2 Existing Operational Characteristics

2.1 Parallel Routes Analysis

Because there are no interstate facilities parallel to the Glenn Highway that can route traffic between Anchorage and areas north of Anchorage, alternative routing for detours relies upon usage of the arterial, collector, and even local road network in the area surrounding the Glenn Highway. This network provides the only alternative routing during major closures of the Glenn Highway. Unfortunately, the road network in many areas of the Glenn Highway study corridor is limited.

To categorize the parallel routes, the Glenn Highway was divided into the following six segments:

- *Segment 1:* Airport Heights Drive to Muldoon Road (MP 0 to 4)
- *Segment 2:* Muldoon Road to Eagle River Loop/Hiland Road (MP 4 to 12)
- *Segment 3:* Eagle River Loop/Hiland Road to South Birchwood Loop (MP 12 to 16)
- *Segment 4:* South Birchwood Loop to Chugiak/North Birchwood Loop (MP 16 to 21)
- *Segment 5:* Chugiak/North Birchwood Loop to North Peters Creek (MP 21 to 23)
- *Segment 6:* North Peters Creek to the Knik River Bridge (MP 23 to 30)

To obtain a high-level estimate of how well the existing network could absorb additional traffic in the event of major closures on the Glenn Highway, each segment was analyzed. Existing peak hour volumes (AM and PM) were estimated for both the Glenn Highway and the alternate routes. Existing AADTs were collected from the DOT&PF *Central Region Annual Traffic Volume Reports* for 2013. Design hour volumes were estimated as 9% in the AM peak and 10% in the PM peak, based on hourly volume data provided by DOT&PF for 19 days at the scale house in 2013. Capacity on the alternate routes was approximated using the AMATs model base year of 2013. Finally, excess available capacity on the alternate routes was calculated by determining the difference between capacity (from the AMATs model) and demand (estimated peak hour volumes) over the entire segment. The excess available capacity represents the extra volume (in addition to usual traffic) that the alternate routes could handle in the event of a major closure on the Glenn Highway.

2.1.1 Segment 1 – Airport Heights Drive to Muldoon Road (MP 0 to 4)

This segment of the corridor runs mostly east-west and falls within the urban core of the Anchorage Bowl. On the south side of the Glenn Highway, there is a system of parallel arterial roadways at 1-mile spacing. On the north side of the Glenn Highway however, there are limited detour options due to Joint Base Elmendorf-Richardson (JBER). Figure 2 shows the network grid in this segment of the corridor.

Figure 3 and Figure 4 show the excess network capacity analysis for this segment of the Glenn Highway in the AM and PM peak periods, respectively. The segment from Bragaw Street to

Boniface Parkway has the least excess capacity during both peak periods. Note that only about ½ of the Glenn Highway traffic could be accommodated on the arterial network in the PM peak hour.

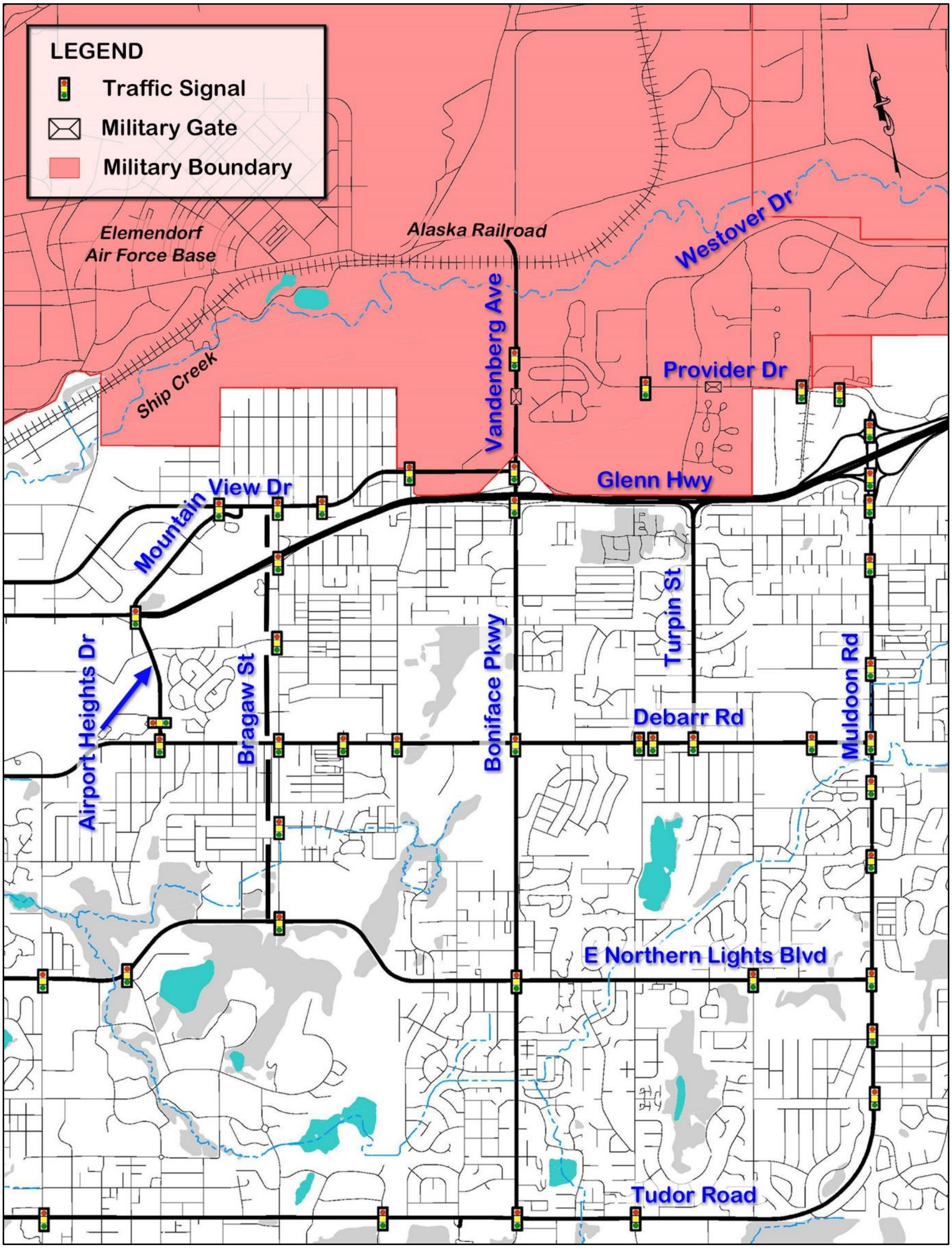

Figure 2: Segment 1 – Airport Heights Drive to Muldoon Road (MP 0 to 4)

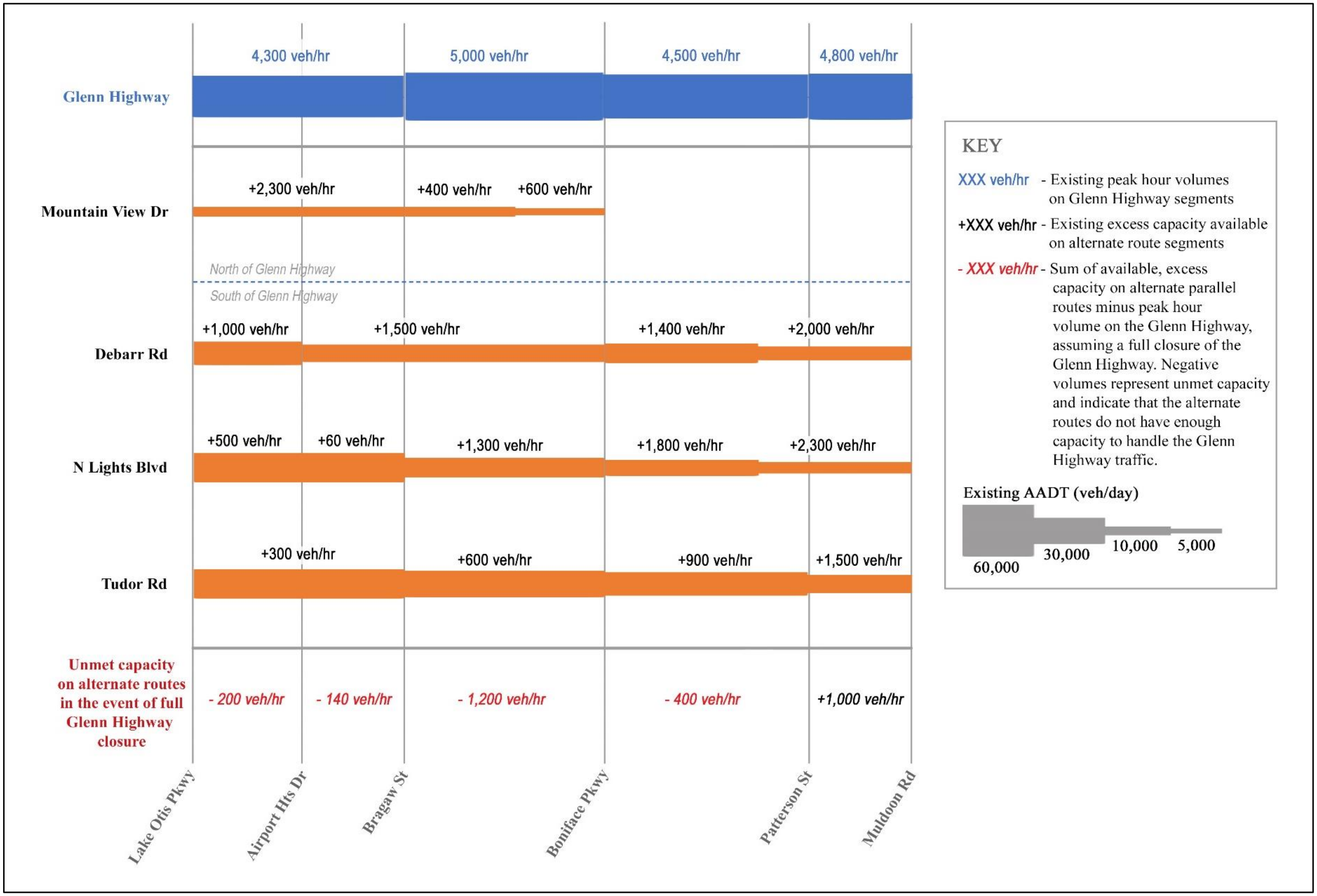

Figure 3: Available Excess Capacity on Segment 1 (MP 0 to 4), AM Peak Hour

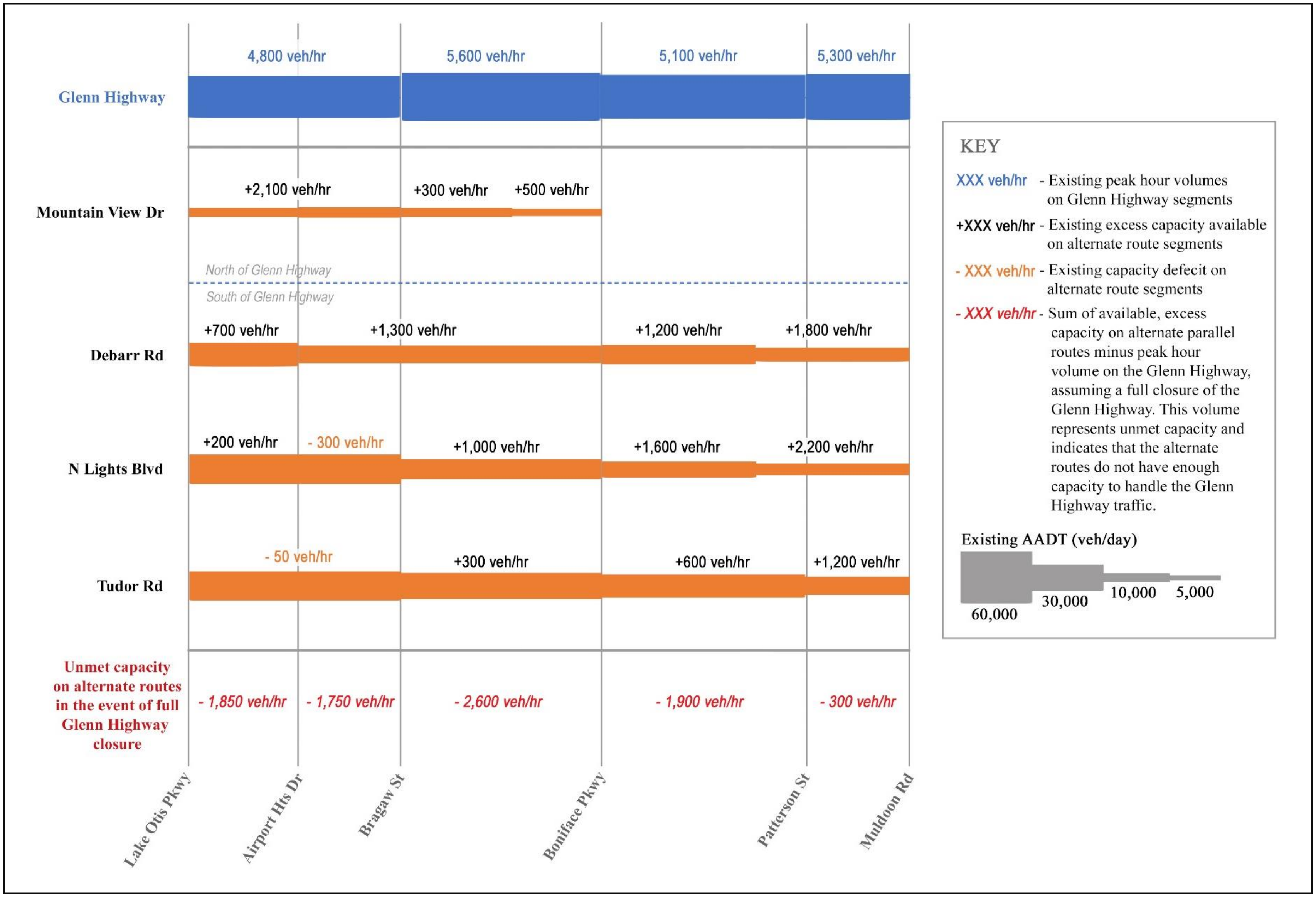

Figure 4: Available Excess Capacity on Segment 1 (MP 0 to 4), PM Peak Hour

2.1.2 Segment 2 – Muldoon Road to E Eagle River Loop/Hiland Road (MP 4 to 12)

This segment of the corridor runs northeast-southwest through JBER. As such, only limited portions of the parallel network are available for general traffic. Figure 5 shows the network grid in this segment of the corridor.

Figure 6 and Figure 7 show the excess network capacity analysis for this segment of the Glenn Highway in the AM and PM peak periods, respectively. The only available parallel route for this segment is between Arctic Valley and D Street, which can only accommodate about 15% of the Glenn Highway traffic in the peak periods.

Note that DOT&PF installed crossover points for this portion of the highway that would allow traffic to cross over the median and travel contraflow. Contraflow plans for this section of highway that were developed in 2003 can be found in the Part 2 Appendix C files. Under the contraflow plan, the northbound traffic uses the frontage road from the Artic Valley Road exit. The frontage road is converted to northbound only (two northbound lanes), and the restricted access road is opened to traffic up to the scale house, where a crossover has been built to return northbound traffic to the highway.

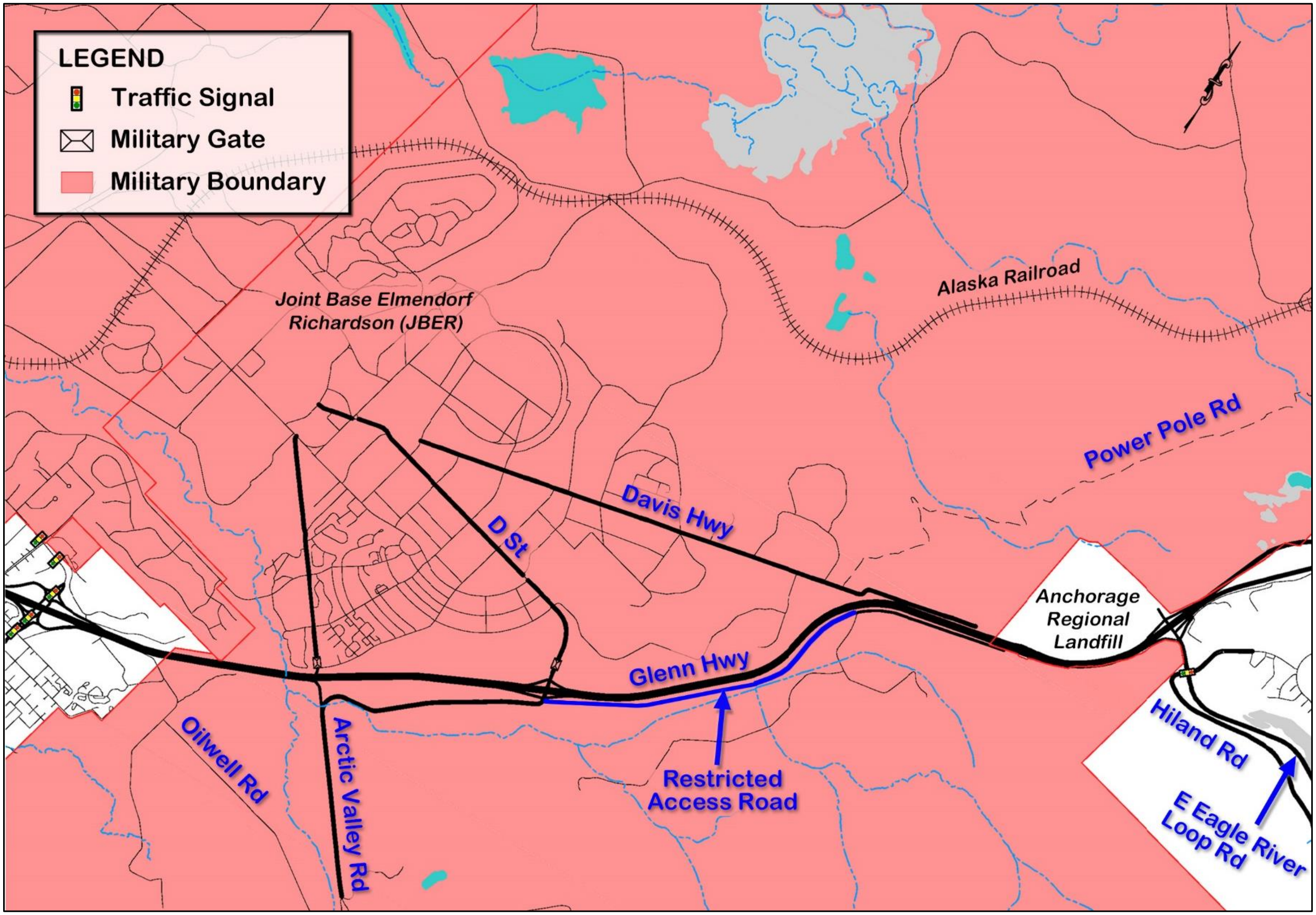

Figure 5: Muldoon Road to Eagle River Loop/Hiland Road (MP 4 to 12)

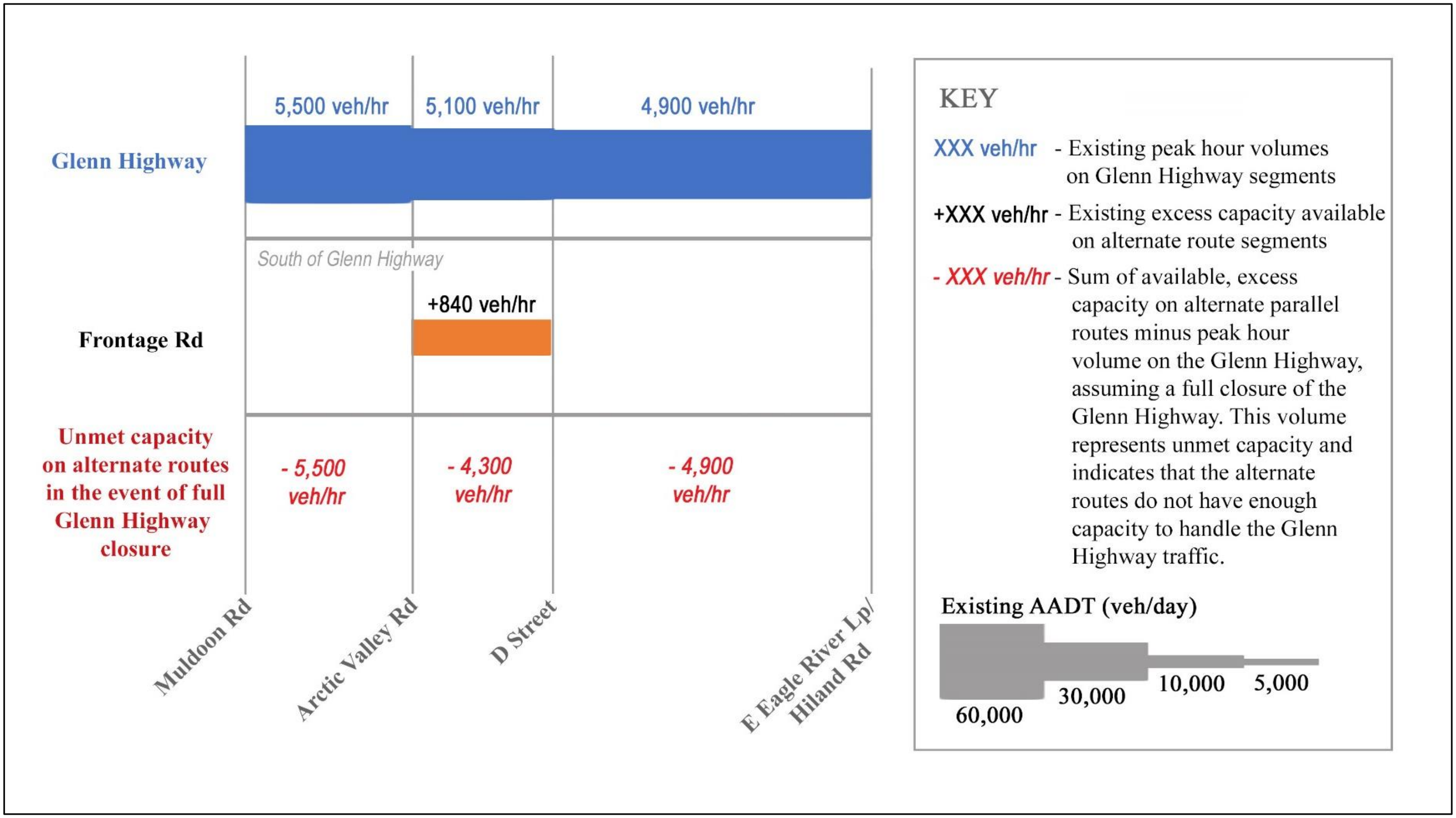

Figure 6: Available Excess Capacity on Segment 2 (MP 4 to 12), AM Peak Hour

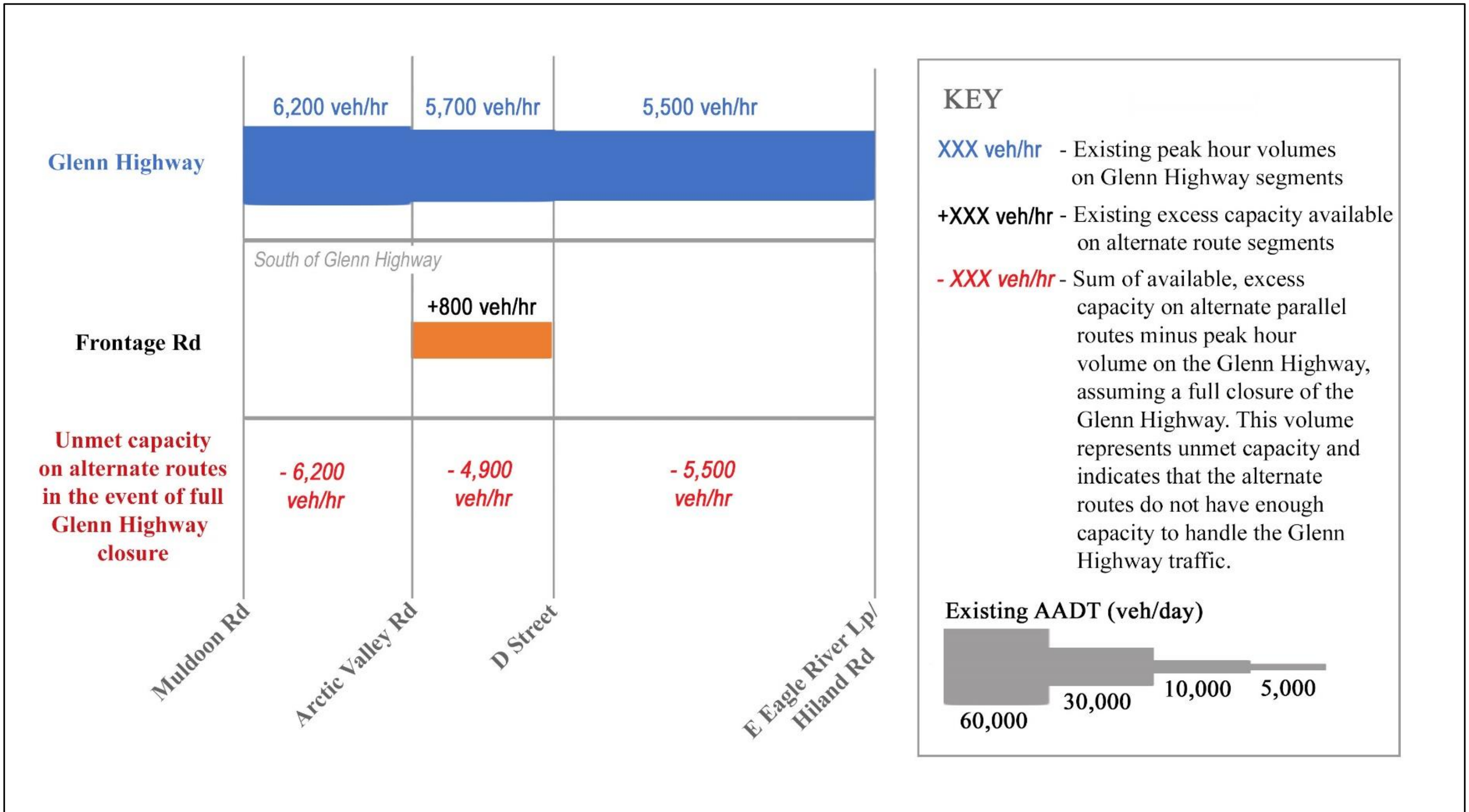

Figure 7: Excess Available Capacity on Segment 2 (MP 4 to 12), PM Peak Hour

2.1.3 Segment 3 – Eagle River Loop/Hiland Road to South Birchwood Loop (MP 12 to 16)

This segment of the corridor runs mostly north-south past Eagle River. West of the Glenn Highway, there is little development and no parallel routes. East of the Glenn Highway, the arterial system for Eagle River is available to accommodate diverted traffic. Figure 8 shows the network grid in this segment of the corridor.

