improving sight distance. This treatment will extend the existing vegetated median and add pavement markings and recessed pavement markers to the median opening at the intersection, to help guide left-turning vehicles to pull further into the median opening to wait for a gap before making their turn.

There is adequate room within the intersection median opening to allow left-turning vehicles to safely yield closer to the opposing through lanes, and therefore, reduce the crossing distance. The existing vegetated median will be extended and painted traffic markings will be applied to the median opening to guide vehicles to a closer yielding point. In doing this, the left-turning vehicle will also be better aligned with the entry point of the cross street, minimizing confusion as to where to direct their vehicle. Inlaid MMA paint is recommended, to ensure that the markings remain visible as much as possible through the winter months. Recessed pavement markers will reinforce the markings when weather conditions make them more difficult to see. Figure 2 on page 2 shows a concept drawing of the treatments.

During the design phase, appropriate turning radii within the painted median should be verified.

Offset Northbound Right-Turn (NBRT) Lane with Recessed Pavement Markers

The project received public comments stating that southbound left-turning (SBLT) drivers have difficulty determining which lane the opposing NB vehicles occupy. In particular, the drivers sometimes perceive that an oncoming vehicle is in the right-turn lane when the vehicle is actually in a through lane. This misperception contributes to left-turn crashes. Separating the NBRT lane from the adjoining through lanes helps the SBLT driver discern between through and right-turning vehicles. Adding recessed pavement markers further enhances this discernment. This treatment includes utilizing the existing pavement as much as possible, constructing a raised channelizing island, restriping the NB approach to the intersection, adding recessed pavement markers, and installing a new oversized yield sign, augmented with LED flashing lights around the sign border.

Guidance for right-turn lane offsets is not widely available, and it is aimed toward increasing sight distance for a vehicle stopped at a minor cross street. The goal of this treatment at the E-Y intersection is to provide the drivers of SBLT vehicles more clarity in determining whether oncoming NB vehicles are in one of the through lanes or in the right-turn lane. Any offset would improve the visual cues for turning traffic. To maximize the offset distance while using the existing pavement width, and therefore, avoiding ROW, environmental, or utility impacts, the concept design reduces the offset for the NB left turn lane (from 14 feet to 10 feet), reduces the right shoulder (from 8 feet to 6 feet), and adds a 6-foot offset for the NBRT lane. Figure 3 shows the existing versus proposed cross section of the NB approach on Egan Drive. The NBRT offset will be delineated by pavement markings, which lead to a new raised channelizing island at the NBRT quadrant of the intersection. The raised channelizing island will follow a slip lane design to reinforce that the NBRT vehicles must yield to the SBLT vehicles.

