Appendix B
Traffic Analysis Memo

KINNEY ENGINEERING, LLC

MEMORANDUM

TO: Marc Frutiger, PE
Jason Osburn, PE

FROM: Jeanne Bowie, PE
Shelley Giraldo

DATE: 9 October 2017

SUBJECT: Midtown Corridor Improvements, Denali Street and Area – Benson Blvd to Tudor Road (16-28)

Kinney Engineering, LLC (KE) has been retained as a subcontractor to R&M Consultants, Inc (R&M), by the Municipality of Anchorage (MOA) to perform traffic analyses to assist in proposing and evaluating alternatives to upgrade Denali Street and 36th Avenue to accommodate all users. KE has prepared this memo to inform the R&M Concept Report.

1 Crashes by Location 2010 – 2014

Table 1 through Table 22 list crashes by location and type within the study area for the years 2010 – 2014. Crash types are defined as Fatal, Major Injury, Minor Injury, or Property Damage Only (PDO). Crashes involving pedestrians or bicyclists are highlighted in blue. Segments or intersections with crash rates that are statistically above the average for similar facilities are highlighted in yellow. Two fatal crashes occurred in the study area: one pedestrian crash between Northern Lights Boulevard and Benson Boulevard, and one right angle crash at the intersection of 40th Avenue and Denali Street.

Table 1. Crashes at Intersection of Denali Street and Northern Lights Boulevard

Crash Type	Fatal	Major	Minor	PDO	Total
Head on/Left Turn			1	3	4
Pedestrian			2		2
Rear End/Backing			6	10	16
Right Angle			6	5	11
Sideswipe			3	13	16
Struck Object				1	1
Total	**0**	**0**	**18**	**32**	**50**

Table 2. Crashes on Denali Street: Segment from Northern Lights Boulevard to Benson Boulevard

Crash Type	Fatal	Major	Minor	PDO	Total
Pedestrian	1		1		2
Right Angle			1	3	4
Sideswipe				1	1
Total	**1**		**2**	**4**	**7**

Table 3. Crashes at Intersection of Denali Street and Benson Boulevard

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle			1		1
Left Turn			1	3	4
Pedestrian		2	4		6
Rear End/Backing		1	7	28	36
Right Angle		1	7	13	21
Sideswipe			5	11	16
Struck Object				1	1
Total	**0**	**4**	**25**	**56**	**85**

Table 4. Crashes on Denali Street: Segment from Benson Boulevard to Calais/33rd Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Right Angle			2		2
Sideswipe			1		1
Total			**3**		**3**

Table 5. Crashes at Intersection of Denali Street and 32nd Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle		1			1
Right Angle			5	5	10
Struck Object				1	1
Total		**1**	**5**	**6**	**12**

Table 6. Crashes at Intersection of Denali Street and Calais/33rd Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle			1		1
Head on				1	1
Left Turn			4	2	6
Pedestrian			1		1
Rear End/Backing			1	3	4
Right Angle			5	3	8
Sideswipe				1	1
Struck Object				4	4
Total			**12**	**14**	**26**

Table 7. Crashes on Denali Street: Segment from Calais/33rd Avenue to 36th Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Left Turn				1	1
Right Angle				1	1
Sideswipe				1	1
Struck Object			1		1
Total			**1**	**3**	**4**

Table 8. Crashes at Intersection of Denali Street and 34th Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Rear End/Backing			3	5	8
Right Angle			5	6	11
Struck Object				1	1
Total			**8**	**12**	**20**

Table 9. Crashes at Intersection of Denali Street and 36th Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Head on				3	3
Left Turn			5	8	13
Pedestrian			1	1	2
Rear End/Backing			9	21	30
Right Angle			5	13	18
Sideswipe				5	5
Struck Object				2	2
Unknown				1	1
Total			**20**	**54**	**74**

Table 10. Crashes on Denali Street: Segment from 36th Avenue to Telephone Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Rear End/Backing			2		2
Total			**2**		**2**

Table 11. Crashes at Intersection of Denali Street and Telephone Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Rear End/Backing			1	4	5
Right Angle			3	1	4
Sideswipe				1	1
Struck Object				2	2
Total			**4**	**8**	**12**

Table 12. Crashes on Denali Street: Segment from Telephone Avenue to 40th Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Rear End/Backing				1	1
Total				**1**	**1**

Table 13. Crashes at Intersection of Denali Street and 40th Avenue

Crash Type	Fatal	Major	Minor	PDO	Total
Left Turn			2	5	7
Rear End/Backing				2	2
Right Angle	1	1	5	12	19
Sideswipe				2	2
Total	**1**	**1**	**7**	**21**	**30**