Figure 9 and Figure 10 show the excess network capacity analysis for this segment of the Glenn Highway in the AM and PM peak periods, respectively. Similar to within the Anchorage Bowl, while many of the alternate arterial roadways can carry significant capacity, there is significant demand on these roadways already in the peak periods. Thus, only about ¼ of the Glenn Highway traffic can be diverted through this network.

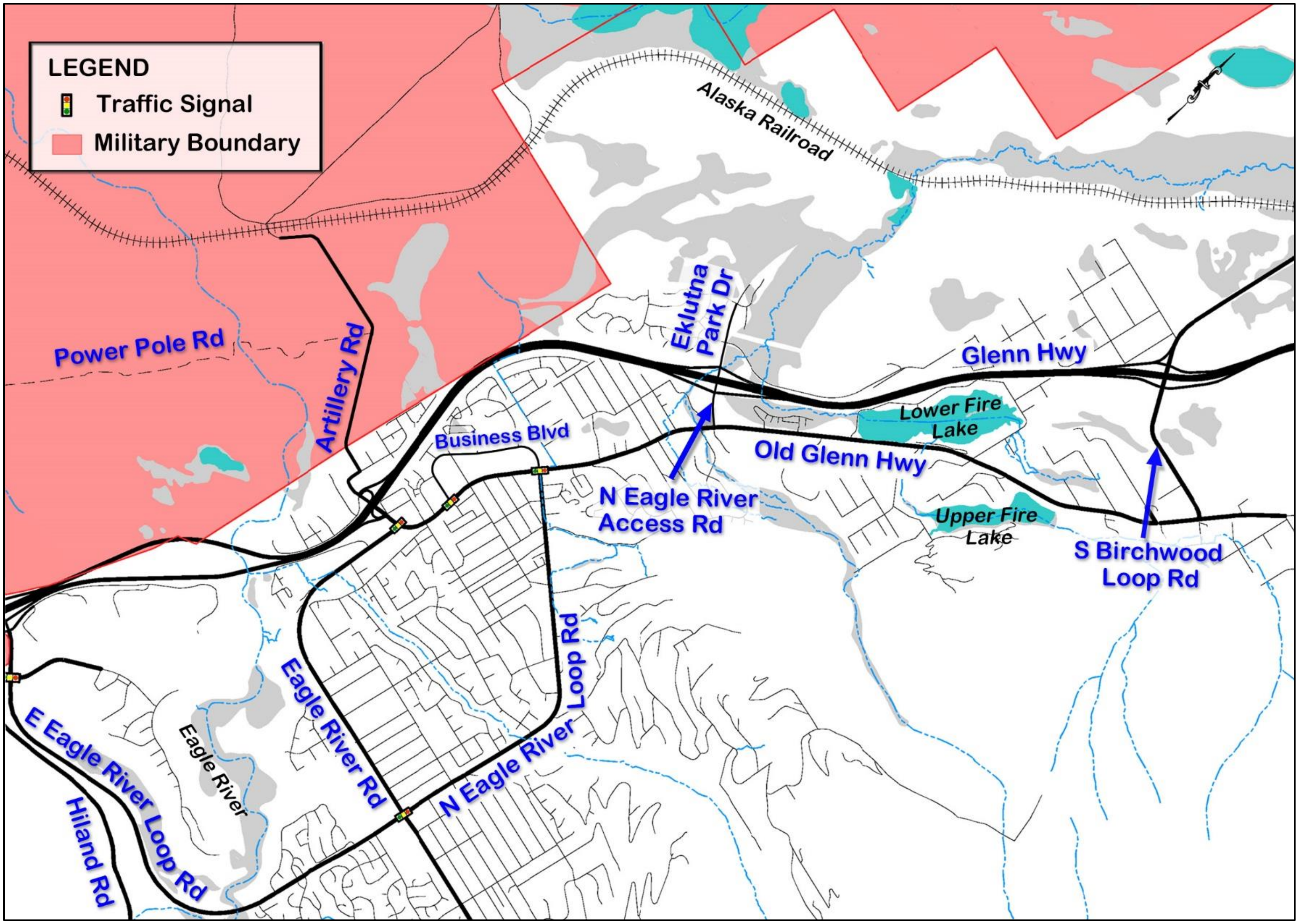

Figure 8: Eagle River Loop/Hiland Road to South Birchwood Loop (MP 12 to 16)

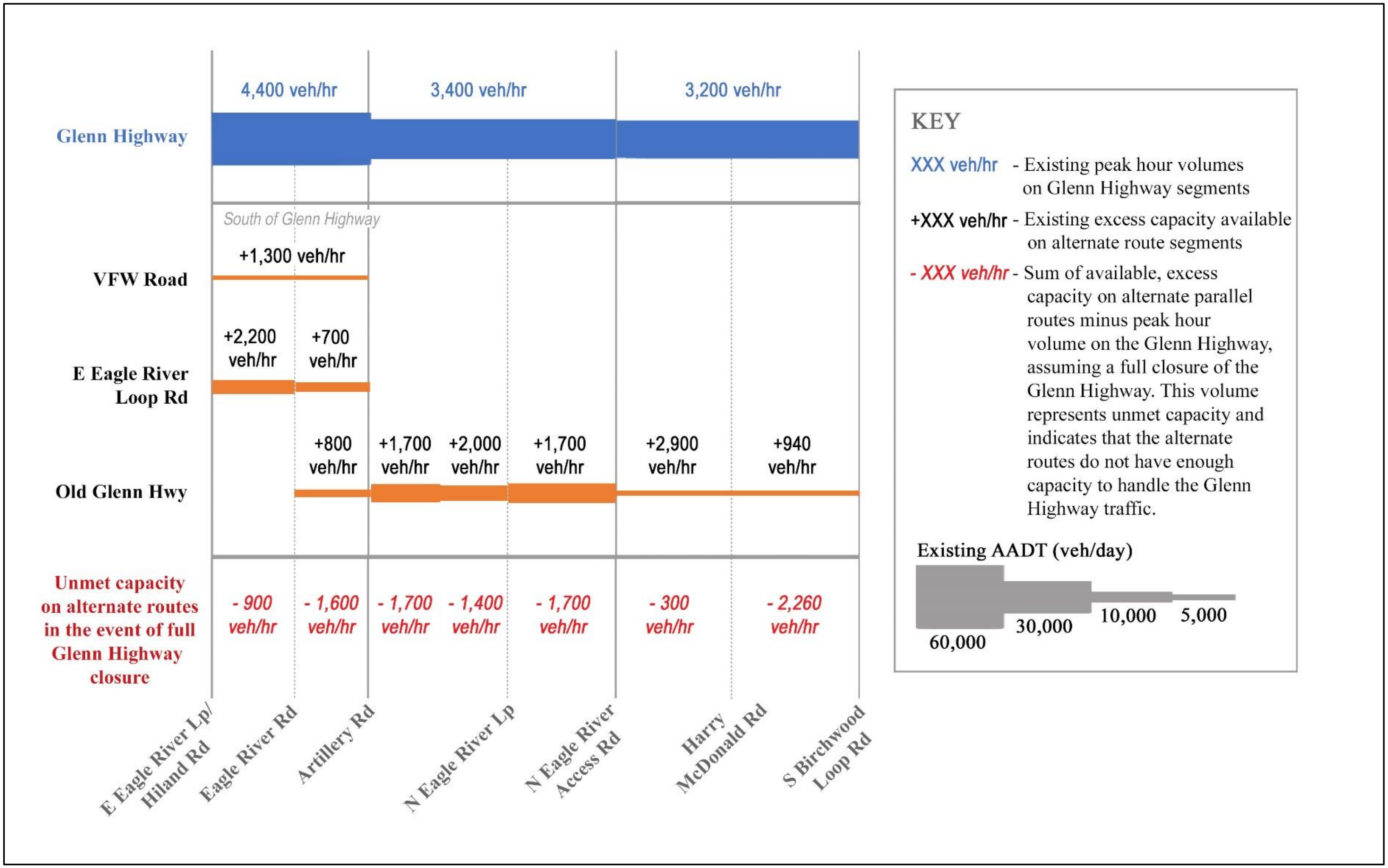

Figure 9: Available Excess Capacity on Segment 3 (MP 12 to 16), AM Peak Hour

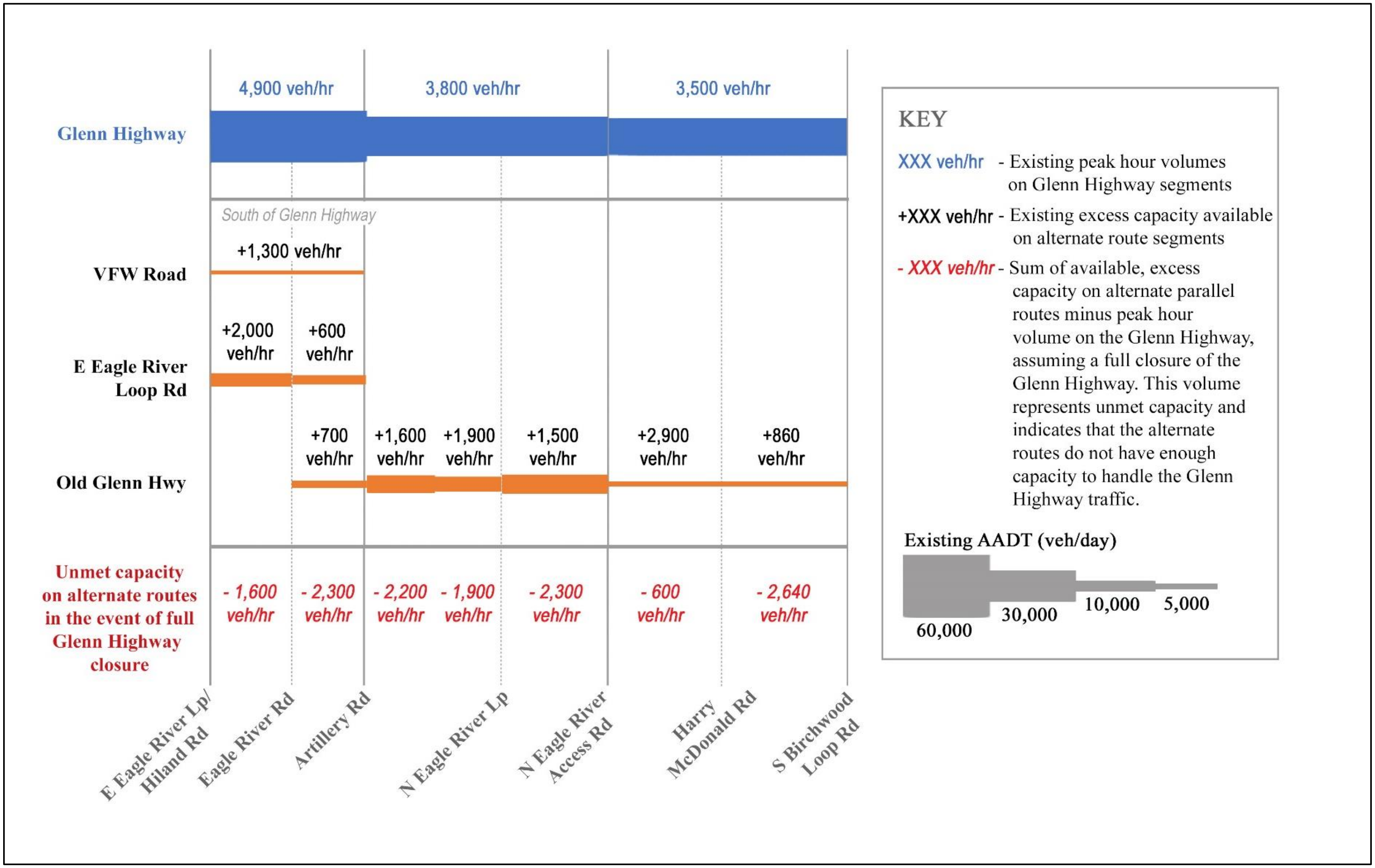

Figure 10: Available Existing Capacity on Segment 3 (MP 12 to 16), PM Peak Hour

2.1.4 Segment 4 – South Birchwood Loop to North Birchwood Loop (MP 16 to 19)

This segment of the corridor runs mostly northeast-southwest through the Birchwood area. West of the Glenn Highway, Birchwood Loop Road (a major collector) connects the two interchanges, running in short segments with frequent sharp turns. East of the Glenn Highway, the Old Glenn Highway (a minor arterial) connects the two interchanges. Figure 11 shows the network grid in this segment of the corridor.

Figure 12 and Figure 13 show the excess network capacity analysis for this segment of the Glenn Highway in the AM and PM peak periods, respectively. These roads can carry about one-third of the Glenn Highway demand.

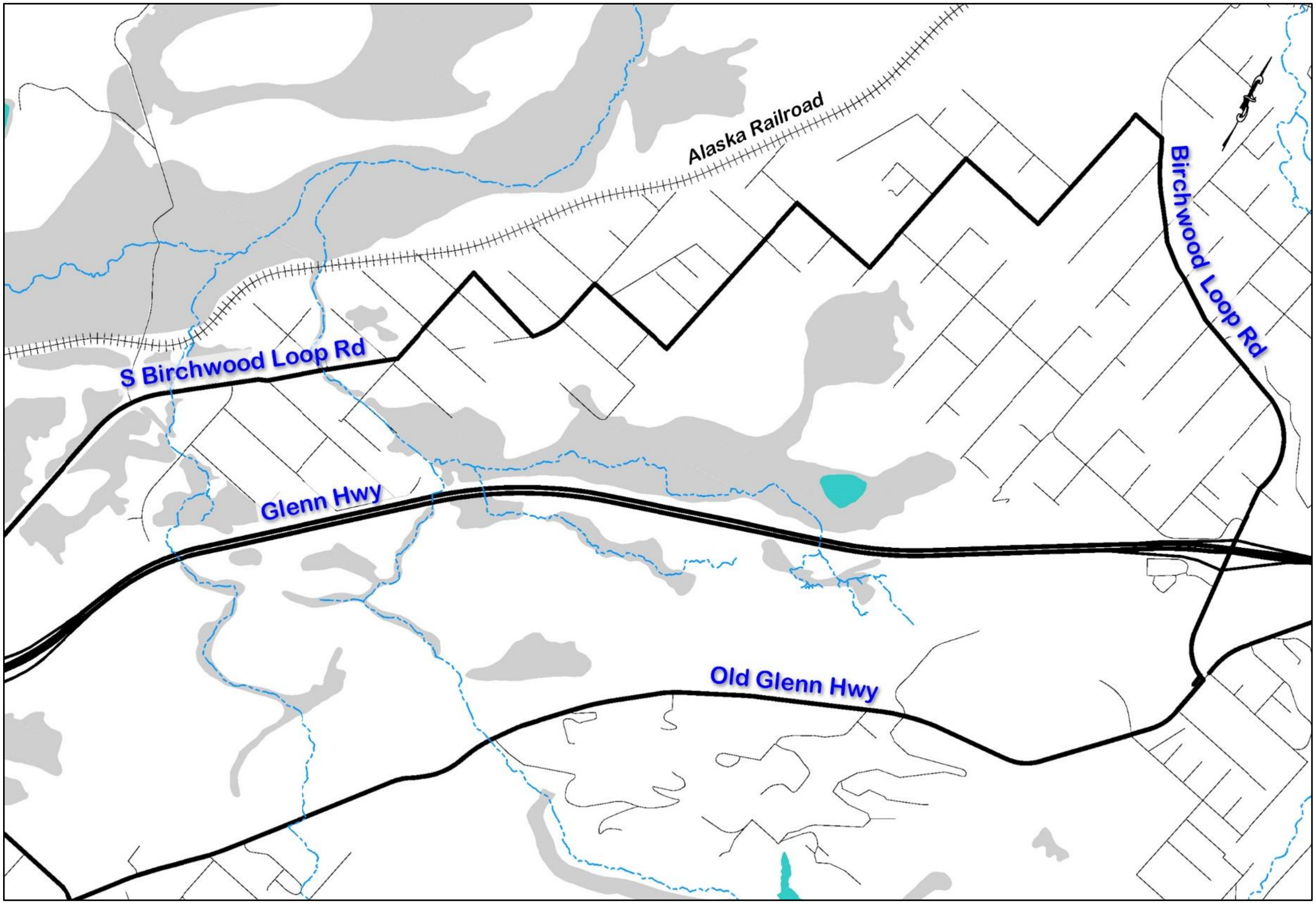

Figure 11: South Birchwood Loop to North Birchwood Loop (MP 16 to 19)

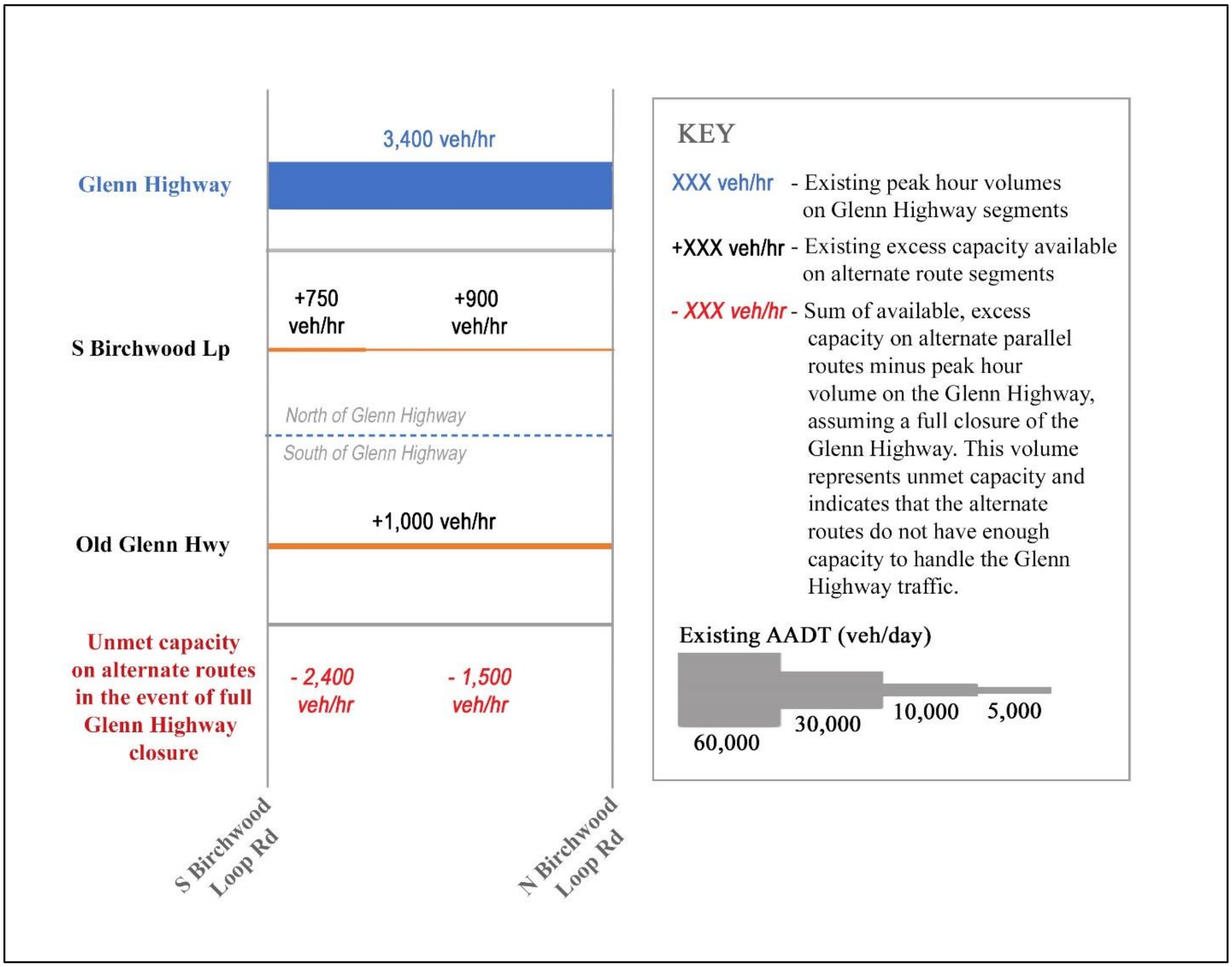

Figure 12: Available Excess Capacity on Segment 4 (MP 16 to 21), AM Peak Hour

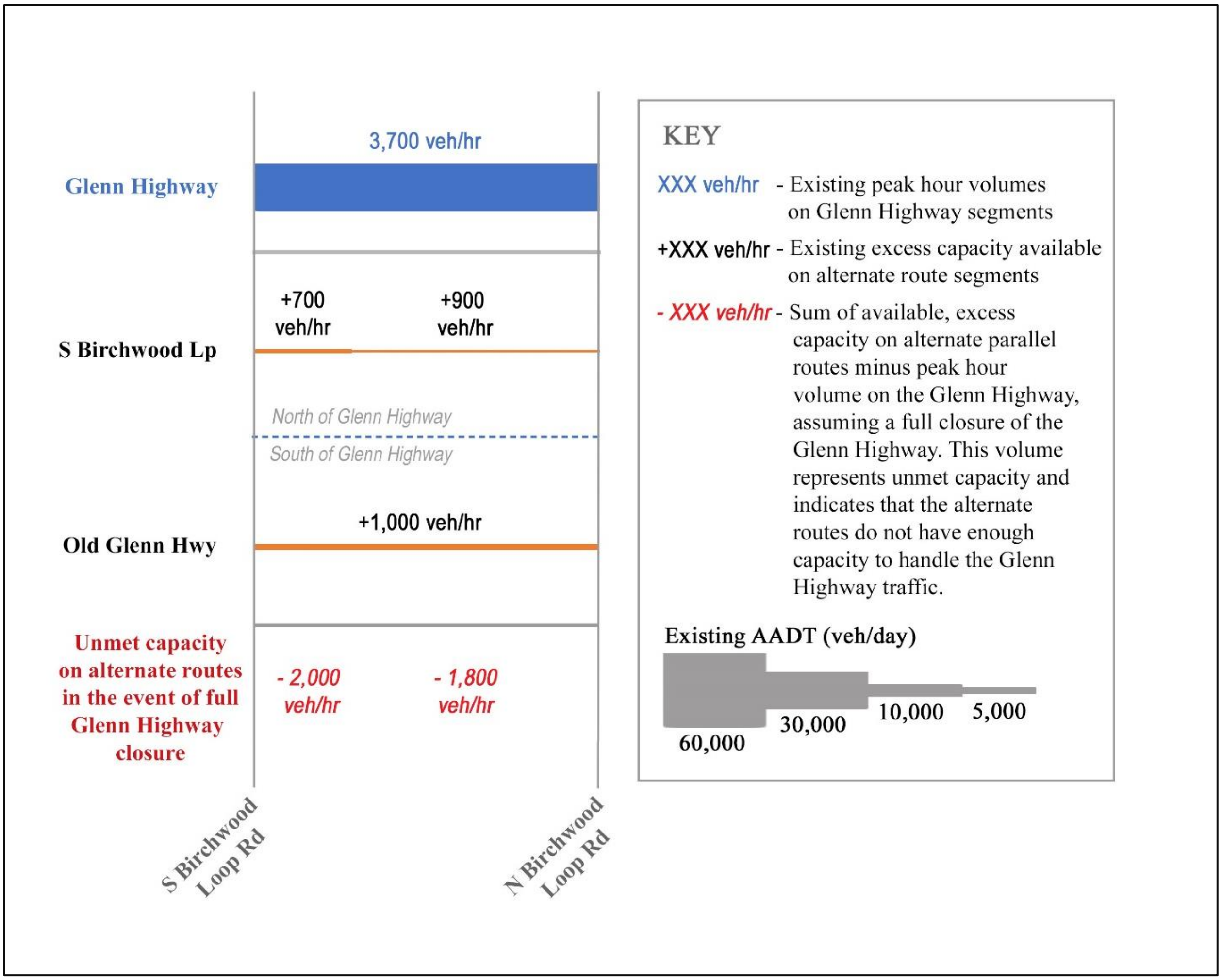

Figure 13: Available Excess Capacity on Segment 4 (MP 16 to 21), PM Peak Hour

2.1.5 Segment 5 – Chugiak/North Birchwood Loop to North Peters Creek (MP 19 to 23)

This segment of the corridor runs mostly northeast-southwest through the Peters Creek area. While there is development on both sides of the highway, parallel routes consist entirely of major or minor collector roadways with limited capacity. Figure 14 shows the network grid in this segment of the corridor.

Figure 15 and Figure 16 show the excess network capacity analysis for this segment of the Glenn Highway in the AM and PM peak periods, respectively. While the parallel routes in this area have limited capacity, the demand volume on the Glenn Highway is also reduced in this area, so that the parallel routes can carry about one-half of the Glenn Highway demand.