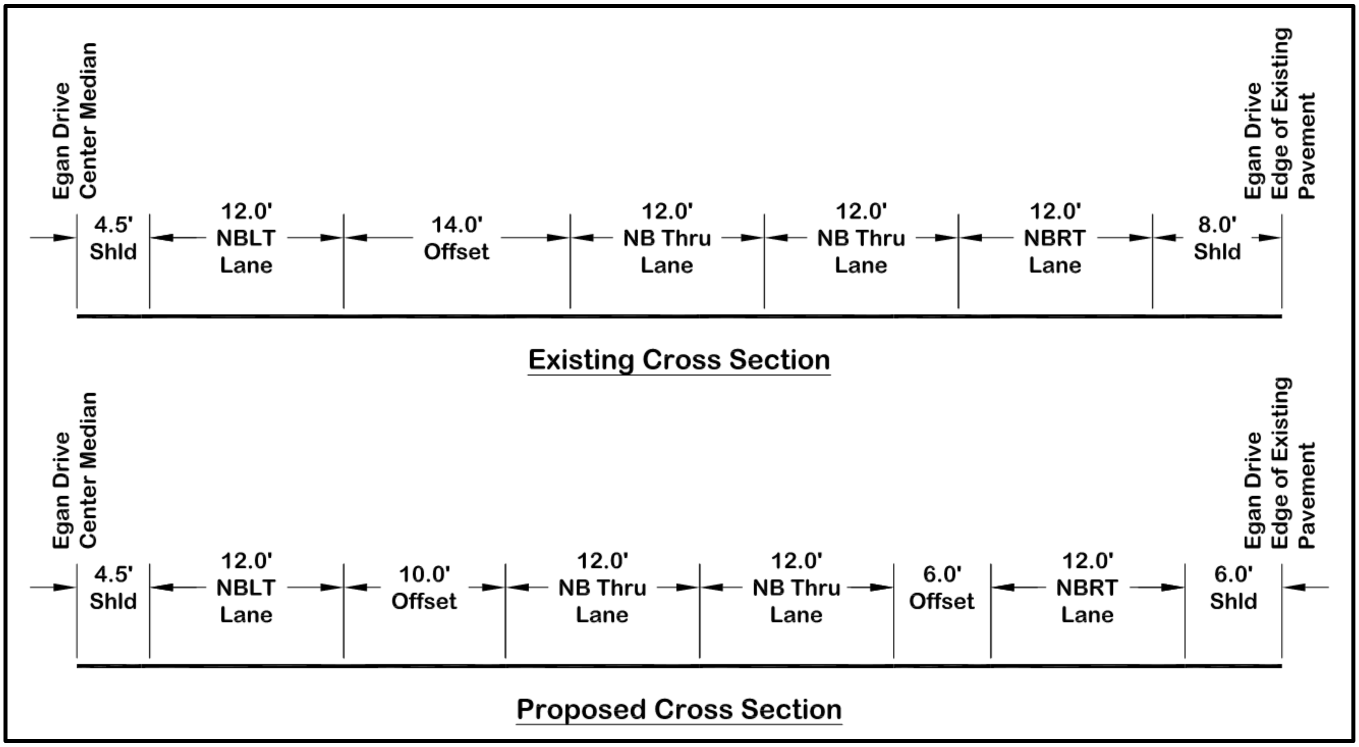

Figure 3. Existing vs Proposed Egan Drive NB Cross Section

Per the Alaska Highway Preconstruction Manual, Table 1150-1, unsignalized intersection turn lane lengths are calculated using NCHRP 457. Figure 2-9 of NCHRP 457 indicates a turn lane length of approximately 450 feet should be used for an operating speed of 60 mph[2]. The existing NBRT lane length appears to be approximately 375 feet; therefore, it is recommended to extend this lane by 75 feet. The taper length for the NBRT lane was calculated using the guidance from AASHTO's 2011 publication titled *A Policy on the Geometric Design of Highway and Streets*. With a six-foot lane offset and 15:1 (AASHTO) taper rate, the recommended taper length is 270 feet. Observation using Google Earth Street View suggest work to extend the NBRT lane to meet NCHRP 457 would not impact ROW, environmental areas, or utilities.

Safety Benefit

The purpose of the proposed safety improvements is to reduce the number and severity of crashes at the E-Y intersection. Between 2013 and 2016 there were 26 crashes at this intersection. The most frequent crashes were left-turn related angle crashes involving vehicles turning left on Egan Drive and colliding with oncoming Egan Drive through traffic. Left-turn related crashes are also the type of crashes that result in the highest severity. In the study period, there were two high severity crashes, all of which were related to northbound left-turn maneuvers from Egan Drive onto Yandukin Drive.

The recommended interim solutions were selected to directly reduce the risk of left-turn related angle crashes. The improvements may also have secondary benefits which will reduce the risk of crashes of other types and locations at or around the E-Y intersection.

Seasonal Speed Reduction

The seasonal speed reduction would reduce the speed limit for Egan Drive traffic from 55-mph to 45-mph through the E-Y intersection. The speed reduction would be active during the winter months when conditions make acceleration and deceleration more difficult and increases the gap times needed to make left-turn

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[2] 85th percentile speed for Egan Drive. See Interim Action Strategies Summary and Comparison, dated January 10, 2020.

maneuvers, which increases the risk of collisions. Reducing the speed of Egan Drive through traffic would increase the number of usable gaps for left turn drivers, encourage through drivers to be alert while approaching the upcoming intersection, and could reduce the severity of crashes that do happen.

The CRF for a 10-mph reduction in the posted speed limit is estimated at 7% based on published findings in the FHWA Desktop Reference for Crash Reduction Factors. This reduction is for all crash types and all severities.