Table 14. Crashes on Denali Street: Segment from 40th Avenue to Tudor Road

Crash Type	Fatal	Major	Minor	PDO	Total
Left Turn				2	2
Rear End/Backing			1	1	2
Right Angle		1	4	4	9
Sideswipe			1	1	2
Struck Object				1	1
Total		**1**	**6**	**9**	**16**

Table 15. Crashes at Intersection of Denali Street and Tudor Road

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle				1	1
Head on			1	2	3
Left Turn			5	5	10
Pedestrian		1	1		2
Rear End/Backing			6	14	20
Right Angle			1	7	8
Sideswipe				2	2
Struck Object				3	3
Total		**1**	**14**	**34**	**49**

Table 16. Crashes at Intersection of 36th Avenue and C Street

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle			1		1
Left Turn			2	2	4
Pedestrian		1	1		2
Rear End/Backing		1	8	18	27
Right Angle		1	22	8	31
Sideswipe			2	8	10
Struck Object				1	1
Total		**3**	**36**	**37**	**76**

Table 17. Crashes on 36th Avenue: Segment from C Street to A Street

Crash Type	Fatal	Major	Minor	PDO	Total
Pedestrian			1		1
Struck Object				1	1
Total			**1**	**1**	**2**

Table 18. Crashes at Intersection of 36th Avenue and A Street

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle		1	3		4
Left Turn			5	5	10
Rear End/Backing		1	4	17	22
Right Angle		1	16	15	32
Sideswipe			1	8	9
Struck Object				1	1
Total		**3**	**29**	**46**	**78**

Table 19. Crashes on 36th Avenue: Segment from A Street to Denali Street

Crash Type	Fatal	Major	Minor	PDO	Total
Rear End/Backing			2	1	3
Sideswipe				1	1
Struck Object			1		1
Total			**3**	**2**	**5**

Table 20. Crashes at Intersection of 36th Avenue and Barrow Street

Crash Type	Fatal	Major	Minor	PDO	Total
Left Turn				2	2
Rear End/Backing			2	3	5
Right Angle			1	6	7
Struck Object				1	1
Total			**3**	**12**	**15**

Table 21. Crashes on 36th Avenue: Segment from Denali Street to Old Seward Highway

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle			1		1
Rear End/Backing				1	1
Sideswipe			1	1	2
Struck Object				2	2
Total			**2**	**4**	**6**

Table 22. Crashes at Intersection of 36th Avenue and Old Seward Highway

Crash Type	Fatal	Major	Minor	PDO	Total
Bicycle			4	1	5
Head on			1	1	2
Left Turn		1	4	11	16
Rear End/Backing			5	22	26
Right Angle		1	4	7	12
Sideswipe			1	8	9
Struck Object				1	1
Total		**2**	**19**	**51**	**72**

Table 23 summarizes crashes involving bicyclists and pedestrians within the study area.

Table 23. Crashes involving Bicyclists and Pedestrians

Intersections	**Bicycle Crashes**	**Pedestrian Crashes**	**Total Crashes**
Benson Boulevard & Denali Street	1	6	7
Old Seward Highway & 36th Avenue	5	0	5
A Street & 36th Avenue	4	0	4
C Street & 36th Avenue	1	2	3
Tudor Road & Denali Street	1	2	3
33rd Avenue/Calais Drive & Denali Street	1	1	2
Denali Street & 36th Avenue	0	2	2
Northern Lights Boulevard & Denali Street	0	2	2
32nd Avenue & Denali Street	1		1
Sub Total	**14**	**15**	**29**
Segments	Bicycle Crashes	Pedestrian Crashes	Total Crashes
Denali Street: Northern Lights Boulevard to Benson Boulevard	0	2	2
36th Avenue: C Street to A Street	0	1	1
36th Avenue: Denali Street to Old Seward Highway	1	0	1
Sub Total	**1**	**3**	**4**
Total Sum of Crashes	**15**	**18**	**33**

2 Speed Studies

KE performed speed studies along Denali Street and 36th Avenue within the study area, as summarized in Table 24. Speed studies showed that speeds on 36th Avenue are generally consistent with the 40 mph speed limit. However, on Denali Street the 85th percentile speeds on all segments exceed the posted speed limit of 35 mph by up to 6 mph. The 85th percentile speed on Denali Street between 40th Avenue and Tudor Road, the fastest segment, is 41 mph.