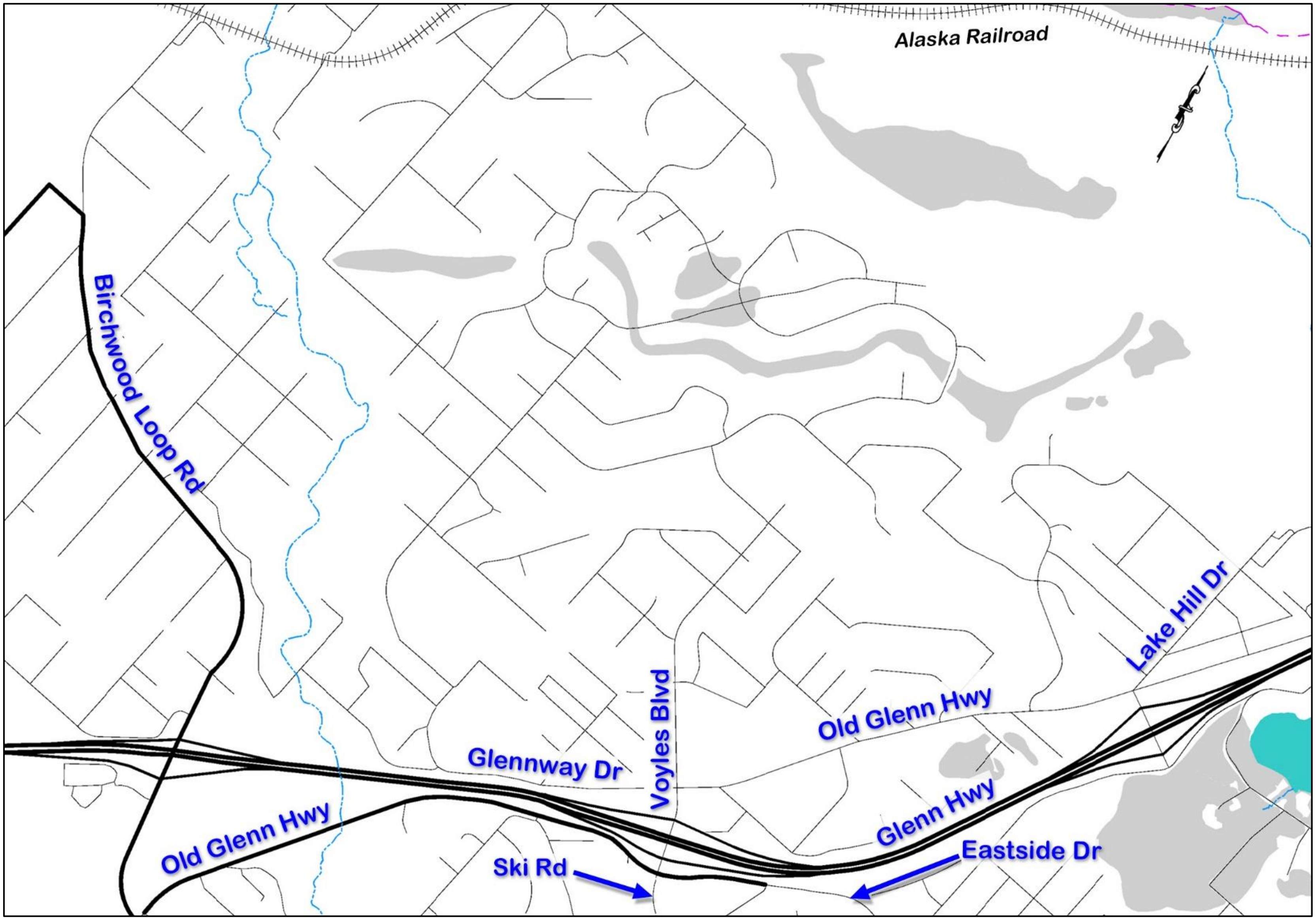

Figure 14: North Birchwood Loop to North Peters Creek (MP 19 to 23)

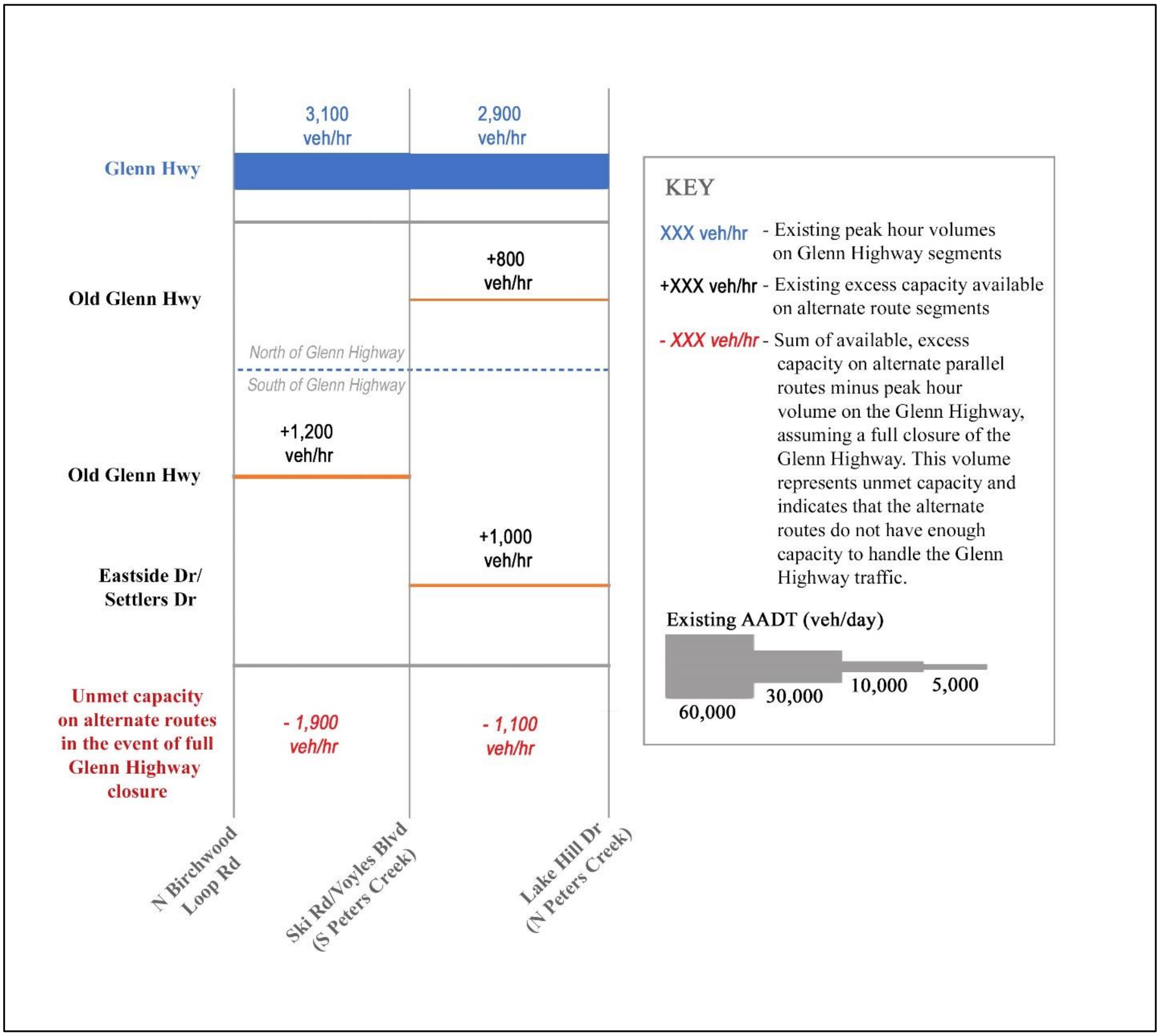

Figure 15: Available Excess Capacity on Segment 5 (MP 21 to 23), AM Peak Hour

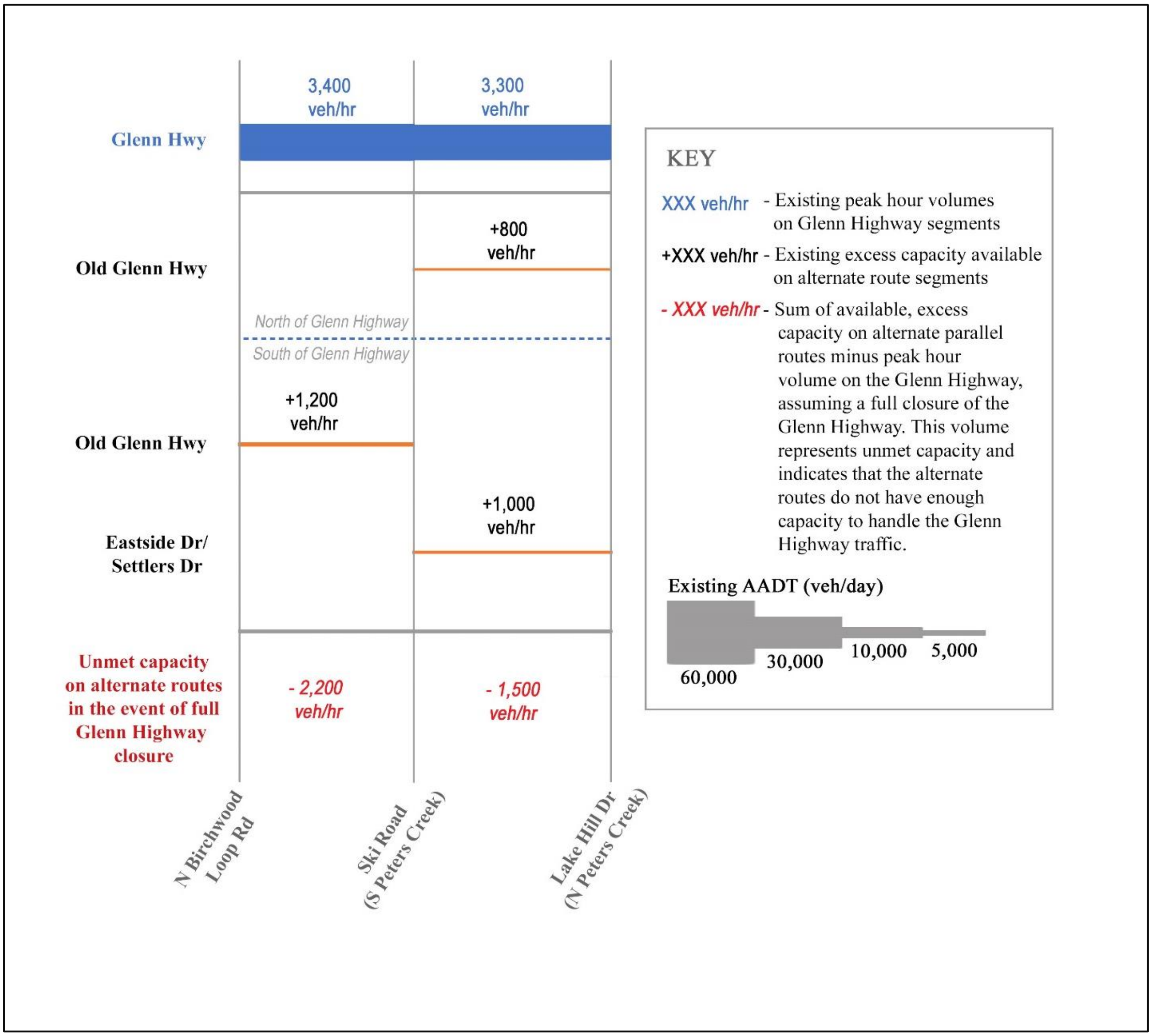

Figure 16: Available Excess Capacity on Segment 5 (MP 21 to 23), PM Peak Hour

2.1.6 Segment 6 – North Peters Creek to the Knik River Bridge (MP 23 to 30)

This segment of the corridor turns to run almost east-west from the Peters Creek area to the Knik River Bridge. There is limited development on either side of the highway, and there are essentially no parallel routes. Figure 17 shows the network grid in this segment of the corridor.

There are no alternate routes available to provide excess network capacity on this segment of the Glenn Highway.

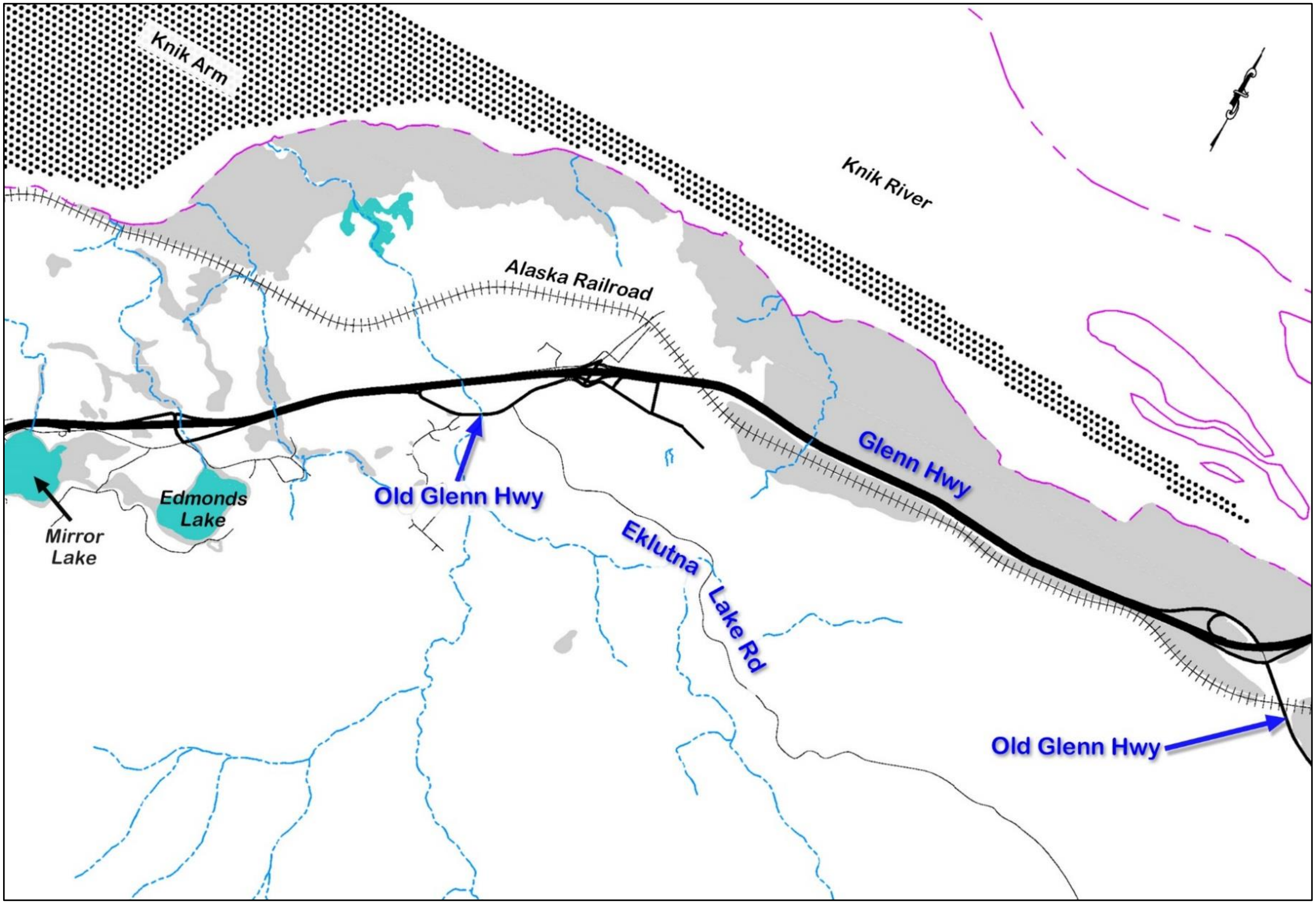

Figure 17: Mirror Lake to the Knik River Bridge (MP 23 to MP 30)

2.2 Crash Analysis

DOT&PF provided crash data for the approximately 30 miles of the Glenn Highway corridor between Airport Heights (milepoint 0.0) and the end of the Municipality of Anchorage (MOA, milepoint 29.1) for the 10 years between 2005 to 2014. For each crash listed in the DOT&PF database, the crash type and location were reviewed and adjusted using engineering judgement to improve the analysis. Crash data was provided for 4,169 crashes that occurred from 2005 through 2014. Out of these reported crashes, 3,684 crashes were analyzed. Crashes were not considered for analysis if the correct location of the crash could not be determined. The focus of the crash analysis is to perform a brief overview of the crash history to find factors that might contribute to crashes along the corridor, so that mitigations that could reduce the number of crashes can be proposed.

2.2.1 Corridor Crash Rates

Crash rates were calculated based on the number of crashes, number of years in the study period, and average annual daily traffic (AADT) over the period of study. The Glenn Highway is classified as a freeway, and average crash rates for the corridor were computed from the 1,760 crashes that occurred in the most recent 5-year period with available data (2010-2014). Using the 2017 Highway Safety Improvement Program (HSIP) Handbook and High Accident Location Screening spreadsheet, the crash rates were compared to statewide average crash rates for similar facilities and corresponding time periods as well as to the Critical Accident Rate (CAR). The CAR is a calculated threshold above which the observed rate at a given location is considered statistically higher than average at a 95% confidence level. When a computed crash rate exceeds the CAR, there is strong evidence that the higher than expected number of crashes are not just random occurrences but are caused by underlying contributing factors.

To calculate the crash rates along the study corridor, the Glenn Highway was divided into fifty-eight (58) half-mile segments, starting at milepoint 0.25 and working north (outbound) to the end of the MOA at milepoint 29.1. The signalized intersection of the Glenn Highway at Airport Heights (milepoint 0.0) was not included in the crash analysis because crash rates at signalized intersections differ significantly compared to crash rates for freeway segments. The milepoint and location of each crash was analyzed and adjusted as needed. Milepoints for crashes associated with the southbound lanes were converted to correspond to northbound (outbound) milepoint locations. The crash rate for segments is given in terms of crashes per million vehicle miles traveled (MVMT).

The state average crash rate for rural freeways is 0.9 crashes per MVMT, while the average crash rate for the entire study corridor was calculated to be 0.8 crashes per MVMT. Figure 18 shows the crash rates for each segment and indicates which segments have higher than average crash rates.

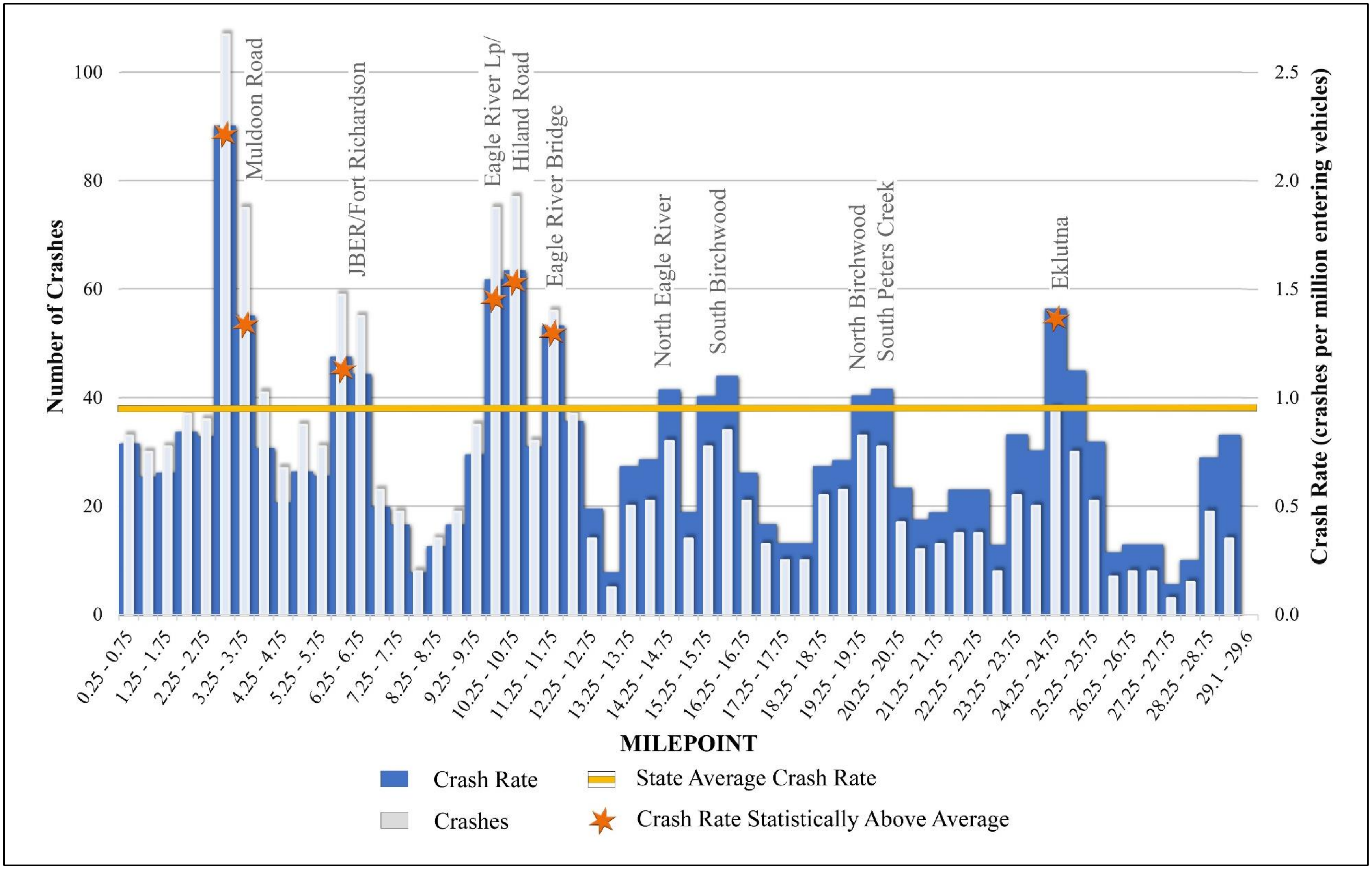

Figure 18: Crashes and Crash Rates by Milepoint (2010 to 2014)

2.2.2 Crash Types and Severity

Figure 19 shows the type and frequency of crashes that occurred in the study corridor. A quarter of the crashes occurred when a vehicle ran off the road. Rear end crashes accounted for 23% of the crashes, while 20% of the crashes occurred when a vehicle struck an object, either fixed or not fixed.

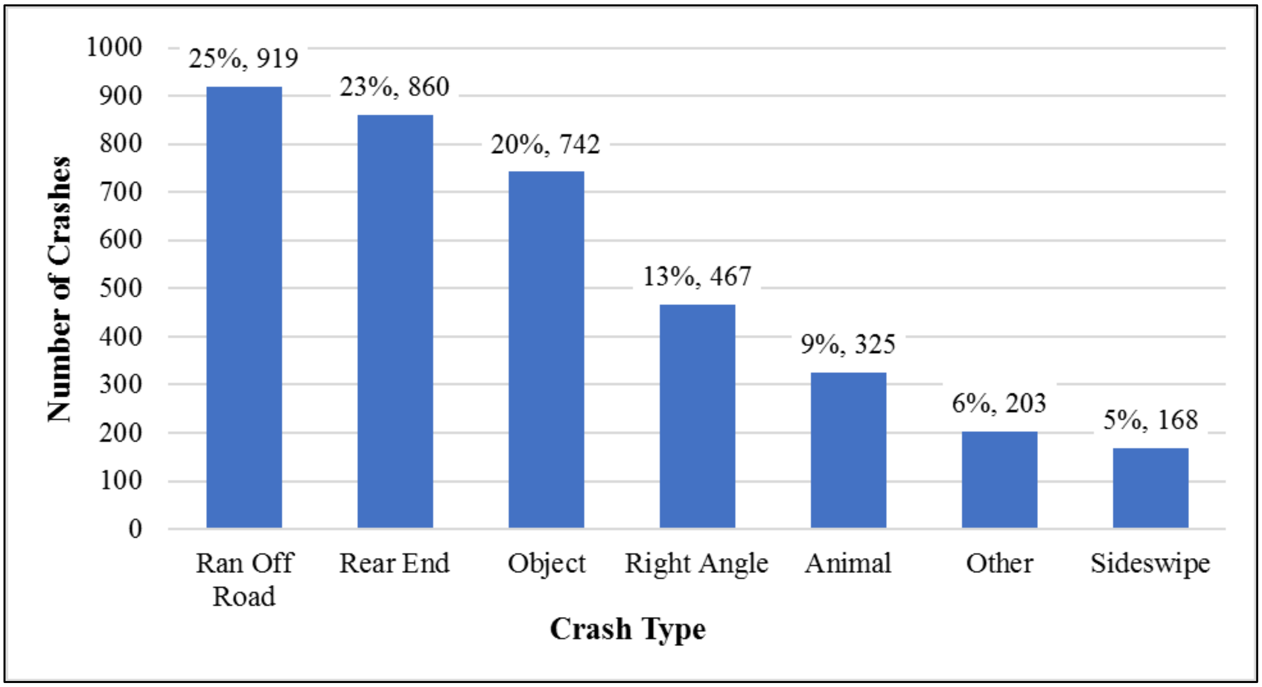

Figure 19: Crash Types on Study Corridor (2005 to 2014)

While animal (wildlife) crashes only accounted for 9% of crashes over the study period, DOT&PF's 1995 *Moose Vehicle Accidents on Alaska's Rural Highways* states that "Alaska has the highest known moose-vehicle accident rate in the world." Public input for this project indicated that wildlife crashes on the study corridor are a concern (see 2.5.2.5.7 Wildlife Concerns). Figure 20 shows the moose crash rate along the study corridor for the crash analysis period. The average crash rate is 10 moose crashes per mile over the five-year crash analysis period. Seventy-five percent of the animal related crashes that occurred were property damage only.

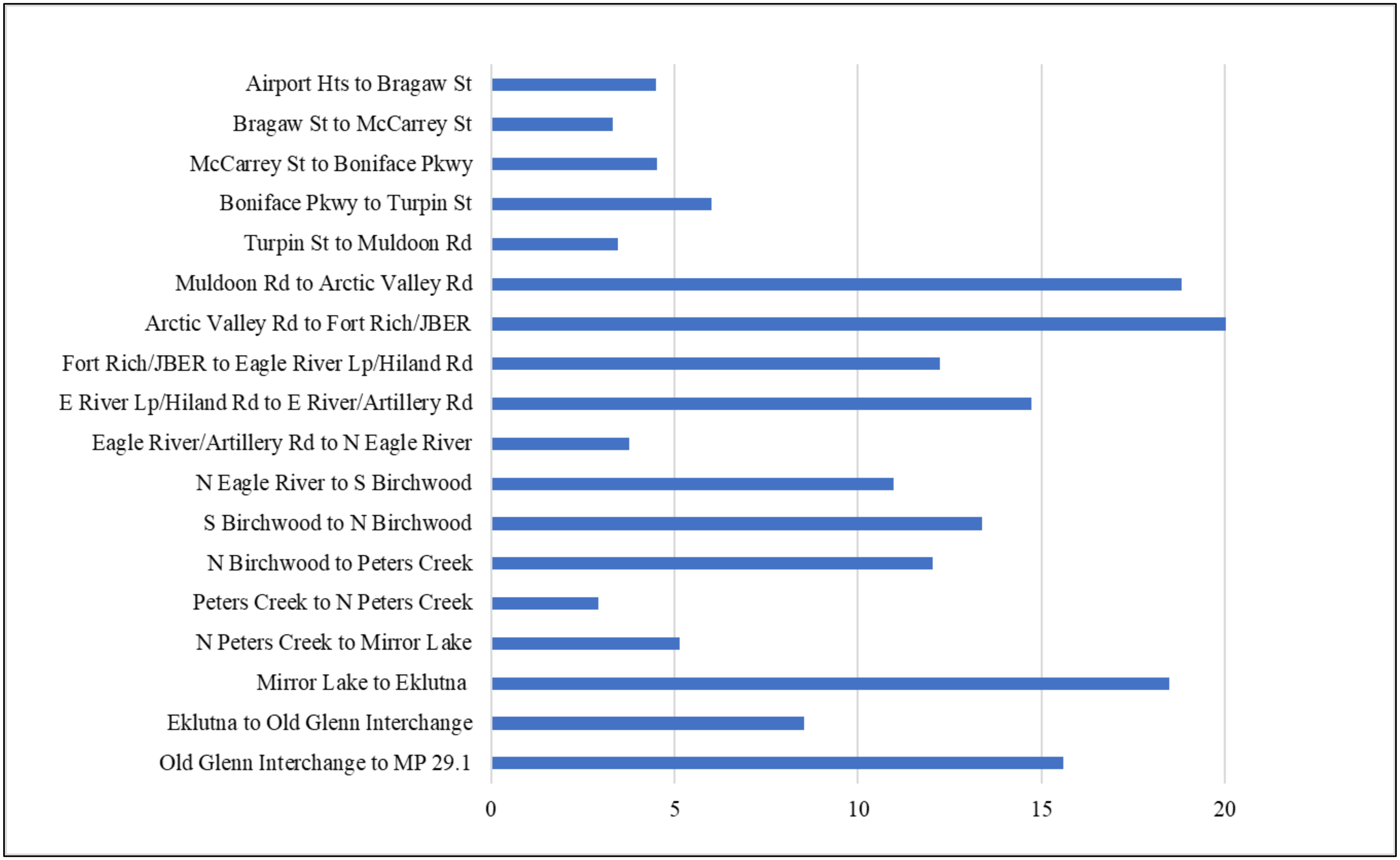

Figure 20: Moose Crashes per Mile (2005 to 2014)

Prior to 2011, DOT&PF prepared annual *Alaska Traffic Crashes* reports that are available on their website. Table 1 compares the percentage of moose crashes that occurred on the study corridor from 2005 to 2011 to the statewide percentage of moose crashes from the same years. A statistical analysis indicates that moose-related crashes are more likely to occur on the Glenn Highway than expected given the statewide data.