Supplementing the changed speed limit signs with speed feedback signs and enforcement/education will be more effective. The effectiveness of speed feedback signs is well documented in the online Crash Modification Factors (CMF) Clearinghouse. The installation of changeable speed warning signs for individual drivers is a modification that has been shown to have the potential of reducing all crashes in the study area by 46% based on the Handbook of Road Safety Measures, 2004 documented in the CMF Clearinghouse. This reduction is further confirmed by the FHWA Desktop Reference for Crash Reduction Factors, which reports a similar 44% reduction in fatal crashes, and 22% reduction in injury crashes based on a 15% reduction in the mean speed. The mean speed of traffic on Egan Drive was found in a 2017 speed study to be approximately 60-mph. A 15% reduction would bring the mean travel speed down to 48-mph.

Note that both of the above cited studies included speed enforcement as a factor in the crash reduction. It is recommended that education and enforcement be included as elements of these solutions to achieve full benefit.

The combination of the seasonal speed reduction and the flashing speed feedback warning signs would result in an approximate net 50% reduction in all intersection crashes and severities.

Left-turn Lane Median Pavement Markings

The effectiveness of the proposed median pavement markings treatment is likewise not documented in any known studies. However, the improvement would adjust the lane lines in such a way that drivers could achieve a safe crossing in a shorter amount of time than in the current configuration. An estimate of the existing crossing distance determined that a 7 second gap was required to safely clear the intersection and avoid collision. The new design would feasibly reduce the needed gap to 5 seconds. Using data from a gap study conducted in 2017, the total amount of gap time of 7 seconds or greater that currently exists at the E-Y intersection was calculated. Using this same data set, decreasing the gap time to 5 seconds would increase the total amount of available gap time by approximately 10%. Therefore, it is estimated that the improvement would plausibly decrease the number of left-turn crashes by a CRF of 10%.

Offset Northbound Right-turn Lane

There are no published CRFs pertaining to the reduction in left-turn related crashes due to geometric modifications of an opposing right-turn lane. However, strong anecdotal evidence from public comments indicates that confusion between the location of traffic in these oncoming lanes is a contributing factor to SBLT crashes. It is estimated that the improvement could possibly reduce the SBLT related crashes of all severities by up to 20%. This estimate is based on an observation of the distribution of traffic on the NB approach that was made in November of 2017. In the critical PM peak hour, approximately 8% of the total oncoming traffic is in the right-turn lane with 40% in the outside NB through lane and the remaining 52% in either the inside through lane or the NBLT lane. The critical condition would be if a SBLT driver saw an oncoming car that they assumed was turning right and, based on this assumption, entered the roadway to discover that the oncoming car was actually in the outside through lane. Given the distribution of traffic, there is an 80% chance that a SBLT driver will encounter a situation where they could misinterpret a NB through vehicle in the outside lane as being in the right-turn lane. The assumption is that it is possible that a quarter of the oncoming vehicles in the outside lane would be misinterpreted in the existing design and the new design would eliminate the cause of that misjudgment, resulting in a 20% reduction in the risk of crashes.

In addition to the crash reduction for left-turn related crashes with NB through vehicles, there would be a secondary benefit of a reduction in crashes between left-turn vehicles and right-turn vehicles at the end of the right-turn exit ramp. CRFs of 59%, for all severities, are published in the CMF Clearinghouse for similar design upgrades as those proposed (CMF ID 8430- Improve angle of channelized right turn lane).

Total Safety Benefit

The total safety benefit for the improvements was calculated using the CRFs discussed above applied to a data set of crashes from 2013 to 2016 at the E-Y intersection. Crash cost data is determined per crash severity type and is published in the 2020 HSIP Handbook.

The combined crash benefit for all the improvements is estimated to be $2,832,000. Table 3 on page 8 shows a breakdown of the crash cost savings for the combined improvement. Note that crash reduction values are cumulative and are applied to the total number of crashes still remaining after the previous reduction has been computed. The crash reductions are applied in order starting at the top of the table and proceeding down.