Table 24. Summary of Speed Studies

Denali Street Segment	**Northbound**		**Southbound**		**Posted Speed Limit (mph)**
	10 mph Pace	**85th % Speed (mph)**	**10 mph Pace**	**85th % Speed (mph)**	
Denali Street: Benson Boulevard to 36th Avenue	32 to 41	38	31 to 40	39	35
Denali Street: 40th Avenue to Tudor Road	32 to 41	41	31 to 40	39	35
Denali Street: At Communications Avenue	29 to 38	36	31 to 40	35	35
36th Avenue Segment	**Eastbound**		**Westbound**		**Posted Speed Limit (mph)**
	10 mph Pace	**85th % Speed (mph)**	**10 mph Pace**	**85th % Speed (mph)**	
36th Avenue: At Loussac Library	32 to 41	39	32 to 40	38	40
36th Avenue: At McDonald's	34 to 43	41	34 to 43	42	40

3 Sight Distance

Stopping sight distance (SSD) is the distance a vehicle travels in the time it takes for a driver to see an object in the road ahead and bring the vehicle to a complete stop. Because the roads have few horizontal or vertical curves, it is assumed that SSD is met along Denali Street and 36th Avenue. Therefore, SSD was not measured.

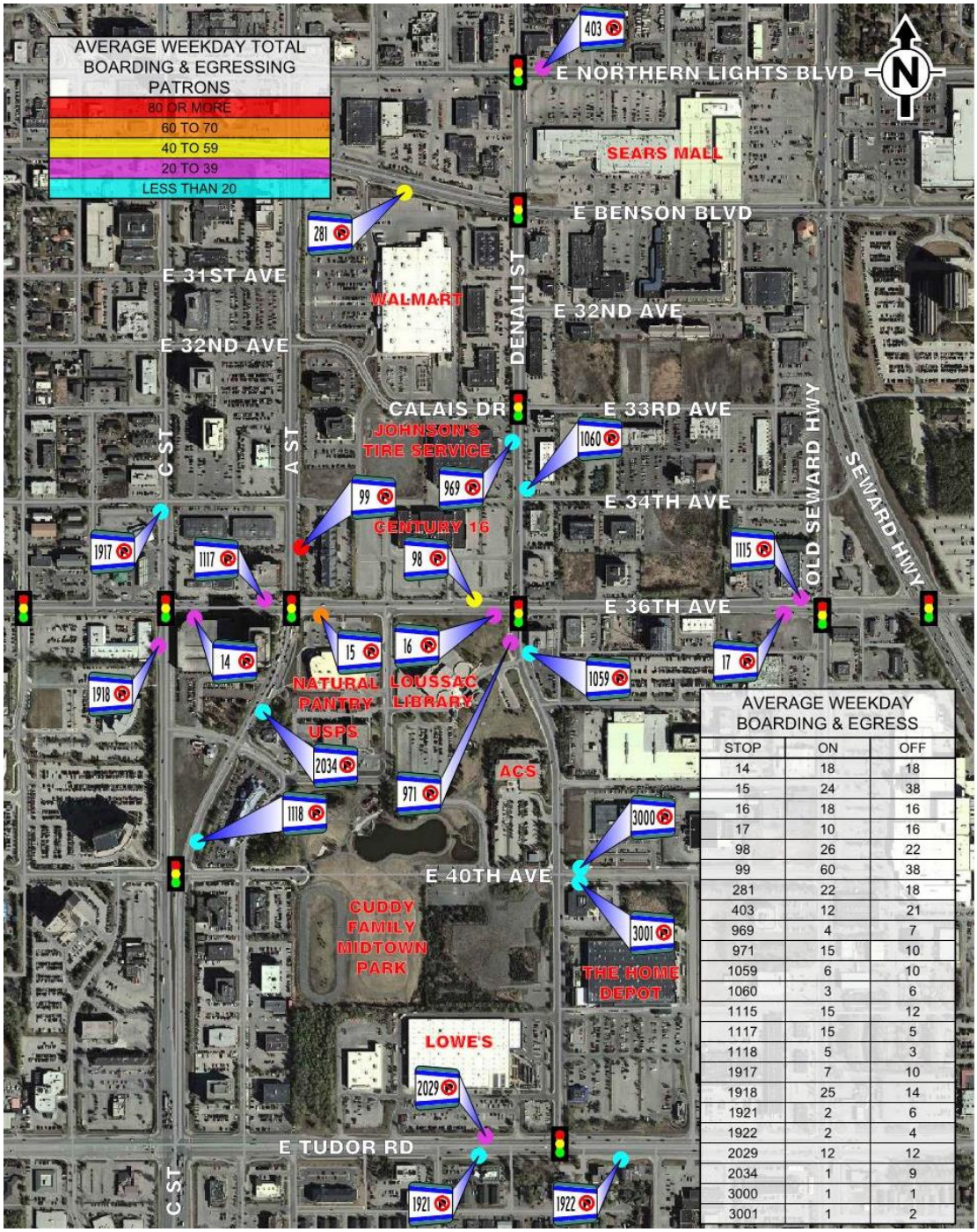
Intersection Sight Distance (ISD) is the distance that a vehicle driver on a minor road needs to be able to see in order to enter the traffic stream on a major road without causing the major road traffic to slow down in response. While ISD is desired to improve operations, it is not required for safety. ISD is calculated using the methodology in AASHTO's *A Policy on Geometric Design of Highways and Streets (PGDHS).* KE measured ISD at each unsignalized intersection in the study area and compared these measurements to calculated ISD values, as shown in Table 25. Cells highlighted in pink indicate movements where the measured ISD is less than desired; at these locations drivers on the side streets may have trouble seeing far enough down the road to feel comfortable. Some locations have sight distances blocked by bushes and trees; maintenance of the bushes and trees may increase ISD to the desired levels.