Table 1: Percentage of Moose Crashes

Year	Glenn Hwy	Alaska
2005	10%	5%
2006	7%	5%
2007	11%	6%
2008	11%	5%
2009	6%	5%
2010	9%	5%
2011	11%	5%
Average	9%	5%

Figure 21 shows the crash severity distribution for crashes that occurred in the study area from 2005 to 2014. Eighteen fatal crashes occurred during the study period. Figure 22 shows the monthly distribution of crashes, categorized by severity. Note that the number of fatal and major injury crashes are roughly the same each month throughout the year, while the number of minor injury and property damage only crashes are higher during winter months and lower during the summer months.

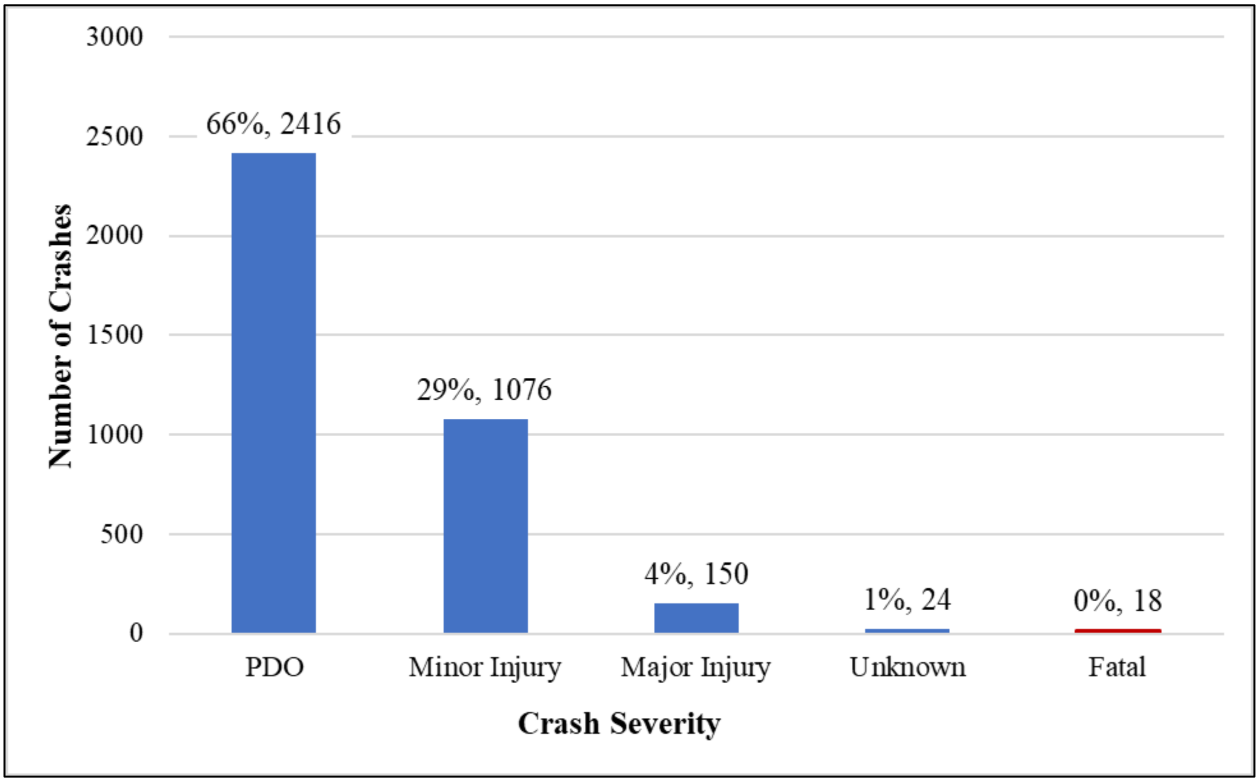

Figure 21: Crash Severity

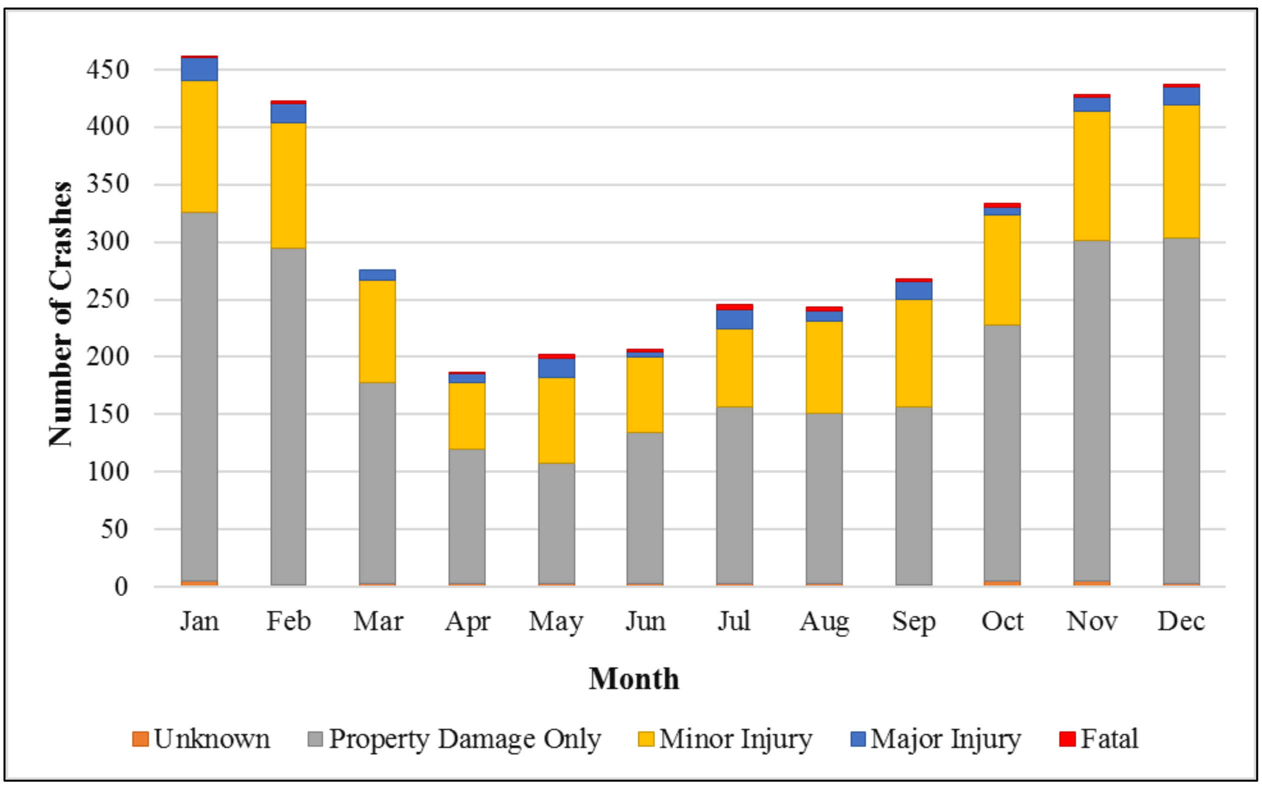

Figure 22: Monthly Distribution of Crashes by Severity

Using the USDOT Value of a Statistical Life for 2016 of $10.1 million, which corresponds to a societal cost of $8,080 for a property damage only crash, $106,050 for a minor injury crash, $707,000 for a major injury crash, and $10.2 million for a fatal crash, the total cost of all of the crashes on the Glenn Highway in the study area over this 10-year period was around $421.5 million, or $42.1 million per year.

2.2.2.1 Fatal Crashes

When a fatal crash occurs, police must collect additional data, resulting in longer road closures. Eighteen fatal crashes occurred between 2005 and 2014. The crashes were generally spread throughout the study corridor, as shown in Table 2. However, three of the eighteen crashes occurred at the North Birchwood interchange.

Table 2: Fatal Crash Locations

Location	Number of Crashes	MP	Year
Airport Heights/ Mountain View Drive	1	0.1	2010
Bragaw Street	1	0.7	2008
Boniface Parkway	1	1.5	2009
Turpin Street	1	2.3	2007
Muldoon Road	1	2.9	2013
Fort Richardson/Arctic Valley	1	6.1	2009
S Curves/Scales	1	8.9	2013
Eagle River Loop/Hiland Road	1	10.0	2011
Eagle River Bridge	1	11.2	2005
N. Eagle River	1	14.1	2010
S. Birchwood	1	16.8	2011
N. Birchwood	3	18.3	2010
		19.3	2009
		19.5	2009
Mirror Lake	1	22.7	2007
Thunderbird Falls	1	24.1	2006
Eklutna Flats	1	26.3	2014
Old Glenn Highway	1	27.4	2007

Figure 23 shows the crash types for the fatal crashes that occurred on the study corridor.

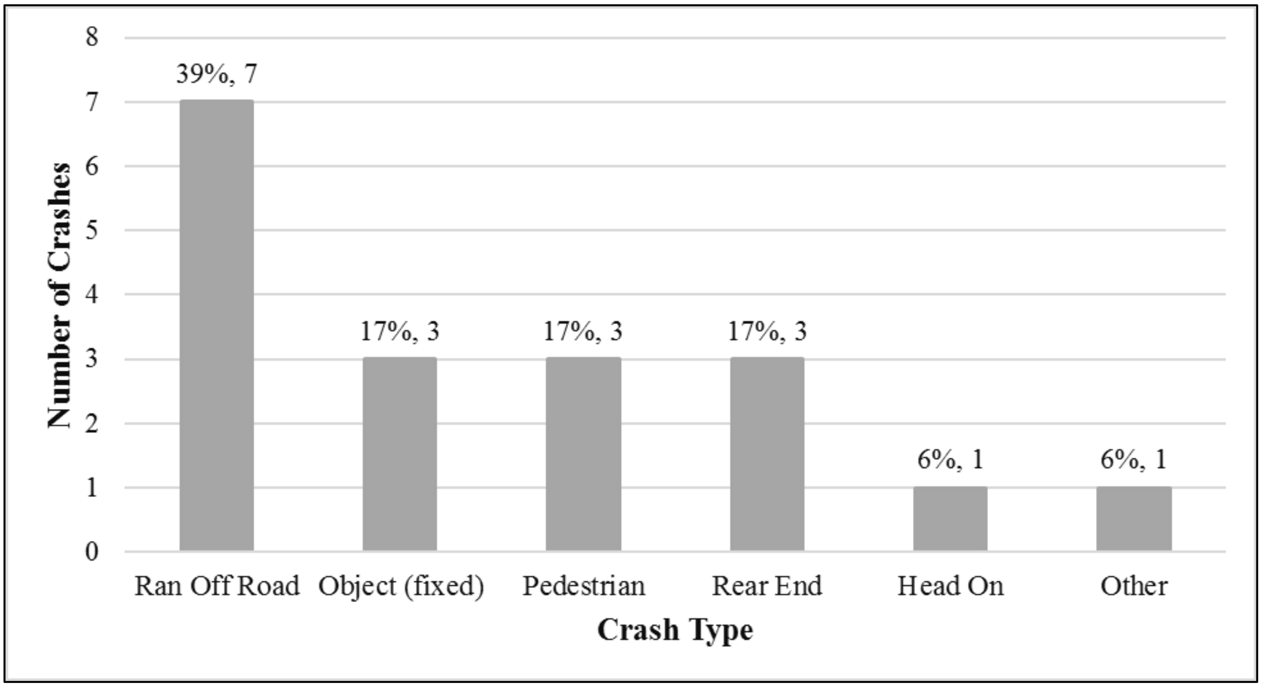

Figure 23: Fatal Crash Types

2.2.3 High Crash Days (> 10 Crashes/Day) Within the Study Corridor

On days with a higher than usual number of crashes, it likely takes responders longer to respond to crashes and clear the highway. Longer response times likely result in increased delay on the study corridor, making days with a high occurrence of crashes of interest to this study. Crash days on which 10 or more crashes occurred in the study corridor are listed in Table 3 along with general crash locations. Out of the 24 days with more than 10 crashes between 2005 and 2011, all fell within the 8-month period from October through May, with the highest number of days with greater than 10 crashes occurring in January (5 days) and February (7 days). About one-third of the crashes on high-crash days occurred in the Anchorage Bowl (MP 0 to 5). Another third occurred in the combined Eagle River-Birchwood area (MP 10 to 20). About 20% of the crashes on high-crash days occurred in the area where the highway passes through JBER (MP 5 to 10).

Table 3: Days with More than Ten Crashes in the Study Corridor

Year	Date	Number of Crashes	MP 0 - 5	MP>5-10	MP>10-15	MP>15-20	MP>20-25	MP>25-30
2005	December 23	11	6	1	2	2	-	-
2006	January 19	11	-	-	7	4	-	-
	February 1	15	9	1	4	-	1	-
	February 10	10	2	2	2	4	-	-
	February 25	12	9	1	2	-	-	-
2007	November 10	9	1	1	-	-	5	2
2008	April 9	11	4	-	3	4	-	-
	October 13	10	1	1	2	5	-	1
	December 10	13	5	5	1	1	1	-
2009	January 9	10	2	2	-	-	6	-
	January 14	13	8	2	3	-	-	-
	January 30	11	2	3	1	4	1	-
	February 28	28	6	10	-	11	-	1
	November 11	10	4	5	-	-	1	-
	December 14	12	4	7	-	-	1	-
2010	February 6	14	3	7	3	-	-	1
2012	January 8	11	5	5	1	-	-	-
	February 21	15	5	-	4	1	5	-
	March 14	10	8	2	-	-	-	-
2013	April 6	11	2	2	2	4	-	1
	May 18	11	1	1	4	2	1	2
	November 9	10	9	1	-	-	-	-
2014	March 5	12	3	2	-	4	2	1
	October 25	11	-	-	5	4	-	2
TOTAL		291	99 (34%)	61 (21%)	46 (16%)	50 (17%)	24 (8%)	11 (4%)

2.2.4 Crash Contributing Factors

2.2.4.1 Traffic Volumes

Historical traffic volume data for the crash analysis period (2005 – 2014) was collected from the DOT&PF *Central Region Annual Traffic Volume Reports*. Crashes in the study corridor were not found to follow yearly traffic volume trends, as shown in Figure 24. A comparison between monthly traffic volumes and monthly crash periods showed that the number of crashes increases during winter months while traffic volumes decrease in these months, as depicted in Figure 25.

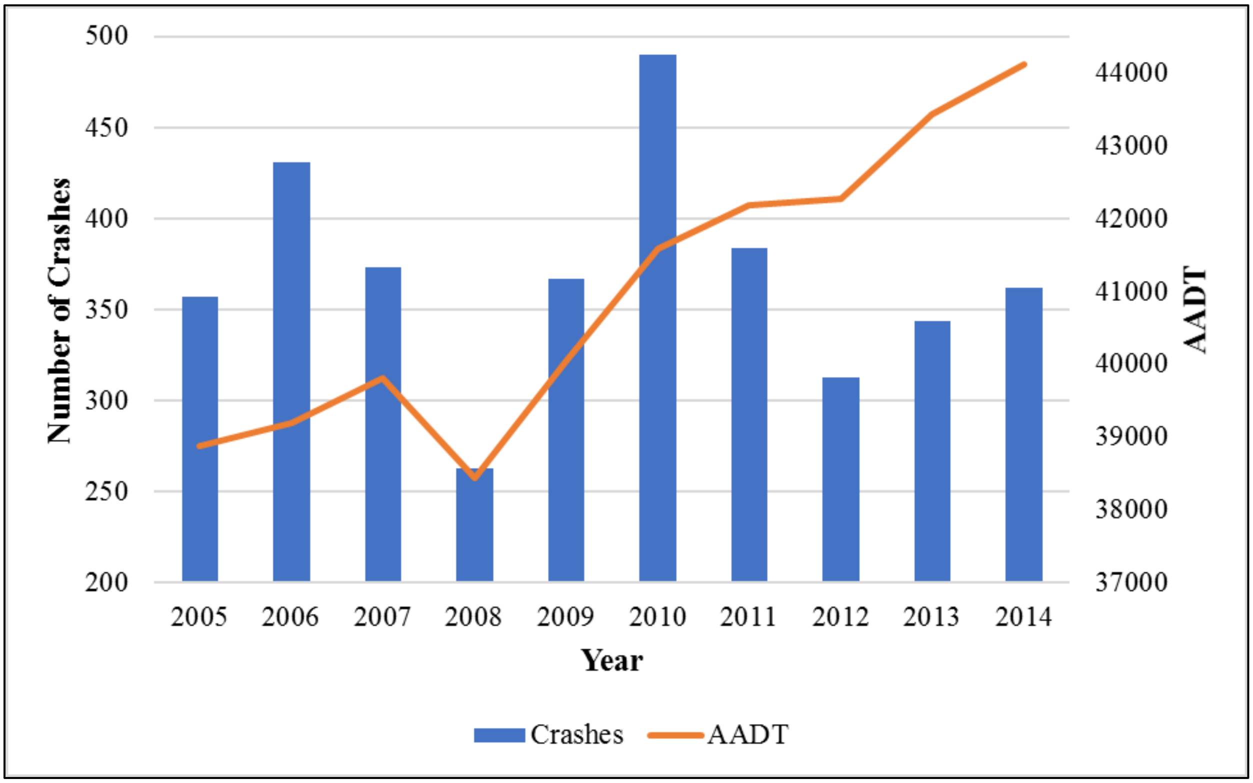

Figure 24: Crash Frequency Compared to AADT

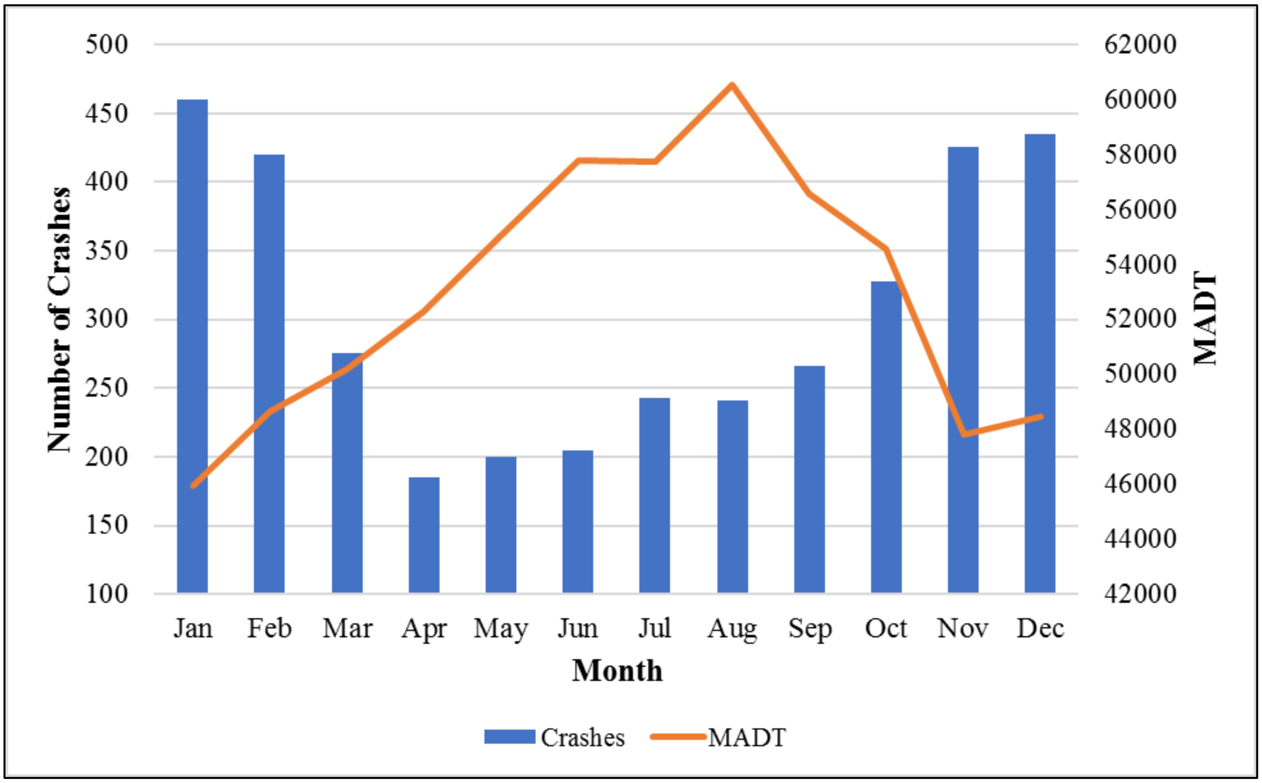

Figure 25: Crash Frequency Compared to MADT

2.2.4.2 Weather

The higher occurrence of crashes in winter suggests that winter weather and road conditions may contribute to the occurrence and frequency of crashes on the study corridor.

Table 4 provides a breakdown of the number and percentage of crashes that occurred in "summer" versus "winter" months for the crash analysis period. On average, 37% of crashes occurred during summer months (April, May, June, July, August, September) and 63% of crashes occurred in winter (October, November, December, January, February, March).

Table 4: Number and Percentage of Crashes, Summer vs. Winter

Crashes/Crash Percentage	Year									
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Summer Crashes	139	106	112	157	157	166	114	103	154	132
Winter Crashes	292	267	151	210	333	218	199	241	203	230
Total Crashes	431	373	263	367	490	384	313	344	357	362
% Summer Crashes	32%	28%	43%	43%	32%	43%	36%	30%	43%	36%
% Winter Crashes	68%	72%	57%	57%	68%	57%	64%	70%	57%	64%

DOT&PF provided weather records from the various weather stations along the Glenn Highway; however, in many cases the weather records were incomplete. Instead, weather records for

Anchorage (Ted Stevens International Airport), which are available from the NOAA website, were used to gain insight into how weather may contribute to crashes. Figure 26 compares crashes along the corridor to average monthly precipitation and snowfall over the 10-year crash analysis period (2005 – 2014). Crashes during winter months do increase as snowfall increases, and crashes during summer months follow the summer precipitation curve, suggesting that the occurrence and frequency of crashes is correlated to weather conditions.

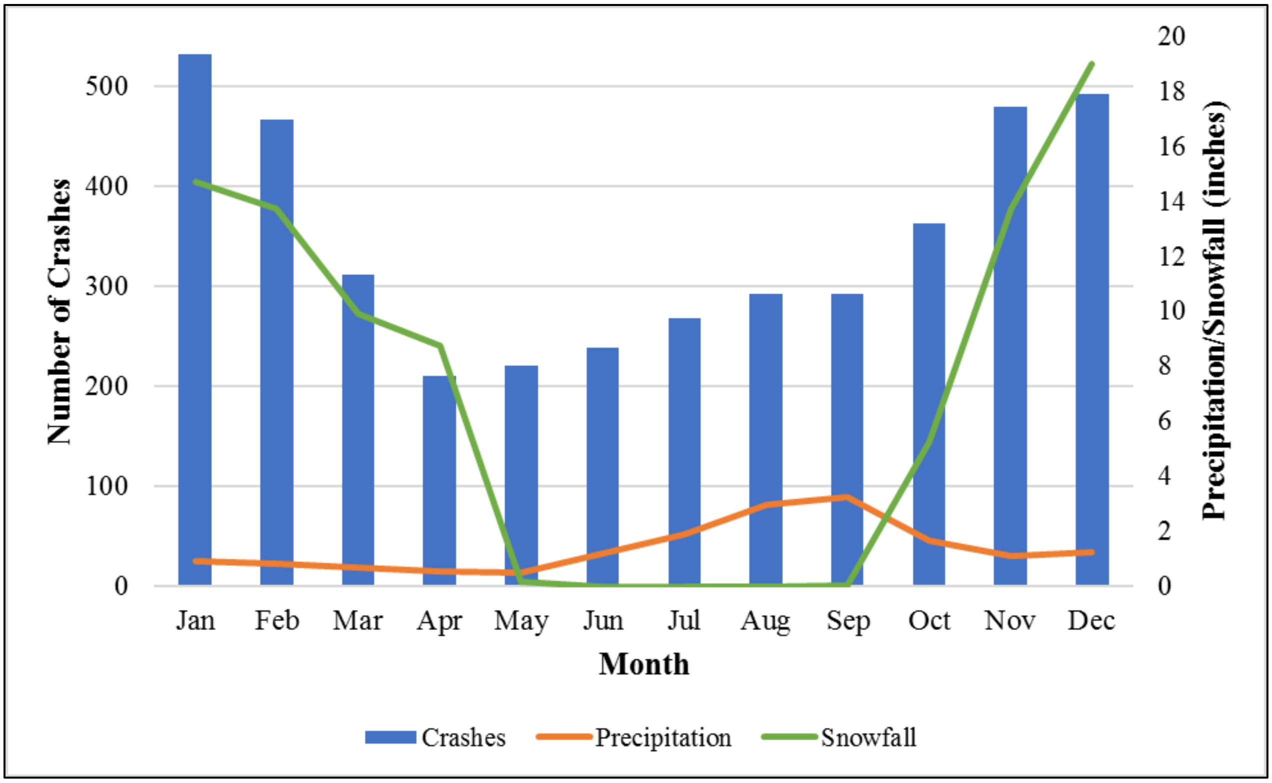

Figure 26: Crashes Compared to Snowfall

Days on which more than 10 crashes occurred were compared to NOAA weather data to determine any correlation between adverse weather and the high occurrence of crashes as depicted in Table 5. Snowfall over 1 inch was recorded on 64% (16 out of 25) of the high crash days. The remaining days saw little to no snow. However, several of the days with little to no snow were preceded by days with very heavy snow (marked with asterisk in Table 5). While it is likely that heavy snow does correspond to an increase in crashes, it is clearly not the only factor. This is further evidenced by heavy snow days which had no or few recorded crashes.

Table 5: Days with Greater than 10 Crashes Compared to Precipitation and Snowfall

Year	Date	Number of Crashes	Precipitation (inches)	Snowfall (inches)
2005	December 23	11	0.28	4.8
2006	January 19	11	T	0.8
	February 1	15	0.11	2.9
	February 10	10	0.08	0.4
	February 25	12	0.18	3.4
2007	November 10	9	0.12	1
2008	April 9	11	0.17	3.2
	October 13	10	0.04	1.7
	December 10	13	0.03	0.5*
2009	January 9	10	0.01	0
	January 14	13	0.21	T*
	January 30	11	0.1	4.4
	February 28	28	0.2	7.6
	November 11	10	0.09	1.3
	December 14	12	0.04	0.8
2010	February 6	14	0.13	2.1
2012	January 8	11	0.25	5.9
	February 21	15	0.08	2
	March 14	10	0.15	2.6
2013	April 6	11	0.21	6.2
	May 18	11	0.02	0.1
	November 9	10	0.06	0.2
2014	March 5	12	0.06	2.4
	October 25	11	0	0

T = trace
* = days preceded by days with heavy snowfall

Pavement surface and air temperature data was provided by the DOT&PF. Consideration was made to determine if days/time periods with large recorded differences between pavement temperature and air temperature or with temperatures close to 32 degrees Fahrenheit were correlated to days and times with a high number of crashes. No clear correlation was discovered.