Table 3. Total Crash Cost Savings

Improvement	Crash Reduction Factors	Reduced Crashes		Cost Per Crash by Severity	Cost Savings	Total Cost Savings per Improvement
		Severity	Crashes			
Left-turn Lane Median Striping	10% Left-Turn Crashes	PDO	0.3	$21,800	$6,540	**$421,040**
		Minor	0.4	$218,000	$87,200	
		Major	0.3	$1,091,000	$327,300	
Offset Northbound Right-turn Lane	20% Left-Turn Crashes, 59% Right-Turn Crashes	PDO	1.1	$21,800	$24,634	**$310,214**
		Minor	1.3	$218,000	$285,580	
		Major	0.0	$1,091,000	$0	
Seasonal Speed Reduction	50% All Crashes	PDO	7.8	$21,800	$168,966	**$2,100,888**
		Minor	2.1	$218,000	$465,553	
		Major	1.3	$1,091,000	$1,466,369	
					TOTAL Cost Savings	**$2,832,000**

Southbound Left-Turn Related Crash Severity

In the study period from 2013 to 2016 there were 11 southbound left-turn related crashes at the E-Y intersection. Four of these crashes resulted in Property-Damage Only (PDO) crash severity and 7 resulted in a minor injury. No major injury crashes were reported during the study period relating to this movement. However, there is an injury crash concern for the southbound left-turn movement based on the number of minor injuries during the study period and the frequency of major injuries prior to the study period.

There is a higher than expected number of minor injury crashes relating to the southbound left turn movement. A statistical comparison of the severity frequencies for the southbound left-turn crashes and all of the other 275 crashes in the vicinity of the E-Y intersection showed that the expected severity of crashes would be 70% PDO, 28% Minor Injury, and 2% Major Injury. The distribution of severities within the study area are statistically similar to the crash severities of all crashes in the Juneau area. The frequency of minor injury crashes involving southbound left-turn movement is therefore much higher than the expected value, with fewer crashes resulting in both PDO and major injuries.

Figure 4 below shows a comparison of the severity frequencies for southbound left-turn related crashes at the E-Y intersection compared to the severity of other crashes in the study area and also the average of all crashes in the whole Juneau Area using data from the 2013 through 2017.