Table 25. Intersection Sight Distance

Minor Road	Major Road	Looking to the Left (Minor Road onto Major Road)			Looking to the Right (Minor Road onto Major Road)		
		Measured ISD (feet)	Desired ISD (feet)	Obstruction	Measured ISD (feet)	Desired ISD (feet)	Obstruction
32nd Avenue	Denali Street	>375	375	-	337	475	Bush
34th Avenue Eastbound	Denali Street	>375	375	-	>475	475	Queued Vehicles
34th Avenue Westbound	Denali Street	279	375	Business Sign	308	475	Tree
Telephone Avenue	Denali Street	>335	335	-	360	465	Queued Vehicles
40th Avenue Eastbound	Denali Street	>375	375	-	415	485	Bushes and Tall Grass
40th Avenue Westbound	Denali Street	>375	375	-	>485	485	-
Home Depot Driveway	Denali Street	278	375	Trees	238	485	Trees
Lowe's Driveway	Denali Street	267	375	Trees	273	485	Trees
Barrow Street	36th Avenue	>375	375	-	-	-	-

4 Transit Activity

Heavy transit activity occurs in the study area. Average weekday ridership volumes are presented in Figure 1. The greatest number of transit patrons are concentrated near the intersections of A Street and Denali Street with 36th Avenue. Stop 99, northeast of the 36th Avenue and A Street intersection, experiences the greatest average volume within the study area, approximately 98 patrons per weekday. Once the transit routes change in October 2017, most bus stops within the study area on Denali Street and 36th Avenue will be removed. This may increase pedestrian and bicycle volumes as transit patrons are likely to traverse the study area to access bus stops or other destinations.



AVERAGE WEEKDAY BOARDING & EGRESS

STOP	ON	OFF
14	18	18
15	24	38
16	18	16
17	10	16
98	26	22
99	60	38
281	22	18
403	12	21
969	4	7
971	15	10
1059	6	10
1060	3	6
1115	15	12
1117	15	5
1118	5	3
1917	7	10
1918	25	14
1921	2	6
1922	2	4
2029	12	12
2034	1	9
3000	1	1
3001	1	2

Figure 1. Transit Volumes

5 Pedestrian Delay

KE calculated pedestrian delay for signalized and unsignalized crossings within the study area. The methodology for determining pedestrian crossing delay and level of service (LOS) is different for signalized crossings than for unsignalized crossings. The *Highway Capacity Manual* (HCM) indicates that pedestrians have greater tolerance for delay at signalized intersections than at unsignalized intersections. Additionally, LOS scores for signalized intersections take performance measures, intersection characteristics, and pedestrian delay into account, while LOS scores for unsignalized intersections only reflect pedestrian delay.

Table 26 depicts projected pedestrian delays and LOS for signalized intersections within the study area at the midday peak hour. Existing and projected future pedestrian delays and associated LOS at signalized intersections are considered acceptable, with a LOS C or better.

Table 26. Future Pedestrian Delays and Levels of Service for Signalized Intersections – Midday Peak Hour

Crossing Location Denali Street	Average Pedestrian Delay (sec)	Average Intersection PED LOS	HCM 2010 LOS
36th Avenue and Old Seward Highway	59	2.86	C
36th Avenue and A Street	53	2.62	B
36th Avenue and C Street	61	2.85	C
Denali Street and 36th Avenue	45	2.78	C
Denali Street and 33rd Avenue	61	2.55	B
Denali Street and Benson Boulevard	52	2.86	C
Denali Street and Northern Lights Boulevard	51	2.70	B
Denali Street and Tudor Road	40	3.00	C

For existing and future pedestrian delays and LOS for unsignalized intersections and unmarked crossing locations, the results are very unfavorable (mostly LOS F), as presented in Table 27 and Table 28.