2.2.5 Summary of Crash Analysis

A brief crash analysis of the study area was completed to gain insight into factors that seem to contribute to increased delay on the Glenn Highway.

- Locations with a higher than expected crash rate seem to be concentrated around some interchanges. A more detailed analysis could identify specific attributes of these interchanges that may be contributing to an increased number of crashes.
- Between 2005 and 2014, there were 18 fatal crashes in the study area. Fatal crashes occur throughout the study area, and do not appear to be concentrated at any specific location. Around 40% of the fatal crashes were related to vehicles running off of the road.
- Between 2005 and 2014, there were 24 days with more than 10 crashes on the study corridor. All 24 of the days were in the months from October through May, with half of them occurring in January and February. On the days with greater than 10 crashes, the crashes appear to be focused in the Anchorage Bowl and in the Eagle River/Birchwood area.
- Weather appears to have a significant impact on the number of crashes, with more crashes occurring in months with more snow. Rain also appears to impact the number of crashes, with more crashes occurring in months with more rain.

2.3 Analysis of Corridor Delay due to Non-Recurring Congestion

The study corridor experiences non-recurring congestion due to unplanned events (such as crashes) and planned events (such as the state fair) that may require lane closures and have a significant negative impact on the movement of people and goods.

During an event where the road capacity is reduced, for example when a crash occurs, travelers experience delay in a number of different ways. Travelers who travel the route where the crash occurred experience queuing and slower speeds through the constricted area. Travelers who choose a detour route generally travel on slower, more circuitous routes, and may also experience queuing and slower speeds on the detour routes, if the demand for the detour route exceeds the capacity of that route. Other travelers choose to delay their trip, or choose not to make a trip.

This report simplifies the analysis of delay by assuming that the delay experienced by all travelers is equal to the difference in travel time between normal conditions and between the condition where all travelers travel the route on which the crash occurred.

DOT&PF provided traffic volume counts from the three continuous count stations (CCS) along the Glenn Highway Corridor at the Bragaw Street Overpass, the Scale Houses, and the Eklutna Overpass. For each year from 2005 to 2014, DOT&PF provided 24-hour volume counts (in one-hour bins) for 40 days of each year; 20 days on which a crash had occurred, and 20 days on which a crash had not occurred. DOT&PF also provided 24-hour speed data (in one-hour bins) for the same days at the Eklutna continuous count station. The data was analyzed to identify delay corresponding to the occurrence of crashes.

Because the number of crashes, volume of traffic and capacity on the study corridor change seasonally, the delay was analyzed separately for winter versus summer months.

2.3.1 Measurement of Historical Delay

DOT&PF has traffic count stations located along the study corridor at the Bragaw Street Overpass, at the Scale Houses (approximately MPT 11), and at the Eklutna Overpass. Hourly traffic volumes are recorded at all three stations, while speed data is recorded at the Eklutna station.

When an incident occurs, both the capacity and speed of traffic are decreased at the incident location. Depending upon the time of day and level of traffic volume, queues may develop and spill back from the incident location, causing significant delay. For each paired data set (hourly volumes on a day a crash was known to have occurred and hourly volumes on the closest following day in which no crashes were identified), hourly volumes (and speeds where available) were compared. Unfortunately, the randomness in the hourly volumes each day was found to be greater than the change in volumes due to crash events. This is likely due to the lack of detail in the available volume data: the data collection locations are often far from the crash location, and the collection of hourly volumes means that shorter term volume changes are hidden.

As a result, the historical volume data could not be used to estimate corridor delay. Instead, corridor delay was estimated using a deterministic analysis, as described in the following section.

2.3.2 Deterministic Analysis for Delay

The calculation of delay using historical volume data, as discussed in the previous section, is limited by the sparsity of the data (volume counts are only available at 3 locations along the 30-mile corridor), the granularity of the data (volume counts are only available in hourly bins), and a lack of detailed information about the highway closures accompanying each crash (how many lanes of travel were closed, and for how long, etc.). Because of these limitations, it is difficult to identify the volume (and therefore delay) effects of each crash, especially for those that are cleared in a short amount of time.

As such, a deterministic model for the analysis of incident delay was developed using methodologies described in the Highway Capacity Manual 2010 (HCM) and Mannering's *Principles of Highway Engineering and Traffic Analysis*. The deterministic analysis estimates the effect of a variety of lane closure conditions on vehicle delay, with an estimation of vehicle delay due to different types of lane closures allowing a more complete estimate of annual vehicle delay due to non-recurring congestion resulting from crashes.

2010-2014 was chosen as the five-year delay analysis period, the same analysis period as for crash rate analysis. Volume data used for deterministic analysis was provided by the DOT&PF

and was collected at the 3 CCS along the study corridor. For analysis of delay, the study corridor was divided into the following three segments based on number of lanes in the segment:

- Segment 1, from Airport Heights Drive to Hiland Road (MPT to MPT 10.3), with three lanes in each direction,
- Segment 2, from Hiland Road to Artillery Road (MPT 10.3 to MPT 12.1), with three lanes in the northbound (outbound) direction and two lanes in the southbound (inbound direction),
- Segment 3, from Artillery Road to the end of the project area (MPT 12.1 to MPT 28.2), with 2 lanes in each direction.

[Note that the southbound lanes transition from two lanes to three lanes in Segment 2; however, the analysis assumed two southbound lanes for the entire segment.]

Since the crash analysis identified a higher occurrence of crashes in winter months (November through April) as compared to summer months (May through October) despite an inverse correlation with monthly average daily traffic (MADT), delay on the study corridor was also analyzed seasonally.

Based on feedback from emergency response agencies, various lane closure scenarios were developed. Each scenario was associated with a crash severity (fatal, major, minor and property damage only (PDO)) allowing a rough estimation of delay for each incident. Crash data provided by the DOT&PF was analyzed to determine the historical, seasonal occurrence of crashes on each of the three segments in the study corridor over the study period. The value of time (cost of delay) was calculated as $32.68 per hour using the US DOT publication, "Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis", updated September 27, 2016. The cost of vehicle delay was then estimated by multiplying estimated delay by crash occurrence by the value of time, to produce an annual estimate of delay due to non-recurring congestion on the study corridor.

2.3.2.1 Analysis Methodology

Seasonal delay during each time period was estimated based on a deterministic queuing model presented in the *Principles of Highway Engineering and Traffic Analysis,* Third Edition. The model assumes deterministic arrivals and deterministic departures, deterministic meaning that the traffic is assumed to arrive at a uniform flow rate. The arrival rate is the demand flow, while the maximum departure rate is the capacity of the roadway.

Assuming demand is below base capacity, arrivals and departures are the same under normal conditions (no incidents). However, if an incident such as a crash occurs and results in a lane or shoulder closure, the capacity of the roadway is reduced. If the demand flow is greater than the reduced capacity, a static or moving queue will form, depending on the lane closures and level of capacity reduction. Once the incident is cleared, the capacity will return to base conditions and the queue will dissipate.

Figure 27 shows a queue diagram of the demand volume on a roadway versus the capacity when all lanes in the direction of analysis are closed due to an incident. In the queue diagram, the demand flow changes after a certain amount of time. Initially, the capacity is 0 veh/hr, indicating a full closure of all lanes on the roadway. Once the lanes are reopened at time t_2, the roadway returns to full capacity. The slope of the full capacity curve is steeper than the slope of the demand, which indicates that the capacity is greater than the demand volume and the queue will dissipate by time t_3.

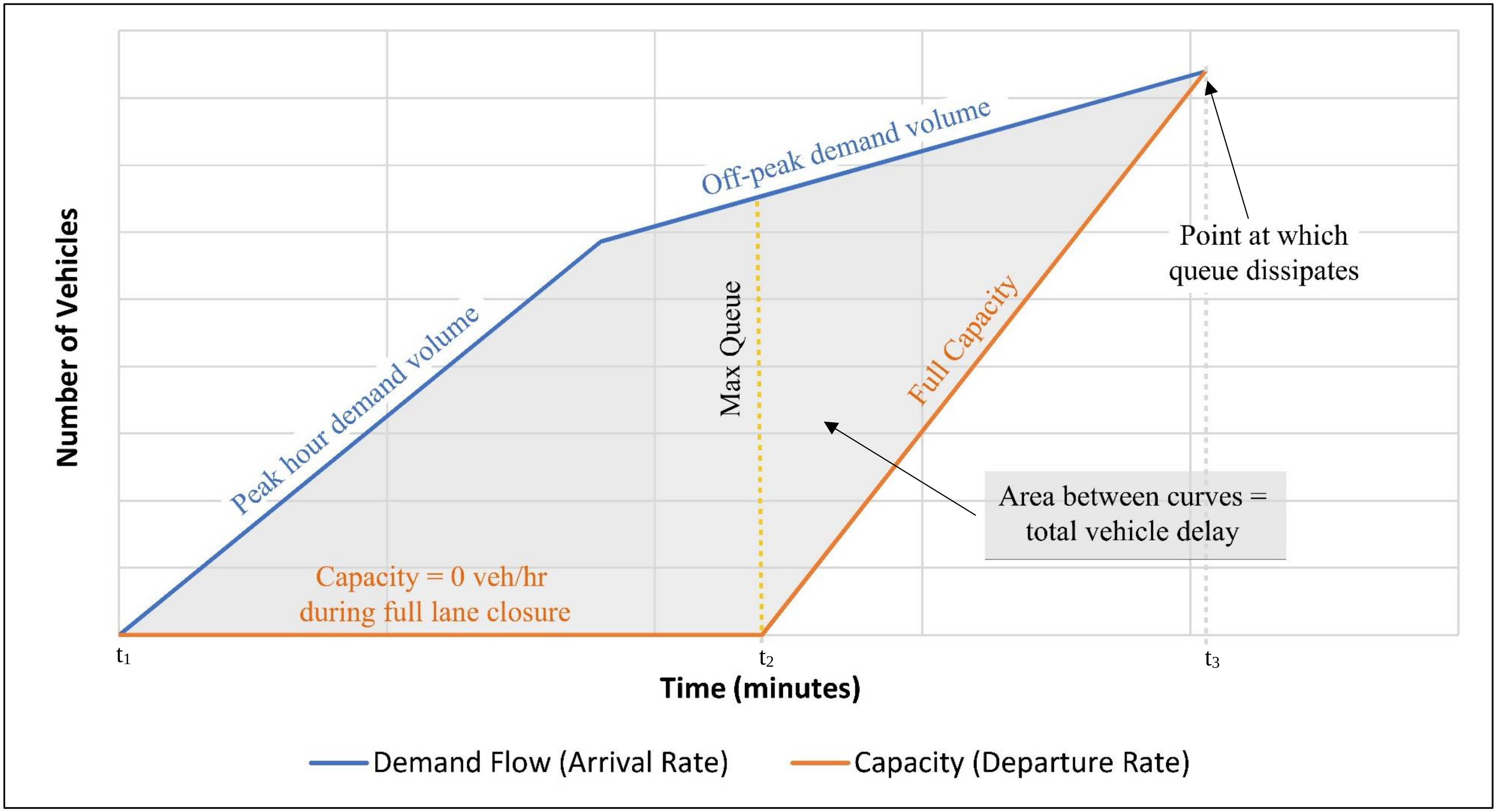

Figure 27: Queue Diagram

For each segment on the study corridor, four incident scenarios were analyzed for each season and time period, as shown in Table 6. Closure types and duration of closures were estimated based on feedback from stakeholder surveys completed by local emergency response agencies (ie. Anchorage Police Department (APD), Anchorage Fire Department (AFD), and Chugiak Volunteer Fire & Rescue Company Inc (CVFRD)) and information they provided at the Stakeholder meeting.

In their survey, APD stated that when a fatal crash occurs, all lanes in the direction of the crash are closed for at least two hours because evidence must be collected prior to clearing the crash. Additionally, if a vehicle is needed for evidence, tow companies are contracted to respond within 45 minutes. Based off of these comments, to estimate delay due to a fatal crash, the queuing model assumed a two-hour closure of all lanes in the direction of the crash, followed by a return to full capacity. (The assumption being that the vehicle is cleared during the 2-hour closure.)

The AFD indicated that when fire equipment is engaged (ambulance, fire truck etc.), all lanes in the direction of the crash are typically closed to provide room for the equipment to maneuver and to focus efforts on the rescue and that either they or CVFRD responds to all injury crashes. For this reason, the queuing model assumed full lane closures in the direction of the crash for both major and minor injuries.

In their stakeholder summary, the CVFRD estimated that the average time spent at the scene of a collision is 28 minutes, or approximately half an hour. Thus, it was assumed that the total lane closure for minor injury crashes will last an average of half an hour. For major injury crashes, it was assumed that the police may need time to collect evidence or clean up even after the fire department has departed, so the length of the total lane closure was assumed to be an average of one hour.

APD indicated that vehicles that are not collected for evidence are often left on the shoulders for an hour or more until rush hour subsides and then tow companies come out to retrieve them. As such, the secondary closure of the shoulder for injury crashes was assumed to last one hour.

APD stated that when a crash results in no injury (PDO), the police can use bumpers on their cars to push damaged vehicles onto the shoulders. It was assumed that one lane of the highway is closed in the direction of the crash for the time until police are able to move the vehicle to the shoulder (assumed to be half an hour). As with injury crashes, the vehicles are often left on the shoulders for an hour or more until rush hour subsides and then tow companies come out to retrieve them. As such, the secondary closure of the shoulder for PDO crashes was assumed to be one hour.

Table 6: Analyzed incident scenarios.

Incident Scenarios	Event	Closure Type in Direction of Crash	Duration (hrs)
Fatal Crash	Primary Closure	All lanes closed	2.0
	Secondary Closure	None	-
Major Injury	Primary Closure	All lanes closed	1.0
	Secondary Closure	One lane open	0.5
Minor Injury	Primary Closure	All lanes closed	0.5
	Secondary Closure	One lane closed	0.5
Property Damage Only	Primary Closure	One lane closed	0.5
	Secondary Closure	Shoulder closed	1.0

2.3.2.2 Analysis Parameters

2.3.2.2.1 Base Conditions

The HCM indicates that base conditions on a freeway will have a free flow speed of 70 mph, a heavy vehicle percentage of 5% and PHF factor of 0.94. The HCM defines free flow speed on freeways as the mean speed of passenger cars measured during periods of low to moderate flow. Speed data from the Eklutna count station was provided by the DOT&PF. Analysis of data gathered between 8 pm and 4 am on 12 weekdays (spread throughout the year) in 2013 confirmed a free flow speed of 70 mph. Available data from the DOT&PF *Central Region Annual Traffic and Volume Reports* identified the average heavy vehicle percentages during summer and winter to be 7% and 5%, respectively. Since 15-minute counts were not available, the PHF factor of 0.94 was applied to calculations.

The HCM defines the base capacity of a basic freeway segment to be 2,400 pc/hr/lane at 70 mph. The *2013 Quality/Level of Service Handbook* presented by the State of Florida DOT identifies that on-ramp and off-ramp influence areas have reduced capacities compared to basic freeway segments. There are 13 full interchanges and 4 half interchanges along the study corridor. If each full interchange has an influence area of 1 mile (as defined in the *Quality/Level of Service* Handbook), the study corridor is then comprised of approximately 15 miles of interchange influence areas and 14 miles of basic segments, resulting in an estimated average overall base capacity of 2,300 pc/hr/lane which was used as a starting point for analysis of delay.

The demand flow rates (ie. directional volumes) on the study corridor are based on traffic counts, which include a variety of vehicle types, while base capacities presented in the HCM are in passenger cars per hour per lane. In order to achieve an estimation of delay in vehicle-hours, base capacities were converted from passenger cars per hour per lane (pc/hr/ln) to vehicles per hour per lane (veh/hr/ln), using the following equations presented in the HCM.

(Equation 12-9) $$f_{HV} = \frac{1}{1 + P_T * (E_T - 1)}$$

(Equation 12-10) $$v_p = \frac{V}{PHF * N * f_{HV}} \rightarrow V = v_p * PHF * N * f_{HV}$$

Where v_p = demand flow rate under equivalent base conditions (pc/hr/ln) demand
V = demand volume under prevailing conditions (veh/hr)
PHF = peak hour factor (decimal)
N = number of lanes
f_{HV} = heavy vehicle adjustment factor (decimal)
P_T = proportion of heavy vehicles (decimal)
E_T = passenger car equivalent of one heavy vehicle

Note that for flat terrain, the passenger car equivalent of one heavy vehicle is 2.0, while on rolling terrain (Segment 2 – Hiland Road to Artillery Road) it is 3.0.

2.3.2.2.2 Speed and Capacity Adjustment Factors

Weather conditions, roadway geometry, driver population, and lane/shoulder closures reduce the base capacity and free-flow speed of a roadway. The HCM presents capacity adjustment factors (CAFs) and speed adjustment factors (SAFs) that account for these conditions.

The CAFs and SAFs presented in the HCM to account for weather conditions are shown in Table 7.

Table 7: HCM Exhibits 11-20 and 11-21 (Modified)

Weather Type	Weather Event Definition	CAFs (70 mph)	SAFs (70 mph)
Medium Rain	> 0.10 – 0 .25 in/hr	0.91	0.93
Heavy Rain	> 0.25 in/hr	0.84	0.91
Light snow	> 0.0 – 0.05 in/hr	0.95	0.84
Light-medium snow	> 0.05 – 0.10 in/hr	0.90	0.83
Medium-heavy snow	> 0.10 – 0.50 in/hr	0.88	0.82
Heavy snow	> 0.5 in/hr	0.74	0.81
Severe cold	< -4 deg F	0.91	0.92
Low visibility	0.50 – 0.99 mi	0.90	0.93
Very low visibility	0.25 – 0.49 mi	0.88	0.91
Minimal visibility	< 0.25 mi	0.90	0.91
Non-severe weather	All other conditions	1.00	1.0

The most common weather types along the study corridor are rain (during summer months) and snow and severe cold (during winter months). To create a winter and a summer scenario that could be used for seasonal estimation of delay along the study corridor, local weather data was retrieved from the NOAA website for the Ted Stevens International Airport. Analysis of data (2010-2014) indicated that the average rainfall event during summer months in Anchorage is below 0.10 in/hr. Hence, no CAFs or SAFs reductions due to weather were applied to traffic volumes or free-flow speed for the summer scenario. Data analysis verified that the Anchorage area experiences a variety of snow events, from light snow to medium heavy, with an average daily snowfall of 0.47 inches during winter months (2010-2014). Thus, to estimate winter conditions, CAF and SAF averages for snow and severe cold were applied. The seasonal CAFs and SAFs used for analysis are shown in Table 8.

Table 8: CAFs and SAFs used for Analysis

Season/Weather	CAF Averages used for Analysis	SAF Averages used for Analysis
Summer/Rainy	1.00	1.00
Winter/Snowy	0.88	0.84

As per the HCM, the roadway geometry on the study corridor is considered typical and the driver population is considered familiar with the roadway, so no capacity or speed reductions were applied due to these characteristics.

The HCM delineates CAFs due to a variety of incidents, and the applicable CAFs vary based on segment cross sections (number of lanes in each direction). The incident CAFs delineated in the HCM and applied during analysis are shown in Table 9. The factors apply to the capacity of each open lane. For example, if a facility with two lanes in one direction experiences a one-lane closure, the reduced capacity is 35% of the base capacity, as shown below $C_R = (0.7 * base\ capacity\ per\ lane * number\ of\ lanes\ open)$,

Table 9: Incident CAFs used for Analysis

Directional Lanes	No Incident	1 Lane Closed	2 Lanes Closed	3 Lanes Closed	4 lanes Closed	Shoulder Closed
2	1	0.70	N/A	N/A	N/A	0.81
3	1	0.74	0.51	N/A	N/A	0.83

2.3.2.2.3 AADT and Directional Distribution

Historical AADT volumes (2010-2014) were collected from the online *Central Region Traffic Volume Reports* and online ArcGIS map presented by DOT&PF. Historical MADT values collected at CCSs located west of the Bragaw Overpass and at the Scale Houses were also available from the online *Central Region Traffic Volume Reports*. Available MADT data was averaged to estimate the percentage of AADT that occurs on the study corridor seasonally (summer versus winter). Average AADT values and seasonal volume values are shown in Table 10.

Table 10: Average Daily Traffic (2010 – 2014)

Location	Annual ADT	ADT from May-Oct	ADT from Nov-Apr
Segment 1, Airport Heights to Hiland Road	53,811	57,904	49,718
Segment 2, Hiland Road to Artillery Road	47,227	50,820	43,635
Segment 3, Artillery Road to MP 29.1	32,440	34,908	29,972

Four time periods with unique traffic characteristics were identified from analysis of hourly volume data collected at the three CCSs located on the study corridor: 1) AM Peak, 2) PM Peak, 3) Off-Peak, and 4) Overnight. Table 11, delineates directional distribution percentages estimated from the data, while Table 12 shows average hourly volume percentages by time period.

Table 11: Directional Volume Distribution Percentages

Location	AM Peak		PM Peak		Off Peak	Overnight
	NB	SB	NB	SB	NB/SB	NB/SB
Segment 1, Airport Heights to Hiland Road	25%	75%	65%	35%	50%	50%
Segment 2, Hiland Road to Artillery Road	15%	85%	80%	20%		
Segment 3, Artillery Road to MP 29.1						

Table 12: Average Hourly Volume Percentages of AADT by Time Period

Location	AM Peak	PM Peak	Off Peak	Overnight
All Segments	9%	10%	5%	1%

Seasonal directional volumes by time period were estimated by multiplying seasonal AADT volumes by directional distributions by average hourly volume percentages, as summarized in Table 13 and Table 14.

Table 13: Estimated Directional Hourly Demand Volumes from May-Oct

Location	AM Peak		PM Peak		Off Peak	Overnight
	NB	SB	NB	SB	NB/SB	NB/SB
Segment 1, Airport Heights to Hiland Road	1,303	3,908	3,764	2,027	1,346	336
Segment 2, Hiland Road to Artillery Road	686	3,888	4,066	1,016	1,181	295
Segment 3, Artillery Road to MP 29.1	471	2,670	2,793	698	811	203

Table 14: Estimated Directional Hourly Demand Volumes from Nov-Apr

Location	AM Peak		PM Peak		Off Peak	Overnight
	NB	SB	NB	SB	NB/SB	NB/SB
Segment 1, Airport Heights to Hiland Road	1,119	3,356	3,232	1,740	1,156	289
Segment, Hiland Road to Artillery Road	589	3,338	3,491	873	1,014	253
Segment 3, Artillery Road to MP 29.1	405	2,293	2,398	599	697	174

2.3.2.3 Occurrence of Crashes

For each segment, the average seasonal occurrence of crashes during each unique time period was determined, using crash data from the five-year analysis period (2010-2014) provided by DOT&PF, as shown in Table 15. For analysis, crashes were further categorized by severity, as outlined in Section 3.5.

The analysis segments are not equal in length, and because of this the average number of crashes on Segments 1 and 3 is significantly higher than on Segment 2. However, the average occurrence of crashes per mile is more similar across segments, with a lower occurrence of crashes in Segment 3 likely corresponding to lower AADT on that segment. On Segment 1, twice as many crashes occur during winter months, while on Segment 2, 1.5 times as many crashes occur during winter months. On Segment 3, the seasonal occurrence of crashes is nearly equal.

Table 15: Average Seasonal Occurrence of Crashes on Study Corridor (2010-2014)

Location	MPT	Length (mi)	May-Oct		Nov-Apr	
			Avg # of Crashes	Avg crash/mi	Avg # of Crashes	Avg crash/mi
Segment 1, Airport Heights to Hiland Road	0.0 - 10.3	10.3	67.6	6.6	135.4	13.1
Segment 2, Hiland Road to Artillery Road	10.3 - 12.1	1.8	16.2	9.0	23.8	13.2
Segment 3, Artillery Road to MP 29.1	12.1 - 29.1	17.0	71.6	4.2	77.8	4.6

2.3.2.4 Example Queuing Diagrams

Queuing diagrams help visualize and quantify the delay that results from incidents of varying severity. Figure 28 through Figure 31 show example queuing diagrams for incident scenarios on Segment 2 analyzed for the AM Peak during summer in the southbound direction. The area between the arrival and departure curves in the queuing diagrams represents the total delay (in vehicle hours) experienced because of the incident.

For all scenarios, it was assumed that the estimated AM peak hour demand volume of 3,888 veh/hr would flow for 1.5 hours, then reduce to off-peak volumes of 1,1181 veh/hour. The full capacity (with no incidents) of the roadway in the southbound direction was calculated to be 3,821 veh/hr.

Figure 28 shows the queuing diagram for a fatal crash. Fatal crashes were modeled as resulting in a closure of all lanes for 2 hours, followed by a return to full capacity (all lanes open). The estimated hours of delay resulting from a fatal crash are 15,250 vehicle hours. A max queue of 6,422 vehicles could form due to a fatal crash, and the queue would not dissipate until about 4.5 hours (266 minutes) after the crash initially occurs.

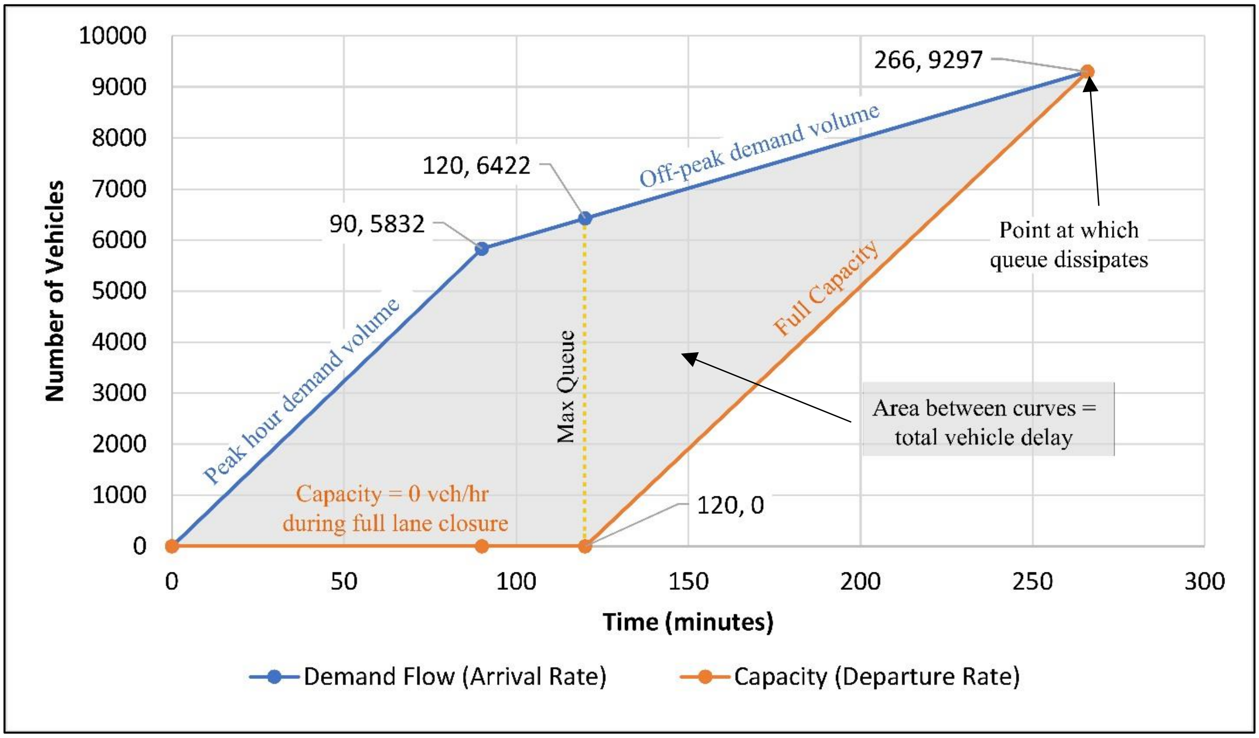

Figure 28: Queueing Diagram for Fatal Crash on Segment 2, Southbound

A major injury was modeled by assuming a one-hour closure of all lanes, followed by one lane being opened for half an hour before a return to full capacity (all lanes open). Figure 29 presents the example queuing diagram for a major injury crash. If a major injury crash occurred, approximately 9,255 vehicle hours of delay could be incurred. A vehicle queue of up to 5,800 vehicles could occur and the roadway could be backed up for up to 3.5 hours (207 minutes).