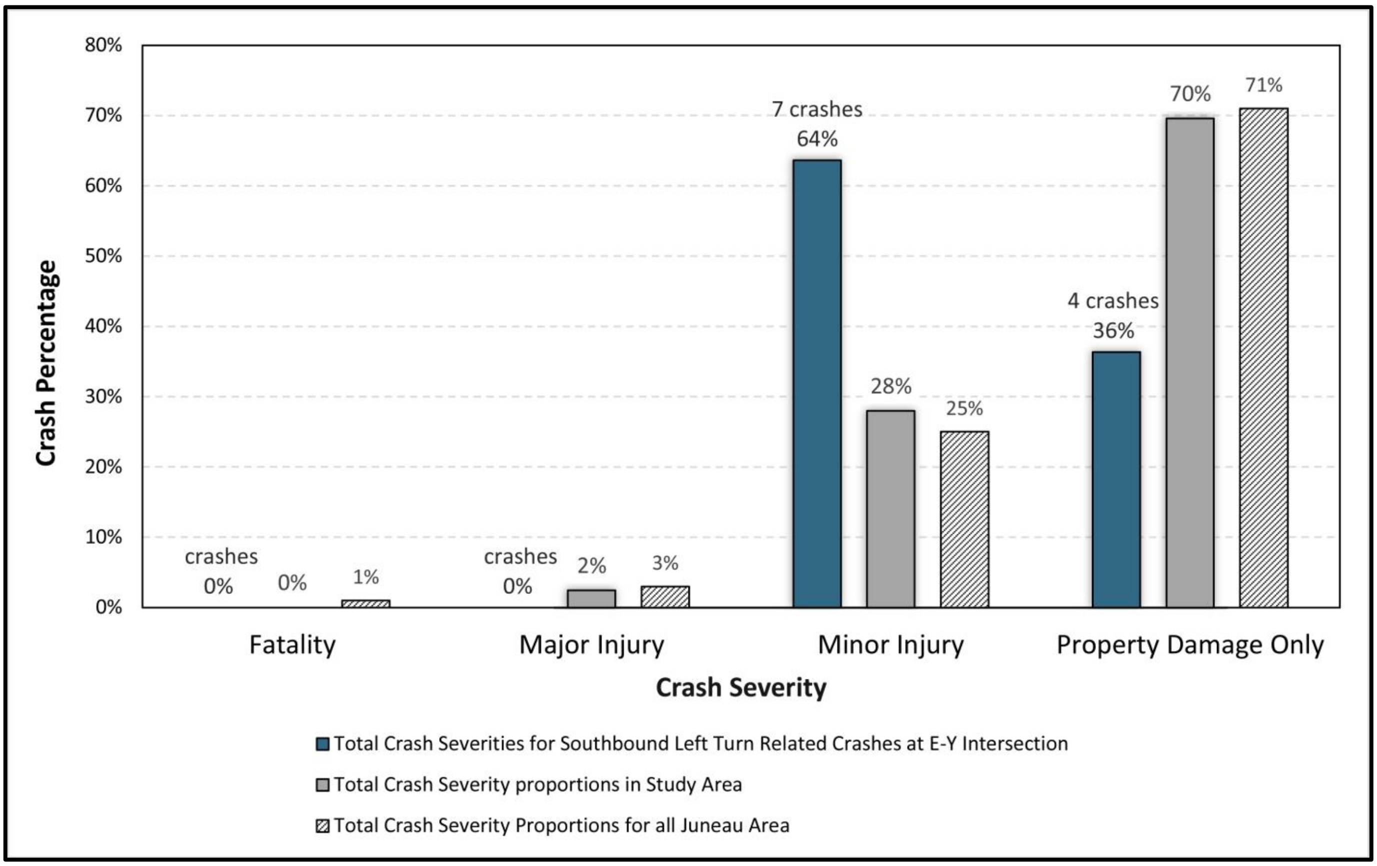

Figure 4. Crash Severity Comparison

The number of minor injury crashes is significantly higher than average for the southbound left-turn movement at the E-Y intersection. This means that when a crash of this type occurs it is much more likely to result in an injury compared to other crashes both in the study area and in general.

Other Crash Considerations

Pre-2013 and Post-2016 Severe Crash History

The claim that a high severity crash issue exists at the E-Y intersection related to southbound left-turn movements is further reinforced by historical crash frequencies which were reported prior to the study period discussed above. Between 2007 and 2012 there were 2 major injury crashes involving vehicles making the southbound left-turn movement and 6 minor injury crashes. This means that 25% of the southbound left-turn injury crashes in the past were major injury. It is possible, due to the random nature of crash severity, that a distribution similar to historical rates could feasibly have occurred between 2014 and 2016. If this had happened, two of the minor injury crashes would have instead resulted in major injuries. If this had happened the total benefit of the proposed improvements would increase from $2,830,000 to $3,900,000.

Additionally, published crash data from 2017 indicates that high severity crash risk still exists beyond the years included in the HSIP study period. Four out of the ten reported accidents at the E-Y intersection in 2017 were minor injury crashes, all of which were related to left-turns, with three involving southbound left turns and one northbound left turn.

It is evident from the available data discussed above that major injury crashes are likely to occur in the future due to the southbound left-turn movement on Egan Drive. Since no major crashes have occurred yet in the 2013 to 2016 study period, the benefits of the proposed mitigations are likely understated in this report when considering the left turn movement.

Other Crash Reductions in the Area Based on Improvements

The seasonal speed reduction zone proposed for this project would extend through the corridor slowing traffic at the adjacent Egan Drive intersections and road segments. This means that the benefits of the improvement would extend to the Egan Drive intersection at Glacier Highway/Nugget, which had 34 reported crashes between 2013 and 2016, one of which was a major injury crash and 10 were minor injury. A 50% reduction in the crashes at this intersection could increase the cost benefit of the improvement by $2,000,000.

Cost Estimate

The preliminary estimate of the cost to complete this interim improvement concept are shown below:

Speed Reduction		Median Treatment		Offset NBRT Lane	
Phase 2 Design	$ 70,000	Phase 2 Design	$ 60,000	Phase 2 Design	$ 50,000
Phase 3 Right-of-Way	$ 0	Phase 3 Right-of-Way	$ 0	Phase 3 Right-of-Way	$ 0
Phase 4 Construction	$ 450,000	Phase 4 Construction	$ 410,000	Phase 4 Construction	$ 330,000
Phase 7 Utilities	$ 0	Phase 7 Utilities	$ 0	Phase 7 Utilities	$ 0
TOTAL	$ 520,000	TOTAL	$ 470,000	TOTAL	$ 380,000
Interim Improvement Grand Total			**$ 1,370,000**		

Due to the minor amount of impacts with no ROW, environmental or utility impacts, it is anticipated this project would take 9 months to design and 3 months to construct.

Benefit/Cost Ratio: 2.1:1