Table 27. Existing Pedestrian Delays and Levels of Service at Unmarked Crossings on Denali Street – PM Peak Hour

	Existing		Future	
Unmarked Crossing Location Denali Street	**Pedestrian Delay (sec)**	**LOS**	**Pedestrian Delay (sec)**	**LOS**
Northern Lights Boulevard to Benson Boulevard	> 45	F	> 45	F
Benson Boulevard to 32nd Avenue	> 45	F	> 45	F
32nd and Denali	> 45	F	> 45	F
32nd Avenue to 33rd Avenue/Calais Drive	> 45	F	> 45	F
33rd Avenue to 34th Avenue	> 45	F	> 45	F
34th and Denali	> 45	F	> 45	F
34th Avenue to 36th Avenue	> 45	F	> 45	F
36th Avenue to Telephone Avenue	30-45	E	> 45	F
Telephone and Denali	> 45	F	> 45	F
Telephone Avenue to Communications Avenue	10-20	C	30-45	E
Denali and Communications	> 45	F	> 45	F
Communications Avenue to 40th Avenue	> 45	F	> 45	F
Denali and 40th Avenue (Unmarked)	> 45	F	> 45	F
40th Avenue to Box Stores	> 45	F	> 45	F
Denali and Box Stores	> 45	F	> 45	F
Box Stores to Tudor Road	> 45	F	> 45	F

Table 28. Future Pedestrian Delays and Levels of Service at Unsignalized Intersections on Denali Street - PM Peak Hour

	Existing		Future	
Unmarked Crossing Location 36th Avenue	**Pedestrian Delay (sec)**	**LOS**	**Pedestrian Delay (sec)**	**LOS**
C Street to A Street	> 45	F	> 45	F
A Street to Barrow Street	> 45	F	> 45	F
Barrow Street and 36th Avenue	> 45	F	> 45	F
Barrow Street to Denali Street	> 45	F	> 45	F
Denali Street to Old Seward Highway	> 45	F	> 45	F

Pedestrian delay calculated at unsignalized intersections using the HCM methodology assumes that vehicles arrive at the crossing location randomly, and does not take into account the platooning characteristics of the corridor. KE's observations indicate that the signals on both corridors provide some gaps that are long enough for pedestrians to cross.

To more accurately characterize pedestrian activity in the study area, KE conducted midday and PM peak hour gap studies at the two unsignalized locations where the highest number of pedestrians crossing were observed: the intersections of 36th Avenue and Barrow Street and Denali Street and 40th Avenue (see Section 6). Since field observations indicate that many pedestrians walk very quickly when crossing at unsignalized intersections, KE calculated the critical gap and resulting gaps per minute for both crossing locations utilizing walking speeds of 3.5 ft/sec and 6.0 feet/sec, as shown in Figure 2 through Figure 5. The *Manual on Uniform Traffic Control Devices* (MUTCD) standard walking speed is 3.5 ft/sec, which represents about the 15th percentile walking speed. For school crossings, the MUTCD Section 4C.06 recommends considering a traffic control signal when the number of adequate gaps in the traffic stream is less that the number of minutes in the same period. This recommendation has become a rule of thumb: one or more gaps per minute is considered acceptable. If pedestrians walk 6.0 ft/sec, Denali and 40th has an acceptable number of gaps per minute. However, if pedestrians walk 3.5 ft/sec, the gap study confirms that the pedestrian LOS is still F.