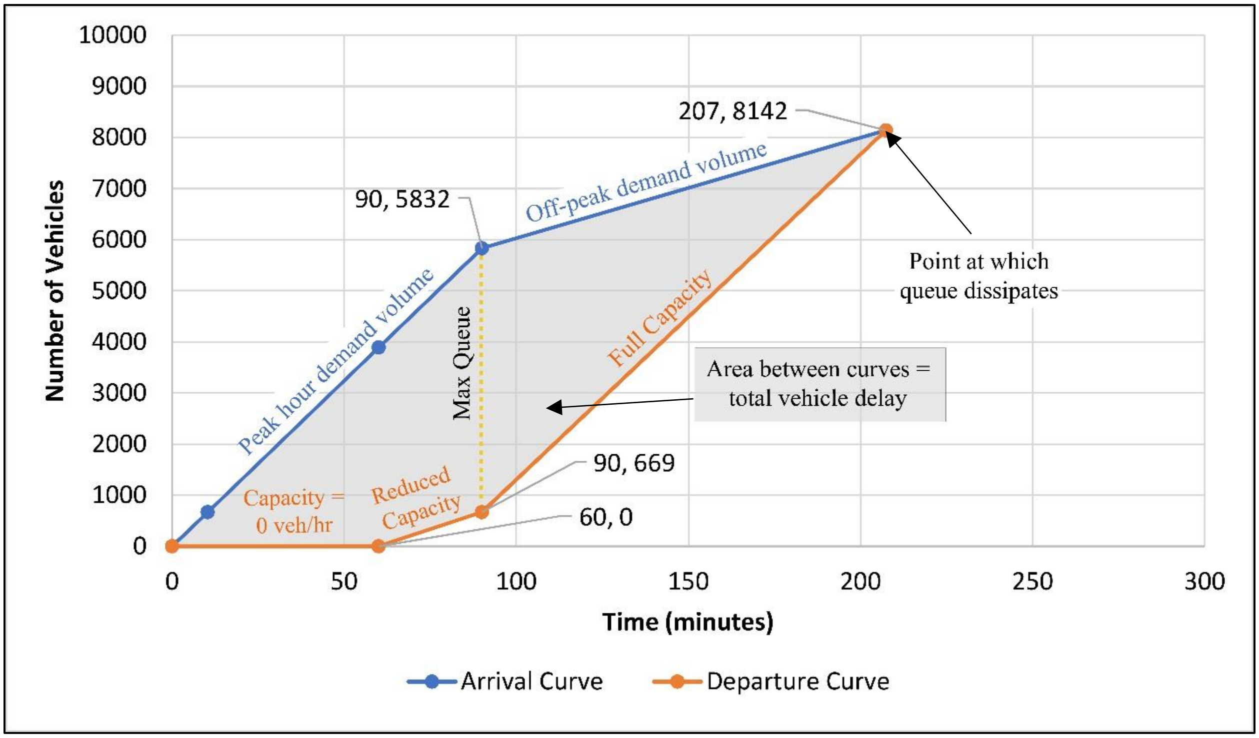

Figure 29: Queuing Diagram for Major Injury Crash on Segment 2, Southbound

It was assumed that a minor injury would result in a half hour closure of all lanes, followed by a half hour closure of one lane before a return to full capacity (all lanes open). Figure 30 presents the example queuing diagram for a minor injury crash. In the event of a minor injury, the traffic flow could be affected for up to 2.5 hours (151 minutes), with a total estimated delay of 3,739 vehicle hours. A queue of up to 3,888 cars could form.

To model a PDO crash, it was assumed that one lane would be closed for half an hour followed by a 1.5-hour shoulder closure before a return to full capacity (all lanes open). Figure 31 presents the example queuing diagram for a PDO crash. A PDO crash would cause the least amount of delay, with an estimated 3,019 vehicle hours of delay, max queue length of 2,048 cars and max congestion lasting up to approximately 2.4 hours (145 minutes).

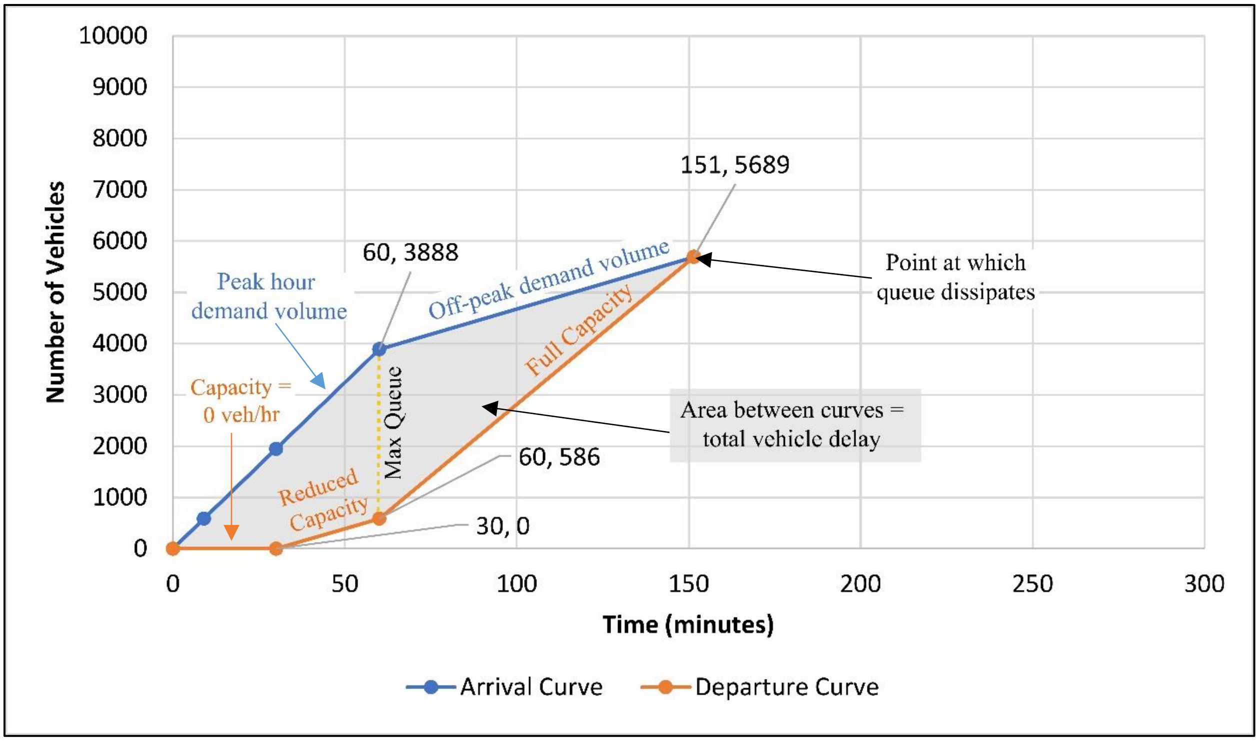

Figure 30: Queuing Diagram for Minor Injury Crash on Segment 2, Southbound

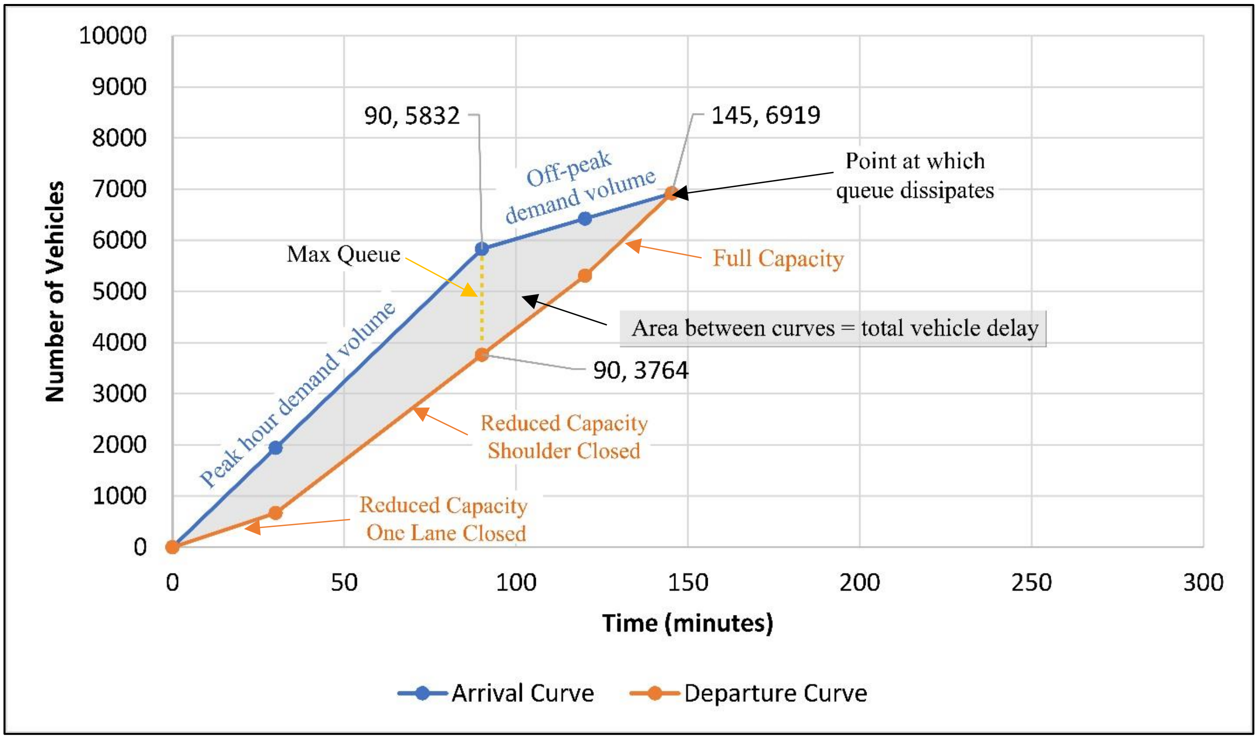

Figure 31: Queuing Diagram for PDO Crash on Segment 2, Southbound

2.3.2.5 Value of Time

The value of time (hourly) was estimated using the US DOT "Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis." The guidance considers local median income, trip purpose, vehicle occupancy rate and number of work hours in a year.

Table 16 shows the recommended values and calculations used to estimate the value of time along the Glenn Highway, estimated at $32.68 an hour.

Table 16: Value of Time Guidance and Calculations

Parameter	**Definition**	**Source or** *Calculation*
Median income (Anchorage)	$ 80,862	US Census
Number of work hours in a year	2,080	US DOT Guidance
Hourly work income	$ 38.88	*= median income ÷ work hours/year*
Value of personal travel time as % of hourly work income	70%	US DOT Guidance
Value of business travel time as % of hourly work income	100%	US DOT Guidance
Value of personal travel time ($/hour)	$ 27.21	*= hourly work income × value of personal travel time as %*
Value of business travel time ($/hour)	$ 38.88	*= hourly work income × value of business travel time as %*
% of personal travel on roadway	78.6%	US DOT Guidance
% of business travel on roadway	21.4%	US DOT Guidance
Vehicle occupancy rate	1.1	AMATS, "Status of the System Report," 2016 and 2010
Value of Time	**$ 32.68**	*= ((value of personal time × % personal travel) + (value of business time × % business travel)) × vehicle occupancy rate*

SOURCE: US DOT Guidance = "Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis", September 27, 2016. Accessed at https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic on September 13, 2018.

2.3.2.6 Analysis Results

For each seasonal scenario within each segment, delay was estimated using the developed deterministic model and the occurrence of crashes was determined based on historical data. The cost of vehicle delay due to non-recurring congestion was then calculated by multiplying estimated delay per incident by the occurrence of crashes by the value of time. While more crashes occur on the study corridor from November through April, the traffic volumes are higher from May through October. Because of this, the estimated cost of delay is higher during summer months.

2.3.2.6.1 Estimated Cost of Delay

Segment 1. The average occurrence of crashes by severity, calculated delay, and estimated cost of delay on Segment 1 are delineated in Table 17 through Table 19 for May through October and Table 20 through Table 22 for November through April. The average annual estimated cost of delay on Segment 1 is approximately $781,900, with $558,400 attributed to delay from May to October, and $223,500 resulting from delay occurring from November to April. Segment 1, with the highest AADT/MADT values, the highest occurrence of crashes, and the largest cross-section with three lanes in each direction, has the highest calculated cost of delay of any segment.

Table 17: Segment 1, Average Seasonal Occurrence of Crashes from May-Oct (2010-2014)

Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	0.0	0.0	0.0	0.0	0.8	1.4	0.6	3.0
PM Peak	0.0	0.0	0.2	0.0	2.0	1.2	5.8	1.8
Off-Peak	0.4	0.0	1.0	0.0	3.1	3.1	6.9	6.5
Overnight	0.0	0.4	0.8	0.4	6.1	5.5	9.5	9.7

Table 18: Segment 1, Estimated Vehicle Hours of Delay per Crash from May-Oct

Estimated Hours of Delay per Incident on 6-Lane Cross Section (veh-hrs)								
Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	3,339	12,001	1,554	7,282	288	2,190	0	203
PM Peak	11,435	5,422	6,879	2,822	2,047	667	152	0
Off-Peak	3,456		1,623		305		0	
Overnight	711		252		47		0	
	Total estimated veh-hours of delay from May-Oct						62,676	

Table 19: Segment 1, Estimated Seasonal Cost of Delay from May-Oct

Time Value	$32.68	per hour

Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	$0	$0	$0	$0	$7,522	$100,215	$0	$19,918
PM Peak	$0	$0	$44,964	$0	$133,772	$26,164	$28,719	$0
Off-Peak	$45,181	$0	$53,038	$0	$30,900	$30,900	$0	$0
Overnight	$0	$9,300	$6,580	$3,290	$9,430	$8,503	$0	$0
			Estimated cost of delay from May-Oct				**$558,400**	

Table 20: Segment 1, Average Seasonal Occurrence of Crashes from Nov-Apr (2010-2014)

Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	0.0	0.0	0.0	0.0	0.7	0.0	1.0	3.0
PM Peak	0.0	0.0	0.0	0.0	1.2	0.0	3.9	3.9
Off-Peak	0.0	0.0	0.4	1.0	4.5	1.0	15.0	19.2
Overnight	0.0	0.0	0.6	0.0	8.3	0.0	15.9	18.9

Table 21: Segment 1, Estimated Vehicle Hours of Delay per Crash from Nov-Apr

Estimated Hours of Delay per Incident on 6-Lane Cross Section (veh-hrs)								
Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	2,851	10,206	1,319	6,128	241	1,828	0	140
PM Peak	9,727	4,624	5,791	2,389	1,709	557	104	0
Off-Peak	2,951		1,377		255		0	
Overnight	610		216		40		0	
	Total estimated veh-hours of delay from Nov-Apr						53,063	

Table 22: Segment 1, Estimated Seasonal Cost of Delay from Nov-Apr

Time Value	$32.68	per hour

Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	$0	$0	$0	$0	$5,516	$0	$0	$13,733
PM Peak	$0	$0	$0	$0	$67,005	$0	$13,193	$0
Off-Peak	$0	$0	$18,001	$45,004	$37,539	$8,342	$0	$0
Overnight	$0	$0	$4,229	$0	$10,973	$0	$0	$0

Estimated cost of delay from Nov-Apr	**$223,500**

Segment 2. Analysis results for Segment 2 are shown in Table 23 through Table 25 (May-Oct) and Table 26 through Table 28 (Nov-Apr). The total average annual cost of delay is $242,800, with $130,200 from May through October and $112,600 from November through April. Because Segment 2 is only 1.8 miles long, the calculated cost of delay is much less than that of Segment 1 (10.3 miles long). However, the occurrence of crashes/mile on Segment 2 is similar to Segment 1, so the cost per mile would be comparable.

Table 23: Segment 2, Average Seasonal Occurrence of Crashes from May-Oct (2010-2014)

Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.4
PM Peak	0.0	0.0	0.0	0.0	0.6	0.0	0.2	0.2
Off-Peak	0.0	0.0	0.0	0.4	0.4	0.8	2.4	2.0
Overnight	0.0	0.0	0.2	0.0	1.3	1.3	3.0	3.0

Table 24: Segment 2, Estimated Vehicle Hours of Delay per Crash from May-Oct

Estimated Hours of Delay per Incident on 5-Lane Cross Section (veh-hrs)								
Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	1,722	15,250	682	9,255	113	3,739	0	3,019
PM Peak	12,687	2,901	7,912	1,115	2,452	364	432	0
Off-Peak	2,976	3,420	1,389	1,392	254	473	0	0
Overnight	622	639	220	212	41	47	0	0
	Total estimated veh-hours of delay from May-Oct						73,330	

Table 25: Segment 2, Estimated Seasonal Cost of Delay from May-Oct

Time Value	$32.68	per hour

Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	$0	$0	$0	$0	$740	$0	$0	$39,462
PM Peak	$0	$0	$0	$0	$48,080	$0	$2,822	$0
Off-Peak	$0	$0	$0	$18,203	$3,316	$12,374	$0	$0
Overnight	$0	$0	$1,438	$0	$1,749	$2,010	$0	$0
			Estimated cost of delay from May-Oct				**$130,200**	

Table 26: Segment 2, Average Seasonal Occurrence of Crashes from Nov-Apr (2010-2014)

Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.7
PM Peak	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.5
Off-Peak	0.0	0.0	0.0	0.2	1.0	1.0	2.1	3.3
Overnight	0.0	0.0	0.0	0.6	0.8	1.6	3.4	3.4

Table 27: Segment 2, Estimated Seasonal Cost of Delay from Nov-Apr

Estimated Hours of Delay per Incident on 5-Lane Cross Section (veh-hrs)								
Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	1,466	12,688	578	7,631	96	3,073	0	2,330
PM Peak	10,669	2,447	6,609	936	2,027	302	266	0
Off-Peak	2,527	2,882	1,174	1,167	211	393	0	0
Overnight	533	547	188	181	35	40	0	0
	Total estimated veh-hours of delay from Nov-Apr						60,998	

Table 28: Segment 2, Estimated Seasonal Cost of Delay from Nov-Apr

Time Value	$32.68	per hour

Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	$0	$0	$0	$0	$627	$20,086	$0	$53,307
PM Peak	$0	$0	$0	$0	$0	$1,973	$2,611	$0
Off-Peak	$0	$0	$0	$7,630	$6,906	$12,839	$0	$0
Overnight	$0	$0	$0	$3,553	$919	$2,098	$0	$0

Estimated cost of delay from Nov-Apr	$112,600

Segment 3. Table 29 through Table 31 (May through October) and Table 32 through Table 34 (November through April) summarize the calculations and results for Segment 3. The total average annual cost of delay on Segment 3 is $668,900, with $348,700 of that cost resulting from delay from May through October and $320,200 resulting from delay from November through April. While fewer crashes per mile occurred on this segment, the total segment is 17 miles long, significantly longer that the other two segments (10.3 and 1.8 miles long, respectively). As such, the total cost of delay is high.

Table 29: Segment 3, Average Seasonal Occurrence of Crashes from May-Oct (2010-2014)

Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	0.0	0.0	0.0	0.0	0.9	1.9	0.4	2.2
PM Peak	0.0	0.2	0.0	0.0	1.8	0.2	0.9	0.5
Off-Peak	0.0	0.2	0.4	0.4	2.6	1.8	5.3	5.7
Overnight	0.0	0.2	0.2	0.8	2.8	9.2	6.7	12.1

Table 30: Segment 3, Estimated Vehicle Hours of Delay per Crash from May-Oct

Estimated Hours of Delay per Incident on 4-Lane Cross Section (veh-hrs)								
Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	1,176	8,107	353	4,500	88	1,750	0	400
PM Peak	8,590	1,736	4,829	625	1,887	172	535	0
Off-Peak	2,029		775		230		0	
Overnight	427		141		30		0	
	Total estimated veh-hours of delay from May-Oct						38,378	

Table 31: Segment 3, Estimated Seasonal Cost of Delay from May-Oct

Time Value	$32.68	per hour

Time Period (May-Oct)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	$0	$0	$0	$0	$2,593	$108,650	$0	$28,726
PM Peak	$0	$11,345	$0	$0	$111,001	$1,122	$15,743	$0
Off-Peak	$0	$0	$10,132	$10,132	$19,528	$13,520	$0	$0
Overnight	$0	$0	$923	$3,694	$2,703	$8,882	$0	$0
			Estimated cost of delay from May-Oct				**$348,700**	

Table 32: Segment 3, Average Seasonal Occurrence of Crashes from Nov-Apr (2010-2014)

Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	0.0	0.0	0.0	0.4	0.2	0.8	1.1	1.5
PM Peak	0.0	0.2	0.4	0.2	1.0	0.6	2.0	1.0
Off-Peak	0.0	0.0	0.4	0.8	2.8	2.4	9.5	8.1
Overnight	0.0	0.0	0.2	0.8	2.1	6.5	7.6	15.0

Table 33: Segment 3, Estimated Seasonal Cost of Delay from Nov-Apr

Estimated Hours of Delay per Incident on 4-Lane Cross Section (veh-hrs)								
Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	1,003	6,859	302	3,782	75	1,466	0	344
PM Peak	7,265	1,479	4,057	529	1,580	143	385	0
Off-Peak	1,728		656		192		0	
Overnight	366		121		25		0	
	Total estimated veh-hours of delay from Nov-Apr						32,356	

Table 34: Segment 3, Estimated Seasonal Cost of Delay from Nov-Apr

Time Value	$32.68	per hour

Time Period (Nov-Apr)	Fatality		Major Injury		Minor Injury		PDO	
	NB	SB	NB	SB	NB	SB	NB	SB
AM Peak	$0	$0	$0	$49,443	$487	$38,319	$0	$16,858
PM Peak	$0	$9,668	$53,033	$3,461	$51,640	$2,804	$25,153	$0
Off-Peak	$0	$0	$8,577	$17,155	$17,543	$15,037	$0	$0
Overnight	$0	$0	$792	$3,166	$1,732	$5,359	$0	$0
			Estimated cost of delay from Nov-Apr				**$320,200**	

Summary. Table 35 summarizes the results of the analysis of delay. The total estimated annual cost of delay on the study corridor is almost $1.7 million.

Table 35: Total Estimated Annual Cost of Delay on Study Corridor

Segment	May-Oct	Nov-Apr	Annual
Segment 1 – Airport Heights to Hiland Road	$558,400	$223,500	$781,900
Segment 2 – Hiland Road to Artillery Road	$130,200	$112,600	$242,800
Segment 3 – Artillery Road to MP 29.1	$348,700	$320,200	$668,900
Glenn Highway Study Corridor	$1,037,300	$656,300	$1,693,600

The US DOT's National Highway Traffic Safety Administration (NHTSA) conducted a "National Telephone Survey of Reported and Unreported Motor Vehicle Crashes" in July 2015. In their report, they stated the "95 percent confidence interval for the percentage of all crashes that are unreported is between 26.7 percent and 31.9 percent." More specifically, about 35.6% of PDO crashes are unreported, while 15.4% of injury crashes go unreported. Based off these statistics, it is likely that crashes on the study corridor have been historically underreported. Increasing the reported occurrence of injury crashes by 15.4% and the occurrence of PDO crashes by 35.6% results in an estimated upper range or delay costs of just over $2 million annually.

Note that the cost of delay per segment does not correspond directly to locations with high crash rates dues to the varying length in segments, varying AADT values and cross sections.

2.3.2.6.2 Example of Delay due to Fatal Crash Visualized using Volume Data

As discussed in Section 2, in general analysis of the limited speed and crash data available from CCSs did not clearly demonstrate the effect of crashes on vehicle delay due to crashes. However, one example was found where the effect of the crash could clearly be seen in the volume data. The fatal crash occurred at milepoint 14 (near the North Eagle River Interchange) on Thursday, July 1, 2010 at 5:25 PM. The crash occurred when a southbound vehicle crossed the median and struck two northbound vehicles. Figure 32 depicts hourly volumes during and after the PM peak on the crash day compared to hourly volumes for the same time-period on the next non-crash day. On the non-crash day (July 2), traffic volumes were highest from 4 PM to 5 PM, and slowly decreased each hour. On the crash day (July 1), traffic volumes were also highest from 4 PM to 5 PM, but then volumes dropped slightly more in the hour in which the crash occurred (between 5 PM and 6 PM) compared to the non-crash day. There was a significant decrease in traffic volumes between 6 PM and 8 PM on the crash day compared to the non-crash day, which supports the APD statement that when a fatal crash occurs, the traffic flow is affected for at least two hours. By 9 PM, traffic volumes on the crash day were higher than on the non-crash day, indicating that the road had been cleared and traffic that was delayed could flow freely. The volumes had dropped to approximately the same level on both days by the hour from 11 PM to Midnight.

Figure 32 shows how the cumulative volume percentage differed between July 1, 2010 (the day with the fatal crash) and July 2, 2010. The difference between the two curves represents the delay experienced by vehicles affected by the crash on July 1, about 5,000 vehicle-hours of delay.