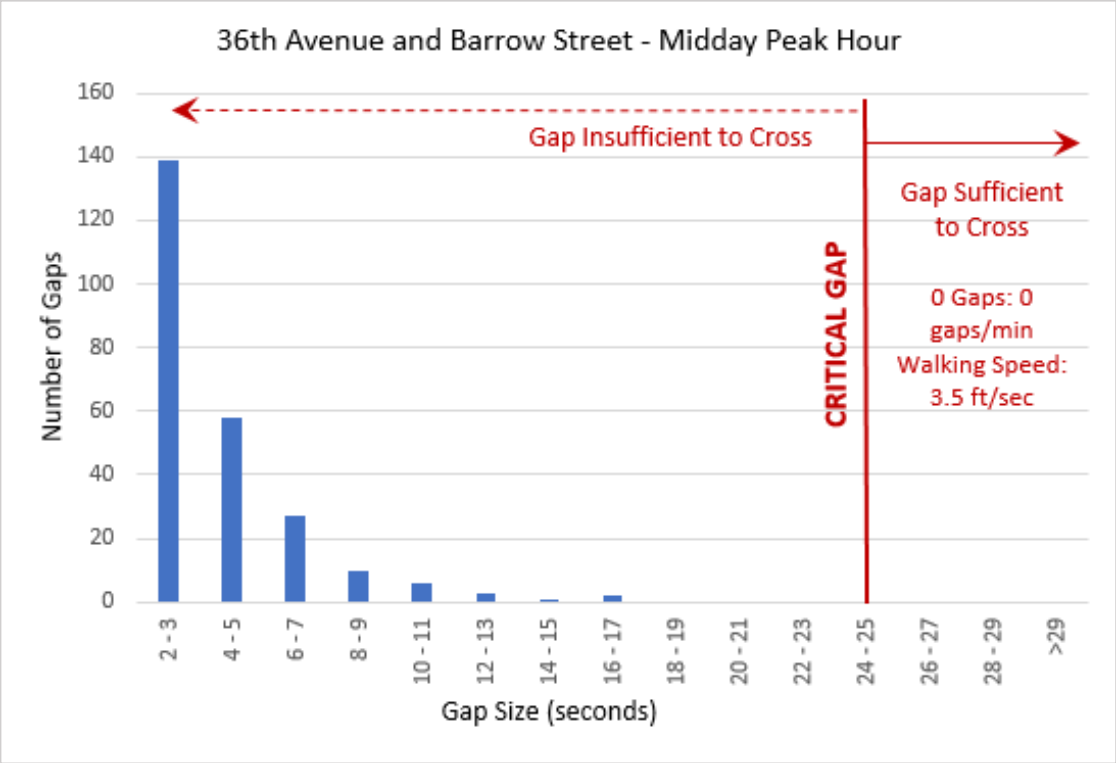


Figure 2. 36th Avenue and Barrow Street (3.5 ft/sec)

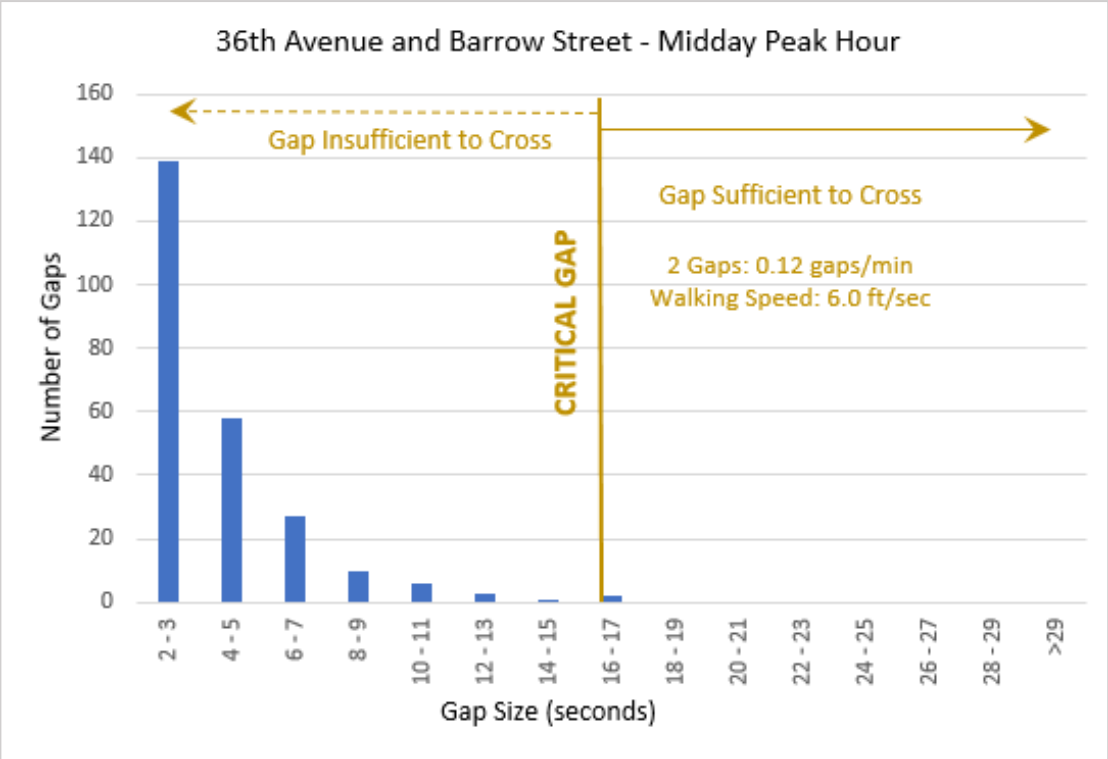


Figure *3*. 36th Avenue and Barrow Street (6.0 ft/sec)

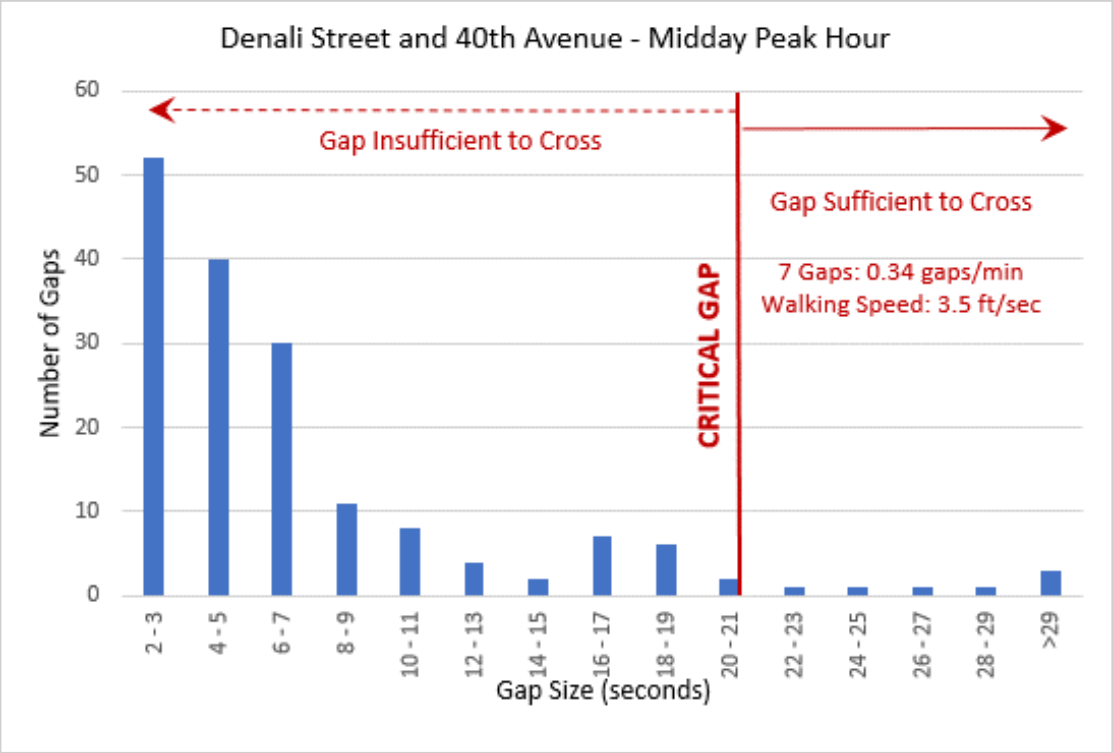


Figure 4. Denali Street and 40th Avenue (3.5 ft/sec)