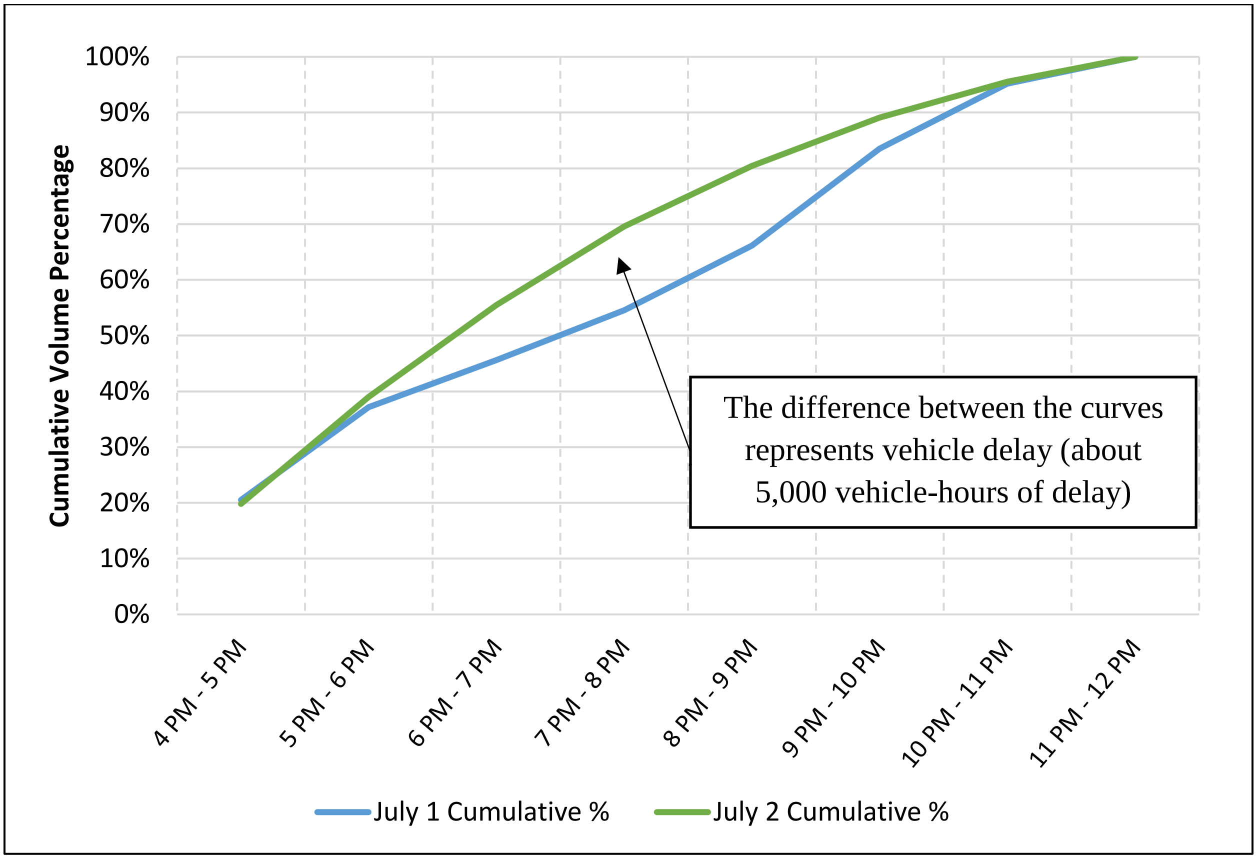

Figure 32: Comparison of Cumulative Vehicle Volume on a Crash Day Compared to a Non-Crash Day

Contrary to our deterministic model, it can be seen that vehicles continued to flow on the Glenn Highway during the 2-hour window after the crash occurred. This may be due to vehicles entering the highway from an interchange north of the crash.

2.4 Stakeholder Summary

In order to identify measures for improvements to the management of the Glenn Highway, it is important to recognize current practices, including and not limited to the role of each agency during an incident, what resources agencies have available, and other entities that each agency collaborates with. Agency stakeholders for the Glenn Highway were contacted about the project and were invited to participate in a Stakeholder Survey. The Stakeholder Survey was designed to gather information regarding how traffic incidents in the project corridor influence each agency. The survey asked questions about the agency’s response to traffic incidents, adjustments agencies make to normal operations due to incidents, and coordination between the different agencies.

Table 36 lists the stakeholders who were invited to participate in the survey and whether they responded.

See Appendix A: for Completed Stakeholder Surveys.

KE also invited stakeholder agencies to meet on April 17, 2018 to help outline the existing coordination and decision making that occurs after an incident, as well as to discuss opportunities for improvements.

See Appendix B: for the Stakeholder Meeting Summary.

2.4.1 Stakeholder Agencies

2.4.1.1 Planning

2.4.1.1.1 DOT&PF Planning

Planning develops projects to improve safety, enhance access and mobility, and lower transportation costs. Planning identifies and evaluates potential projects, coordinates new projects with other projects, and obtains input from the public and other agencies. The planning section also has a representative on the Anchorage Metropolitan Area Transportation Solutions (AMATS) technical advisory committee to facilitate coordination between MOA and DOT&PF when evaluating and recommending projects on DOT&PF roads within the Municipality. While the planning section is not involved directly during an incident with non-recurring congestion, the planning section would help program infrastructure improvements that could reduce delay during non-recurring congestion.

2.4.1.1.2 MOA Planning Department

The MOA planning department is comprised of three divisions: Current Planning, Long-Range Planning, and Transportation Planning/AMATS. The Current Planning Division administers the MOA's land use and subdivision regulations, implements comprehensive land-use plans, and updates Title 21, municipal ordinances related to land use regulations, as well as development and design standards. The Long-Range Planning Division helps plan for community growth and development based on land use, urban design, economic and environmental planning principles. The Transportation Planning/AMATS division is the Metropolitan Planning Organization (MPO) for the Anchorage Bowl and Chugiak-Eagle River areas, representing all of the different agencies with jurisdiction within the AMATS area when federal transportation funds are being used.

Table 36: Stakeholder Agencies that received and responded to the Stakeholder Survey

Agencies Invited to Complete our Stakeholder Survey	
Agency	**Completed Survey**
Alaska Department of Transportation and Public Facilities	
Planning	X
ITS	X
Maintenance & Operations	X
Traffic	X
Municipality of Anchorage	
Traffic	X
Long Range Planning	X
Maintenance & Operations	
PM&E	X
MSB	
MSB Planning and Land Use Dept	
Emergency Responders	
Anchorage Police Department	X
State Troopers	X
Anchorage Fire Department	X
Chugiak Volunteer Fire and Rescue	X
LifeMed	X
Transit	
People Mover	
Valley Transit	
Other Organizations	
Native Village of Eklutna	X
CBERRSA	X
Alaska Trucking Association	X
Anchorage School District Transportation Department	X
NIT (Northern Industrial Training)	X
Bore Tide Construction	X
United Freight and Transport	X
Additional Agency Coordination	
Agency	**Action**
JBER	Letter sent to Colonel Dietrich
Alaska Railroad	Meeting
MetroQuest Survey	
Organization	**Distributed to Members**
Chugiak-Eagle River Chamber of Commerce	X
Passenger Rail for Commuters Anchorage-MatSu	X
Alaska Trucking Association	X

AMATS is responsible for developing, updating and approving the Metropolitan Transportation Plan (MTP) and Transportation Improvement Program (TIP), which help determine how federal funds will be used for transportation projects. The MTP is updated every four years and documents the recommended transportation improvements over the next twenty years. The 2035 MTP was published in 2012; it included projects to improve the Glenn Highway interchanges at Hiland Road and Artillery Road and a new partial interchange at Farm Avenue. It also included projects to improve the Glenn Highway interchange at Muldoon Road (construction has been nearly completed) and add high-occupancy vehicle (HOV) lanes to the Glenn Highway corridor from Boniface Parkway to the Peters Creek interchange. The plan also recommended a Mat-Su to Anchorage Express Bus that leaves every 30 minutes during morning, afternoon, and peak periods, and a new Park and Ride at Hiland Road. The draft MTP 2040 Plan is expected to be published winter 2019. It includes a possible toll for the Glenn Highway and discusses HOV versus high-occupancy toll (HOT) lanes.

2.4.1.2 Operations

2.4.1.2.1 Alaska Department of Transportation and Public Facilities (DOT&PF) – Central Region

Several groups within DOT&PF are involved with operations of the Glenn Highway corridor. DOT&PF is always involved in incidents on the highway that affect the infrastructure, since DOT&PF is the owner of the highway. DOT&PF does not have any 24-7 operations, and therefore relies on the Anchorage Police Department for immediate responses to all crash incidents.

2.4.1.2.2 DOT&PF Maintenance and Operations (M&O)

M&O is responsible for maintenance response, weather response, and some construction response on the Glenn Highway. During weather events, they provide equipment and personnel as necessary, including plowing and sanding. Depending on the incident, M&O might adjust their shift from day to night or adjust to around the clock operations. The M&O division alerts the public of operations through Alaska Navigator, Facebook, Twitter, radio, and other onsite methods. Alaska Navigator is an online source for road construction information within the State of Alaska. The site is updated daily during construction season to provide users with information pertaining to road closures and traffic impacts.

2.4.1.2.3 DOT&PF Traffic and Safety

DOT&PF Traffic and Safety responds to preplanned, unplanned, and emergency construction prior, during, and after an event along the Glenn Highway. Traffic and Safety can adjust traffic flow with lane and road closures. Traffic and Safety alerts the public of construction through Navigator, Facebook, Twitter, radio, television news, and other onsite methods. Traffic and Safety coordinates with the MOA; APD, Anchorage Fire Department (AFD) and other emergency responders; Anchorage School District (ASD); utilities; and any other agency involved with the construction. DOT&PF Traffic and Safety coordinates through preseason meetings, designs and specifications, and announcements. One of the biggest hurdles is a lack of personnel working 24 hours a day, 7 days a week. It was mentioned in the stakeholder survey that it would be helpful for the section to have emergency incident preplanning and drills. This training is currently being conducted by the department.

2.4.1.2.4 DOT&PF Intelligence Transportation Systems (ITS)

The ITS section uses advanced technologies to make travel smarter and more efficient. One objective of the section is to use equipment with the same specifications to promote interoperability between systems. One example is the changeable message sign (CMS) on the northbound Glenn Highway near Arctic Valley. Anchorage Police Department (APD) is responsible for putting the messages on the board, but DOT&PF Central Region Traffic section is responsible for ensuring the messages conform to guidelines and that the board is in working order. DOT&PF also provides APD with safety messages to be posted at certain times of the year (for example, holiday weekends). If there is an issue with the CMS, DOT&PF Traffic contacts the Central Region Public Information Officer or APD Dispatch through email or phone. There is not a formal agreement between DOT&PF Traffic section and other agencies identifying responsibilities, but rather, they have developed informal practices that are working well.

Another ITS tool being used are the Road Weather Information Systems (RWIS). RWIS is a network of metrological and pavement sensors located along highway system that can provide weather information. Between Anchorage and the Knik River Bridge there are four RWIS along the Glenn Highway that include cameras. However, none of the cameras currently record and store information, though they have that ability. The RWIS/camera systems are at the S Curves (MP 10), Eagle River Bridge (MP 12.8), Thunderbird Falls (MP 24.5), and Knik River Bridge (MP 31.1).

Additionally, DOT&PF is responsible for the 511 website and text or email notifications that update the public about driving conditions and events. DOT&PF posts the information provided via the 511 system. For information regarding crashes and lane closures, DOT&PF receives alerts from the Anchorage Police Department (via Nixle) and automatically posts all alerts pertinent to the highway system to 511.

2.4.1.2.5 MOA Traffic

The MOA Traffic Department is responsible for the operation of all traffic signals within the MOA (whether owned by the state or by the municipality). The MOA is also responsible for all MOA-owned roads, including pavement markings and street signs to ensure safe and efficient transportation and communications. For the Glenn Highway, DOT&PF alerts the MOA Traffic Department if there will be changes or if construction will affect a MOA road. While the MOA is capable of adjusting signal timing within Eagle River, if necessary, the MOA does not usually change signal timing in Eagle River in reaction to incidents on the Glenn Highway because the unsignalized intersections at the interchange ramps are the limiting factor in terms of capacity.

The MOA has a traffic camera at the Airport Heights signal, but no cameras in Eagle River at this time. They use Centrax Econlight controllers and loop detection, but they are starting to experiment with radar detection. This department also manages the Traffic Operations Center;

however, this center only has 3 staff members and it is not staffed 24 hours a day, 7 days a week. Adjustments to signal timing can be done remotely, if needed.

2.4.1.2.6 MOA Project Management and Engineering (PM&E)

The Municipality of Anchorage Project Management and Engineering division manages design and construction of roads, sidewalks, storm drains, trails and parks projects owned by the MOA. PM&E coordinates with DOT&PF during construction. PM&E used to manage a website that listed all of the muni-wide construction projects by any agency; this website is no longer used and communication/information about construction is sent to the various agencies via fax.

2.4.1.3 Fire and Emergency Response

2.4.1.3.1 Anchorage Police Department (APD)

APD responds to 911 calls along the highway system and monitors for traffic violations. Along the Glenn Highway, APD performs emergency response, crash investigation, evidence collection, vehicle removal, traffic control, and lane and road closures. APD coordinates with AFD and other emergency responders through a common dispatch. APD oversees the CMS messages and APD-related Nixle reports. Nixle provides notifications to the public directly from government agencies; these messages include alerts, advisories, community information, or traffic information. The public can sign up to receive texts or emails from specified organizations like the police department, schools, or other organizations. During construction events, APD helps with traffic control, and APD will try to help with traffic calming during weather events. When weather causes an incident on the highway, APD is the first responder to the crash.

2.4.1.3.2 Anchorage Fire Department (AFD)

AFD responds to fire and medical emergencies along the Glenn Highway. They also coordinate with APD for lane and road closures to prevent and reduce secondary crashes due to the primary crash. AFD will sometimes dispatch the Chugiak Volunteer Fire & Rescue Company (CVFRD) to respond or assist in the response or DOT&PF or MOA for sanding or other assistance. If there are hazardous materials associated with an incident, AFD will call Alaska Department of Environmental Conservation (ADEC). AFD only responds to weather events if there are crashes. AFD will also respond to calls for medical assistance along the corridor, even if there is not any impact to traffic conditions from the incident, for example, collapsed persons, bicyclists or ATV medical emergencies, search and rescue, etc. AFD response includes emergency apparatus and personnel scaled to the type and severity of the incident. When responding to a collision on the Glenn Highway, all lanes of traffic are generally closed for the affected direction of traffic while the fire equipment is engaged, simply because of the size of the equipment and the need to focus on the rescue operation.

According to the survey from AFD, the biggest hurdle when working in the highway corridor is accessing the scene and providing for the safety of their personnel. The lack of alternate routes hinders emergency responders getting to the scene. The Fire Department indicated that more immediate notification to the public to stay off the road after crash events would help reduce congestion along the corridor.

2.4.1.3.3 Chugiak Volunteer Fire and Rescue Company Inc (CVFRD)

The Chugiak Volunteer Fire and Rescue Company provides fire protection and emergency medical services (EMS) on the Glenn Highway from the Knik River to the North Eagle River overpass and access road. CVFRD responds to nearly 900 emergency calls per year of which 75 to 80 percent are medical emergency responses. The 100 or so members of CVFRD are all volunteer. There are four crews, each on call for one week of a four-week rotation, from 6:30 pm to 6:30 am on weekdays and all hours of the weekend.

The CVFRD responds to emergencies on the Glenn Highway when APD dispatch believes CVFRD will be able to respond faster than APD or AFD. During a crash incident, CVFRD directs its resources to the Glenn Highway and they also often stage additional equipment on the overpasses for possible secondary incidents. CVFRD coordinates with APD, Alaska State Troopers, Lifemed, and DOT&PF through dispatchers as needed. According to CVFRD, the biggest hurdle responding to incidents is getting through the traffic to the incident. They believe widening turn-arounds and having the ability to re-route traffic would help alleviate these issues. Additionally, better mile marker signs would help their response efforts. During response, CVFRD follows standard operating procedures for fire and EMS response. CVFRD indicated that the average time engaged at the scene of a collision is 28 minutes.

2.4.1.4 Transit

2.4.1.4.1 People Mover

People Mover is a public transportation agency that serves Anchorage, Alaska as well as Eagle River. People Mover maintains 52 buses that serve Anchorage and Eagle River with 14 regular transit routes. A recent route restructuring reduced service to Eagle River. Currently, Route 92 is a commuter route traveling between Eagle River and Anchorage. The bus schedule is as follows:

Monday through Friday - Eagle River Transit Center to City Hall

- Leaves: 5:47 am, 5:48 am, 6:47 am, 6:48 am. 7:14 am, 7:15 am, 4:20 pm

Monday through Friday - City Hall to Eagle River Transit Center

- Leaves: 6:32 am, 3:35 pm, 4:20 pm, 4:11 pm, 5:12 pm, 5:13 pm, 6:10 pm

2.4.1.4.2 Valley Transit

Valley Transit provides public transit service between the Matanuska-Susitna Valley and Anchorage as well as demand response within the Valley. Valley Transit operates Monday through Friday. The commute between the Valley and Anchorage costs $7 one way, $10 per day, or $120 per month. Valley Transit travels between the Valley Transit Park and Ride and the Anchorage Downtown Transit Center:

Monday through Friday – Valley Transit Park and Ride to Downtown Transit Center

- Leaves: 4:40 am, 4:55 am, 6:10 am, 6:25 am, 11:40 am. 12:50 pm, 1:55 pm, 2:55 pm, 3:10 pm, 4:30 pm

Monday through Friday – Downtown Transit Center to Valley Transit Park and Ride

- Leaves: 5:55 am, 7:40 am, 8:35 am, 1:10 pm, 2:05 pm, 4:10 pm, 5:15 pm, 5:35 pm, 6:40 pm

2.4.1.5 Alaska Railroad Corporation (ARRC)

The Alaska Railroad Corporation (ARRC) provides year-round transportation throughout Southcentral and Interior Alaska. The two trains that run parallel to the Glenn Highway project limits are the Denali Star and the Aurora Winter Train.

The Denali Star train runs daily from mid-May to mid-September between Anchorage and Wasilla (and points further north). It departs Anchorage to head northbound at 8:15 am arriving in Wasilla at 9:30 am and departs Wasilla at 6:20 pm arriving in Anchorage at 8:00 pm. Additionally, during the State Fair weekends, ARRC runs six to eight passenger trains a day between Anchorage and the fair-grounds in Palmer.

The Aurora Winter train runs from the end of September to mid-May. It runs northbound once a weekend and southbound once a weekend, with some mid-week service that varies from month to month, according to demand.

If the Glenn Highway faced significant closures, ARRC would potentially be able to provide service to carry people around the closure; however, in the summer, ARRC has all passenger trains running at or close to capacity and the rail tracks themselves are at or near capacity. Mobilizing to be able to transport additional passengers during an event on the Glenn Highway would take two to three days.

Providing passenger rail in the winter has additional challenges. Only about 12 train cars are winterized, as most of the train cars are not designed for winter passenger use and do not have adequate heating for a comfortable ride. Additionally, equipment that runs regularly in the winter must be stored inside between trips.

Nevertheless, there is precedent for ARRC to aid in carrying passengers during a highway closure event. During a wildfire in 2015, the ARRC rail tracks remained open while the Parks Highway was closed. ARRC assisted in ferrying many persons around the fire, back and forth between Wasilla and Talkeetna. Tour companies who would normally carry passengers on buses reached out to ARRC passenger services and filled otherwise empty spots on ARRC trains. Similarly, whereas under normal circumstances the luggage for some of ARRC's tour passengers is carried on trucks on the Parks Highway, during this event ARRC arranged to take the luggage as well.

According to the stakeholder summary, in order for ARRC to serve commuters short or long term, there needs to be better connecting commuter services/infrastructure. Commuters need to get from their house to the train station and have ways to get from the train station to their place of employment. Additionally, there needs to be sufficient parking at the train depots, which is particularly lacking in Wasilla. One solution might be to partner with vanpooling to take passengers from the train station to their work. Another solution may be for large employers to provide shuttles for their employees. A number of commuters work at Joint Base Elmendorf-Richardson (JBER), but due to security issues it would be difficult to add a train stop at the base. See Appendix D: ARRC Meeting Summary for more information.

Note that Governor Bill Walker convened a task force to discuss the feasibility and implementation of a pilot project for a commuter rail system between the Matanuska-Susitna Valley and Anchorage using existing railroad infrastructure to the extent possible. This task force has held several meetings. Initial findings and recommendations indicating what is needed for a pilot study in 2019 were sent to the Governor in May 31, 2018. (Meeting minutes for the task force can be found at http://dot.state.ak.us/commuterrail/.)

2.4.1.6 Joint Base Elmendorf-Richardson (JBER)

The Glenn Highway serves four gates onto JBER through the Boniface Interchange, Muldoon Interchange, Arctic Valley Interchange, and the Fort Richardson Interchange. JBER asked for additional time to complete the agency survey, so that the answers could be vetted by the proper authority, and the completed survey has not yet been received from JBER as of the writing of this draft report. In addition to the questions asked of all other agencies, JBER was asked whether or not it would be possible to route traffic onto military property in the event of a major incident on the Glenn Highway.

2.4.1.7 Anchorage School District (ASD) Transportation

The ASD Transportation department provides transportation for public school children between their homes and the schools, including developing bus schedules, safe walking routes, safety training, and school bus/support maintenance. Four high schools have school zone boundaries that overlap the Glenn Highway: Bartlett High, East High, Eagle River High, and Chugiak High. There are also numerous Elementary, Middle, Charter, and Alternative Schools that would be accessed by traveling along the Glenn Highway.

During a crash incident, ASD initiates an adjustment to normal operations based on information from bus drivers, Nixle alerts, and radio stations. Departments that may be impacted are notified of the incident. Depending on the severity and location of the crash, operations can be diverted or delayed. During construction events, the State of Alaska, Municipality, and private contractors communicate with ASD for needed adjustments, such as accelerated departure times or route changes. ASD monitors weather on the Glenn Highway from the National Oceanic and Atmospheric Administration (NOAA) weather information and sometimes APD, if crashes are occurring. ASD will delay or accelerate school bus departure times or require the use of chains, depending on weather conditions. Additionally, schools will be closed or have delayed opening of up to two hours to help with weather incidents. The challenges ASD have are congestion caused by an incident and communication to parents and school staff.

See the ASD survey in Appendix C for ASD alternate routes currently used to avoid the Glenn Highway.

ASD suggests the following improvements:

1) Put a third lane southbound from the South Eagle River on-ramp across the Eagle River Bridge with a dedicated non-merge lane.
2) Extend the on-ramp for entering the Glenn Highway Southbound from Highland Road, similar to the northbound South Eagle River on-ramp.
3) Improve the grade on the Glenn Highway from Eklutna to North Peters Creek.
4) Open a Frontage Road all the way from Arctic Valley to Highland Road northbound on the Glenn Highway.
5) Mandated communication to all stakeholders about any construction projects. Continuing to create a very efficient communication system among all the agencies. Better use of the information board currently at the Northbound Glenn Highway just past Arctic Valley.

2.4.1.8 Other Agencies

In addition to key stakeholders for the Glenn Highway, other agencies were contacted to fill out the stakeholder survey. These stakeholders either provide service along the Glenn Highway corridor or they are located along the Glenn Highway corridor.

- The Eklutna Reservation includes 1,819 acres, including a large amount of land adjacent to the Glenn Highway. The Native Village of Eklutna is on the west side of the Glenn Highway at the Eklutna interchange.
- LifeMed provides emergency air ambulance services 24/7 through-out Alaska and is headquartered in Anchorage, Alaska. If LifeMed is needed along the Glenn Highway, an EMS agency will contact and coordinate with LifeMed via radio channels.
- The Chugiak/Birchwood/Eagle River Rural Road Service Area (CBERRRSA) encompasses over 350 lane miles of roadway in the Chugiak, Birchwood, and Eagle River areas. Each area has a representative from their community council that meets to help communicate with MOA about the level and type of road services the residents of the area need.
- Alaska State Troopers (AST) assists APD if an incident occurs near the Knik River end of the Glenn Highway project area. AST can assist APD with traffic control and scene documentation and can attempt to reroute traffic whenever possible. They also notify radio stations to broadcast roadway issues and coordinates with DOT&PF if the roadway is damaged or needs sand, etc.

2.4.2 Existing Coordination and Decision Making

Coordination between different agencies is vital during incident mitigation. This is especially important along the Glenn Highway due to the lack of alternate routes. The stakeholder survey provided some information regarding how each agency coordinates with other agencies during crash, weather, and construction incidents. Additionally, the stakeholder meeting enabled agencies to discuss in more detail the coordination that occurs when there is a crash incident along the Glenn Highway.

2.4.2.1 Crash Incident

2.4.2.1.1 Detection & Verification

Detection and verification are the means by which an incident is discovered and confirmed. After a crash on the Glenn Highway, 911 calls are received by dispatch and directed to APD who then sends an officer to the scene to verify the incident. The time it takes to complete verification depends on the severity of the incident reported. If there are no injuries reported it may take a while for an officer to reach the scene. If there is a medical or fire emergency reported, APD Dispatch will call AFD to assist with the response.

Other agencies are alerted of a crash incident through witnesses to the event, Nixle alerts, 511, Google maps, radio stations, and social media. Nixle alerts are issued during business hours through the APD Public Information Officer; during after hours, dispatch sends Nixle alerts out directly. The 511 system receives Nixle alerts and automatically posts those related to traffic incidents. DOT&PF does not receive any real-time direct reporting of a crash incident unless infrastructure is impacted. Traffic cameras are not used to detect crashes as there are not resources to man the cameras.

2.4.2.1.2 Onsite Public Communication

At the scene, APD can alert the public of an incident through portable message boards that are kept in response vans and can be set up on a patrol car on site. The APD supervisor on shift can request dispatch to issue a message to the CMS. There was general agreement from the agency stakeholders present at the stakeholder meeting that the CMS isn’t in the right location for effectively allowing drivers to read the sign and choose an alternate route or time to travel on the Glenn Highway.

2.4.2.1.3 Response

APD responds to every crash incident. If there are injuries AFD, will be dispatched, and APD will inform AFD from the scene if they determine AFD is needed or not needed. Rollover incidents are assumed to involve injuries. When AFD responds, an ambulance, fire truck, battalion chief, and any additional apparatuses needed will be sent. If medics respond to an incident, the highway in the direction of travel is closed to give the emergency response vehicles room to maneuver. When a helicopter is needed, the highway gets closed down. AFD uses their fire engines to block traffic. ADEC will be called if there is a hazardous materials spill.

If the crash involves a moose, APD is dispatched and they call a charity to come harvest the moose. APD now requests that charities haul the moose away to avoid traffic slowing down when the moose remains on the shoulder/roadside.

APD does their own traffic control for most crashes. However, the municipality has a contract with a private traffic control contractor (Shaman), who will be called to set up traffic control if the closure is expected be longer than a couple of hours. If there is damage to infrastructure, APD coordinates with DOT&PF.

One of the harder locations for detours, response time, and incident management is between the Highland Road interchange and Muldoon Road because there are no frontage roads in that segment and when traffic backs up, it can be very difficult to get emergency vehicles to the incident. Sometimes APD will dispatch out of Eagle River or call CVFRD to respond to incidents if their response time can be faster.

2.4.2.1.4 Clearance

As part of their response, APD must document the scene of the incident. APD now uses 3D scanners to document the scene during major crash events. While this helps speed the clearance time, it still takes time to collect evidence. This is especially true when there is a fatality, because every fatality is treated as a homicide. Collecting evidence in these cases causes at least a two-hour shut down of the highway lane/lanes. After an incident is cleared, APD will alert dispatch to send out a Nixle message indicating the highway is open.

For clearing disabled vehicles from the highway, APD rotates through a list of nine tow companies. Drivers of the disabled vehicles can request a specific company, or APD dispatch calls the next tow company on the rotation list. If the disabled vehicle is needed for evidence, tow companies are contracted to respond within 45 minutes. For non-injury collisions, APD can use push bumpers to get disabled vehicles off the road quickly. In these cases, the tow companies generally come out after rush hour, and can frequently take an hour or more for a tow truck to reach the scene after being called.

Because of the congestion that builds up behind an incident and the narrow shoulders on the Glenn Highway, emergency vehicles may have difficulty getting to the crash scene. APD and AFD have to use extreme caution and sometimes need to drive off the road surface or in the medians to reach an incident. If congestion is not allowing access to the scene, portions of the highway may be closed so the opposite direction of travel can be used for emergency vehicles. Emergency vehicles are able to detour through JBER if necessary, but usually if the Glenn Highway is backed up, traffic on JBER is also congested. AFD and APD can also dispatch from different directions if they are unable to reach the scene from the closest point.