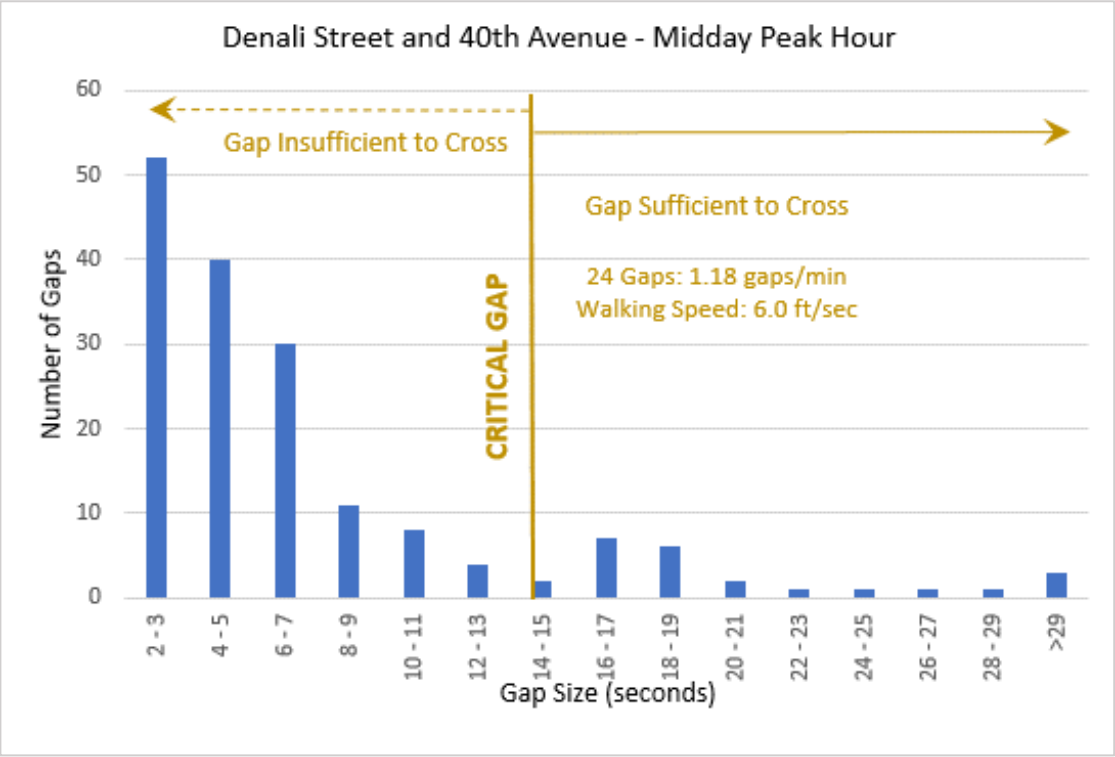


Figure 5. Denali Street and 40th Avenue (6.0 ft/sec)

6 Pedestrian Crossing Volumes

At each intersection in the study area, KE collected pedestrian volumes. Table 29 shows that the highest total number of observed pedestrian crossings at unsignalized intersections occurred at two intersections: Denali Street and 40th Avenue and 36th Avenue and Barrow Street.

Table 29. Pedestrian Crossings at Unsignalized Intersections

Unsignalized Crossing Location		Number of Pedestrians			
Crossing Major Street	At Minor Street	7:00 am to 8:45 am	11:00 am to 12:45 pm	4:00 pm to 5:45 pm	SUM
Denali Street	32nd Avenue	2	5	12	19
Denali Street	34th Avenue	10	0	4	14
Denali Street	40th Avenue	14	10	24	48
Denali Street	Telephone Avenue	0	2	1	3
Denali Street	Communications Avenue	0	3	0	3
Denali Street	Lowe's and Home Depot	1	7	4	12
36th Avenue	Barrow Street	6	8	37	51

At these locations, pedestrian crossing treatments could be considered. At all other unsignalized crossings, hourly pedestrian volumes are less than 20 pedestrians per hour.

7 Forecasted Vehicle Volumes

KE projected average annual traffic volumes for all road segments within the study area as depicted in Table 30.

Table 30. Projected 2045 AADT

Street	Segment From	Segment To	2045 AADT
Denali Street	Fireweed Lane	Northern Lights Boulevard	4,937
	Northern Lights Boulevard	Benson Boulevard	14,037
	Benson Boulevard	Calais Drive/33rd Avenue	17,612
	Calais Drive/33rd Avenue	36th Avenue	17,963
	36th Avenue	Telephone Avenue	15,087
	Telephone Avenue	40th Avenue	14,051
	40th Avenue	Tudor Road	13,895
36th Avenue	Arctic Boulevard	C Street	15,303
	C Street	A Street	19,166
	A Street	Denali Street	23,891
	Denali Street	Old Seward Highway	21,042
	Old Seward Highway	New Seward Highway	23,450

8 Potential for Pedestrian and Bicycle Treatments

There is interest in improving the pedestrian and bicycle infrastructure in the study area. One option that has been suggested is to convert the typical section from a 4-lane undivided roadway to a 3-lane roadway (one lane each direction with a center two-way-left-turn lane) and to convert the right-of-way to pedestrian or bicycle amenities.

FHWA had provided guidelines for determining whether or not a roadway is a candidate to be converted to a three-lane roadway based on traffic volumes, as shown in Table 31. Due to the higher traffic volumes, converting 36th Avenue from a 4-lane to a 3-lane road with bicycle amenities is likely not feasible (listed as a "possible candidate," with a feasibility study

needed). However, a 3-lane option is still a possibility for Denali Street or portions of Denali Street (listed as an "often good" or "sometimes good" candidate, with a need for an intersection or corridor analysis).

Table 31. Candidate Guidelines from FHWA for Conversion to 3-Lane

Volume	Candidacy	Recommended Analysis
Less than 10,000 ADT	Great Candidates	Capacity will most likely not be affected
10,000 – 15,000 ADT	Often Good Candidates	Intersection analysis; signal retiming
15,000 – 20,000 ADT	Sometimes Good Candidates	Corridor analysis
More than 20,000 ADT	Possible Candidate	Feasibility study

Longitudinal options for converting one of the traffic lanes on Denali Street to be used for bicycle or pedestrian amenities could include wider sidewalks, bike lanes, or cycle tracks. There are also a range of bicycle treatments available for the intersection 36th Avenue and Denali Street. Possible solutions that differ from what is normally done in Anchorage include colored pavements and developing protected intersections. For reference, see *The Protected Intersection* in the NACTO guide (https://nacto.org/wp-content/uploads/2015/07/Nick-Falbo-Alta-P-D_Protected-Intersection.pdf).

Options for improving the roadway crossings include constructing pedestrian crossing medians and installing signs or signals to alert drivers to the pedestrian crossings.