2.4.2.2 Weather

When there is a weather event on the Glenn Highway, maintenance is done to help maintain traffic flow and decrease the chance of incidents. When weather causes a crash incident, the response is the same as it would be for any crash; however, the road conditions generally decrease response times and it is harder to find available tow trucks.

2.4.2.3 Construction

The Traffic and Safety section of DOT&PF responds to preplanned, unplanned, and emergency construction prior, during, and after a construction event along the Glenn Highway. During a construction event, the public is alerted of construction through Navigator, Facebook, Twitter, radio, news outlets, and other on-site methods. Before, during, and after the construction event, Traffic and Safety coordinates with MOA, APD, AFD, ASD, utilities, and any other agency involved with the construction through preseason meetings, designs and specifications, and announcements. Specifically, DOT&PF will communicate if an MOA road will be affected, and then MOA will make adjustments, if necessary. During construction events, DOT&PF can adjust traffic flow with lane and road closures and APD helps with traffic control if needed. ASD Transportation might adjust bus departure times or routes during construction events.

2.4.3 Stakeholder Outreach Summary

In most incidents, the first agency to coordinate and make decisions is APD. APD assesses the situation and then determines which agencies need to be dispatched to assist. APD is also the main channel to the public via Nixle alerts and the CMS. At this time, there is no formalized incident management plan that includes all potentially affected stakeholders.

2.5 Public Outreach Summary

This section describes efforts to reach out to the public regarding their experience with the Glenn Highway within the Municipality of Anchorage (MOA). Public outreach was anchored by an online interactive survey that allowed participants to describe:

- How often, when, what time, and what portions of the Glenn Highway they use.
- Where on the Glenn Highway they believe there are issues regarding safety/crashes, road conditions, congestion, wildlife, other issues, and suggestions.
- How they get information about traffic conditions on the Glenn Highway, their travel time flexibility, their mode of transport, and any additional ideas for improvements.
- Home and destination zip codes (start and end of trip) and the main purpose of their travels along this portion of the highway.

The survey was advertised to the public via social media outlets (such as Facebook pages and the NextDoor app) and at the Community Council meetings for the Eagle River area.

One objective of the Glenn Highway ICM Study is to develop a feasible solution for improving traffic flow along the Glenn Highway between Knik River Bridge and Airport Heights Intersection during a non-recurring event. The project team reached out to the public, per methods presented in Table 1, to understand the public's current concerns with the Glenn Highway, as well as to determine what alternate routes are already in place. The public was also given the opportunity to suggest improvements they would like to see or believe would help with congestion, safety concerns, road conditions, etc.

Table 37: Public Outreach

Outreach	Description	Dates
Announcements	Included: • Project Website (http://dot.alaska.gov/glennstudy) • Facebook • Nextdoor App • Community Council Meeting Announcements • Federation of Community Councils • Email	February 2018 – ongoing
Community Council Presentations	Visited the following Community Councils at their monthly meetings: • South Fork (March 1) • Eagle River (March 8) • Eagle River Valley (March 14) • Birchwood (March 14) • Chugiak (March 15)	March 2018
Anchorage Metropolitan Area Transportation Solutions (AMATS) Meetings	Presented at the following AMATS meetings: • Technical Advisory Committee (TAC) (March 8) • Policy Committee (March 22) • Freight Advisory Committee (February14)	February and March 2018
Anchorage Transportation Fair	Provided graphics and project fact sheet at the Transportation Fair. Tablets were available for the MetroQuest survey. Written comments were also accepted.	February 8, 2018
Mat-Su Transportation Fair	Provided graphics and project fact sheet at the Transportation Fair. Written comments were also accepted.	September 27, 2017
Online Survey (MetroQuest)	The survey included 5 screens soliciting input, including an interactive map.	Survey was live from February 5 until April 4, 2018

2.5.1 General Outreach

2.5.1.1 Announcements

The Alaska Department of Transportation and Public Facilities (DOT&PF) and Kinney Engineering worked together to advertise the project and the online survey. The survey was shared on the Alaska DOT&PF Facebook account, Central Region website, and Twitter. Kinney Engineering also shared this information through direct emails, community council presentations, transportation fairs, and posting to the Nextdoor website. Links to the survey were also posted on the Glenn Highway Traffic Report Facebook page.

2.5.1.2 Community Council Meetings

Kinney Engineering team members visited five Community Council meetings in March 2018: South Fork, Eagle River, Birchwood, Eagle River Valley, and Chugiak. The purpose of the project was explained, and attendees were encouraged to complete the online MetroQuest survey.

<u>Summary Comments/Questions from attendees:</u>

- Some locations were identified as congested or needing improvements including: Eagle River Loop Road interchange, Artillery Road interchange, southbound bridge over Eagle River, and the Mirror Lake interchange. Kinney Engineering responded that while the focus is not increasing capacity for recurring congestion, the study will consider all types of solutions for non-recurring congestion.

- Better use of the railroad for public transportation, Farm Road as an alternative access, and a frontage road connecting Mirror Lake and Thunderbird Falls were mentioned by community council members as possible alternative route options. Other improvements mentioned were emergency telephones with emergency light signaling, messaging boards, and promptly clearing vehicles from the side of the road.

See Appendix E: for the Community Council Meeting Summaries.

2.5.1.3 AMATS Meetings

KE team members gave presentations about the project to the AMATS TAC, Policy Committee, and Freight Advisory Committee. KE explained the purpose of the project, which is to improve the efficiency of moving people and goods through the corridor, with an emphasis on non-recurring congestion (congestion due to crashes, construction, weather, etc.). KE also introduced the online survey, and everyone was encouraged to take the survey. Preliminary findings from the MetroQuest survey were reviewed and questions/comments/concerns were addressed.

See Appendix F: for the AMATS Meeting Summaries

2.5.1.4 Transportation Fairs

Kinney Engineering attended the Mat-Su Borough Transportation Fair and the Anchorage Transportation Fair to inform the public of the study and encourage visitors to participate in the MetroQuest survey. Project fact sheets and project area graphics were presented. Additionally, tablets were available for attendees to take the MetroQuest survey at the Anchorage Transportation Fair. KE also accepted written comments at both fairs.

See Appendix G: for Transportation Fair Public Comments.

2.5.1.5 MetroQuest Survey

MetroQuest is an online software program that was used to prepare and operate an online interactive survey. The online interactive survey facilitated public involvement and feedback on the Glenn Highway. The survey was available to the public from February 5 until April 4, 2018.

The online survey is comprised of five different screens that asked users questions and guided them through the survey. During each section of the survey, participants were given opportunities to provide additional comments. The five screens were:

- **Welcome Screen**: Visitors were introduced to the goal of the project and were provided a map of the project boundaries.
- **Survey Part 1**: Visitors were asked a series of questions that help describe how often, when, what time, and what portions of the Glenn Highway they use.
- **Map**: Visitors were presented with an interactive map, where they were given the opportunity to identify, by dropping a marker, specific locations where they believe there is an issue, where they have a suggestion, or to provide comments. There were six markers available: safety/crashes, road conditions, congestion, wildlife, other issues, and suggestions.
- **Survey Part 2**: Visitors were asked how they get their information about traffic conditions on the Glenn Highway, their travel time flexibility, their mode of transport, and any additional ideas for improvements.
- **Wrap Up**: Visitors were asked to indicate their home and destination zip codes (start and end of trip) and the main purpose of their travels along this portion of the highway.

See Appendix H: for the MetroQuest Survey Screens.

2.5.2 Online Survey Results

There were 4,891 participants in the online survey, as shown in Figure 1. The busiest comment period was March 28 through April 2, after a crash on March 21 that damaged the northernmost span of the Eagle River/Artillery Road overpass. This crash resulted in southbound traffic being diverted off the Glenn Highway, at the North Eagle River exit, through downtown Eagle River to the Hiland Road Interchange and caused significant delays.

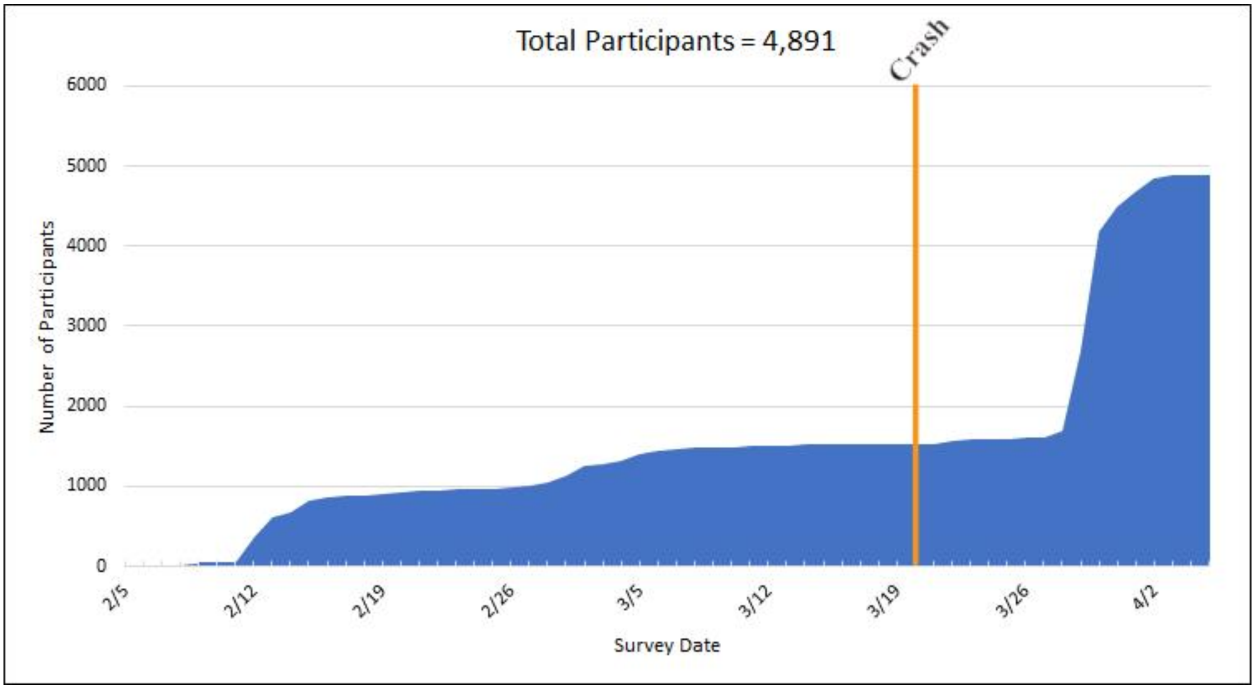

Figure 33: Participants in MetroQuest Survey

Though 69% of respondents participated in the online survey after the March 21 crash, analysis of the comments and suggestions shows there was not a significant change in the type or comment or location identified for improvements after the crash. See Appendix J: for a summary comparison of comments and suggestions before and after the crash.

2.5.2.1 How and Why Survey Respondents Travel on the Glenn Highway

Participants were asked how often they travel the Glenn Highway between Airport Heights Drive and the Knik River Bridge. The survey allowed them to choose one of the following: daily (4+ times a week), weekly (1-3 times per week), twice a month, once a month, or never (<12 times annually). The majority of survey respondents answered four or more times per week, as seen in Figure 34.

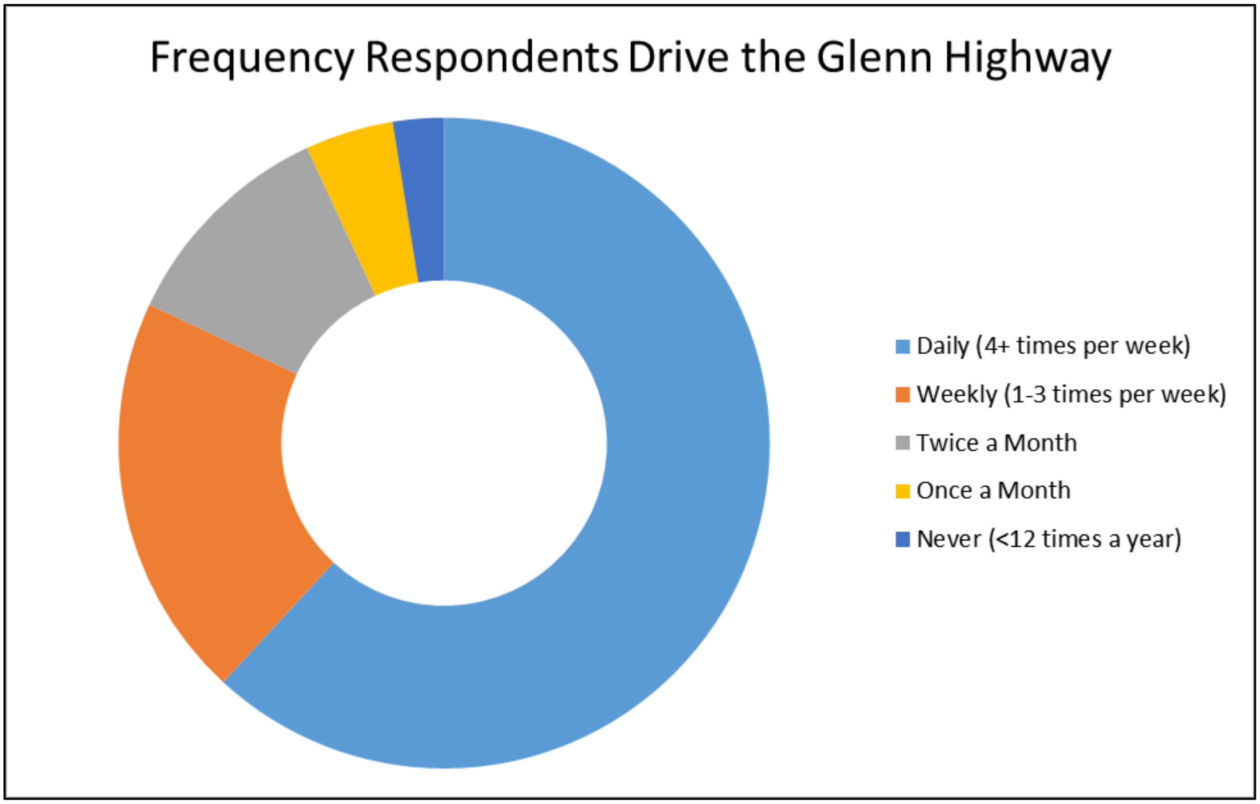

Figure 34: Frequency of Travel

Respondents were asked to select what direction they typically travel along the Glenn Highway by time of day (southbound in the morning and northbound in the evening, northbound in the morning and southbound in the evening, or other). Eighty percent of respondents indicated that they typically head southbound in the morning and northbound in the evening, as shown in Figure 35.

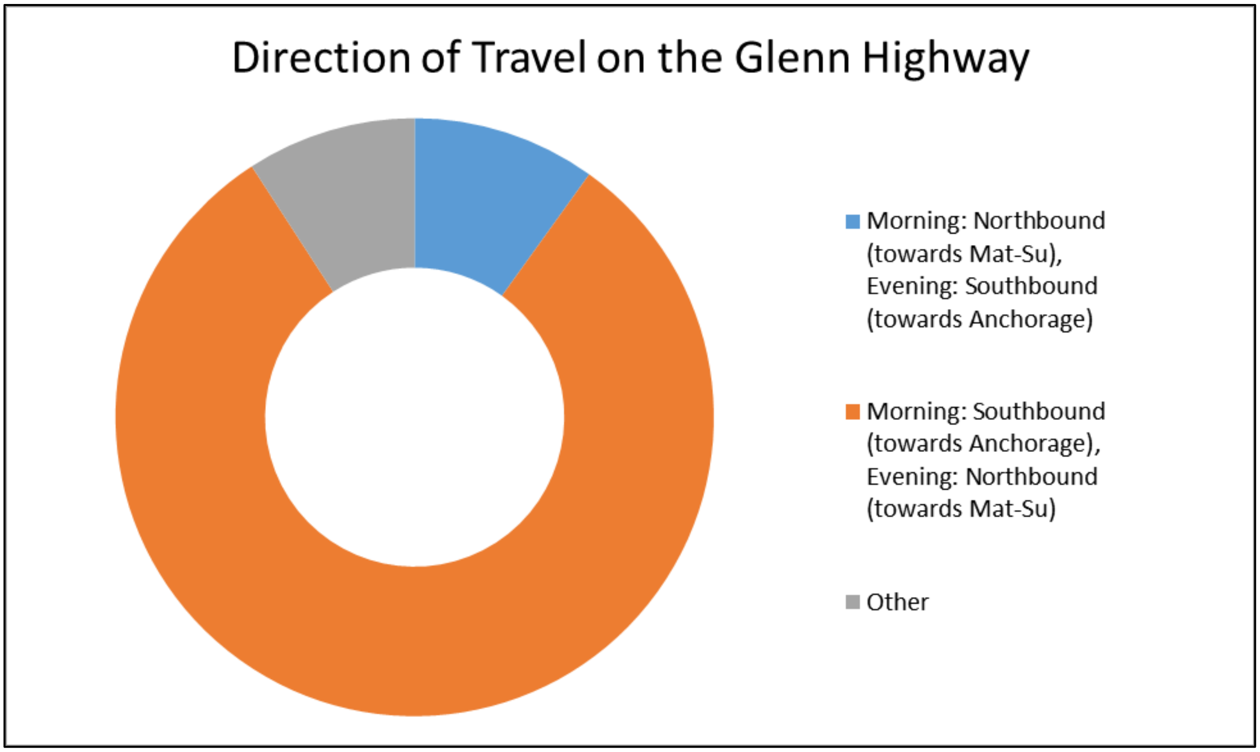

Figure 35: Direction of Travel

Sample of 'Other' Responses:

- Weekend traveling - all times of the day
- Alternating southbound and northbound every morning
- I go into town from Eagle River generally after commuting hours
- I'm a shift worker and our schedule rotates. I'm on the highway at various hours throughout the year
- Weekends: outbound 10:00 am-12:00 pm; inbound 4:00 pm-8:00 pm
- Varies
- I switch days - two days a week I go northbound in the morning and return, three days per week I go southbound and return. I am in Eagle River
- Occasional trips to the Valley
- Anytime during the day

Each respondent was asked to select where they most frequently get on and off the Glenn Highway. The following access points were available to select:

- Glenn Highway north of Knik River
- Old Glenn Interchange
- Eklutna
- Thunderbird Falls
- Mirror Lake/ Edmonds Lake
- N Peters Creek
- S Peters Creek
- N Birchwood

- S Birchwood (Chugiak High School)
- N Eagle River
- Eagle River/ Artillery Rd
- Eagle River Loop Rd/Hiland Rd
- JBER-Richardson
- Arctic Valley Rd
- Muldoon Rd
- Turpin Street
- Boniface/Mt View Dr/JBER-Elmendorf
- Bragaw St
- Airport Heights Dr
- Downtown

The access points used the most when traveling southbound, towards Anchorage, are displayed in Figure 36. The access points used the most to travel northbound, towards Mat-Su, are displayed in Figure 37.

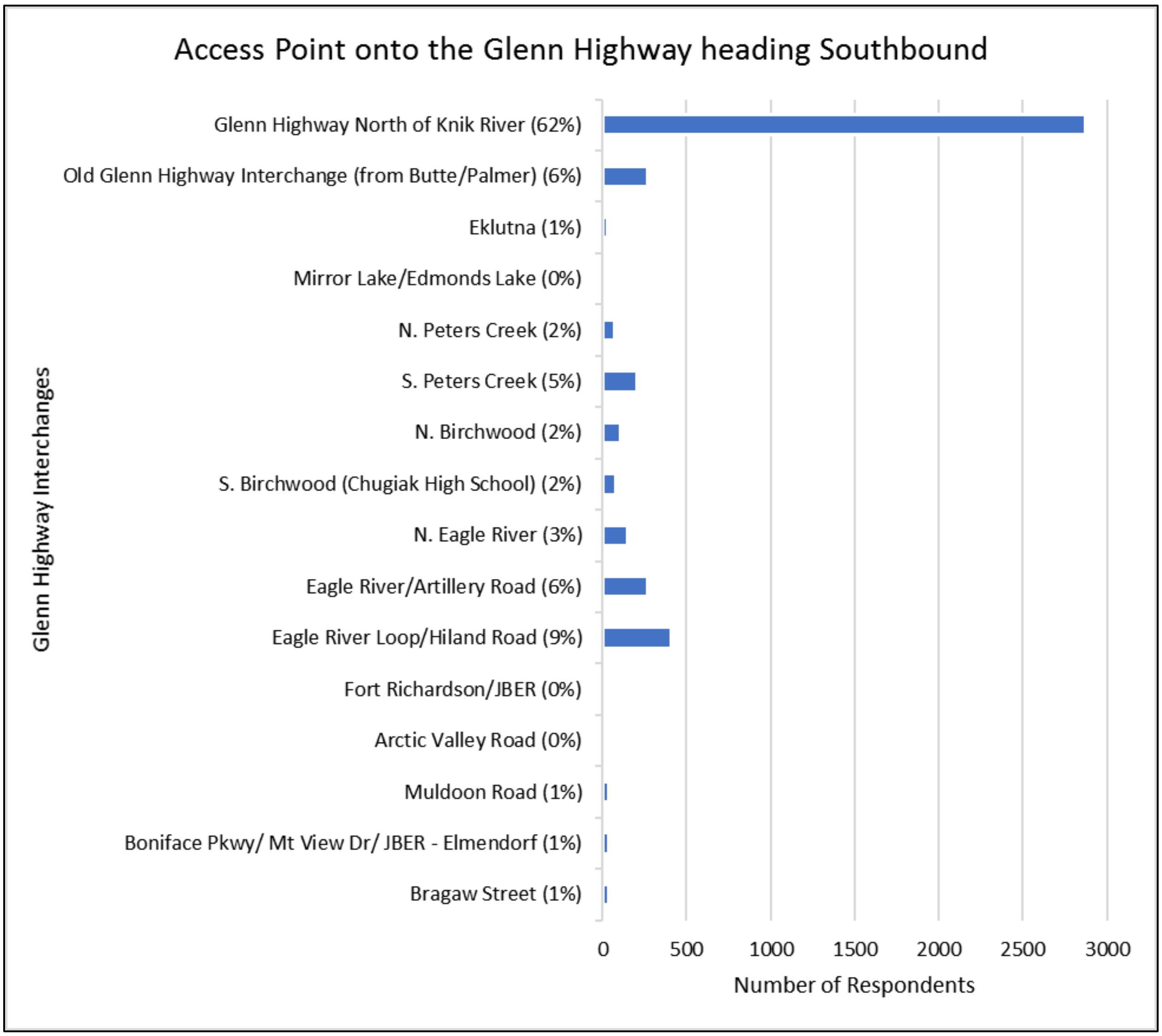

Figure 36: Access Point Heading Southbound (Towards Anchorage)

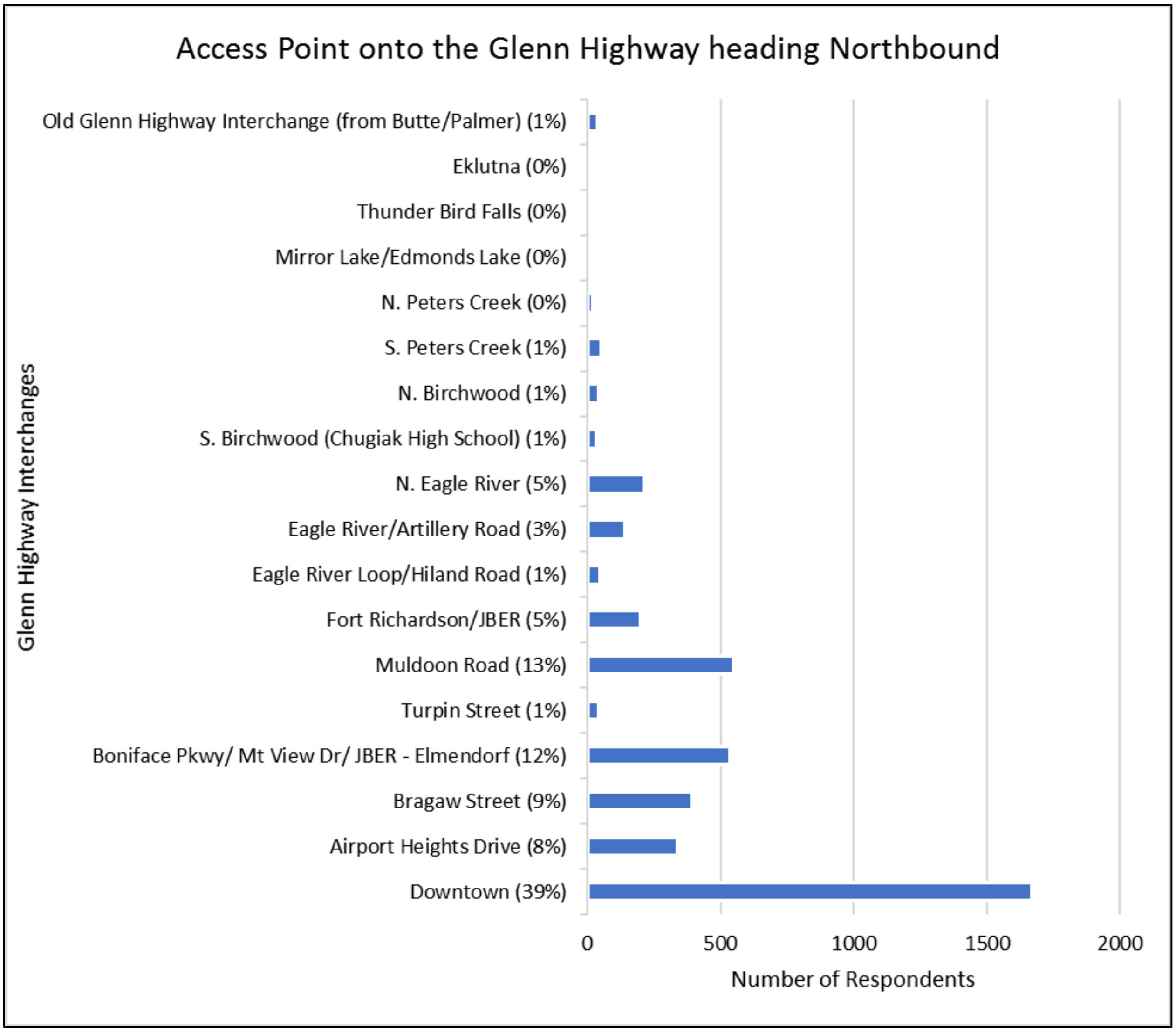

Figure 37: Access Point Heading Northbound (Towards Mat-Su)

Heading southbound, 18% of respondents enter the highway from Eagle River, with the highest number coming from the Eagle River/ Hiland Road interchange. Heading northbound, 82% enter the highway in Anchorage, with the highest number coming from downtown.

The exit points used the most to exit the Glenn Highway when traveling southbound, toward Anchorage, are displayed in Figure 38. The exit points used most by respondents when traveling northbound on the Glenn Highway are displayed in Figure 39.

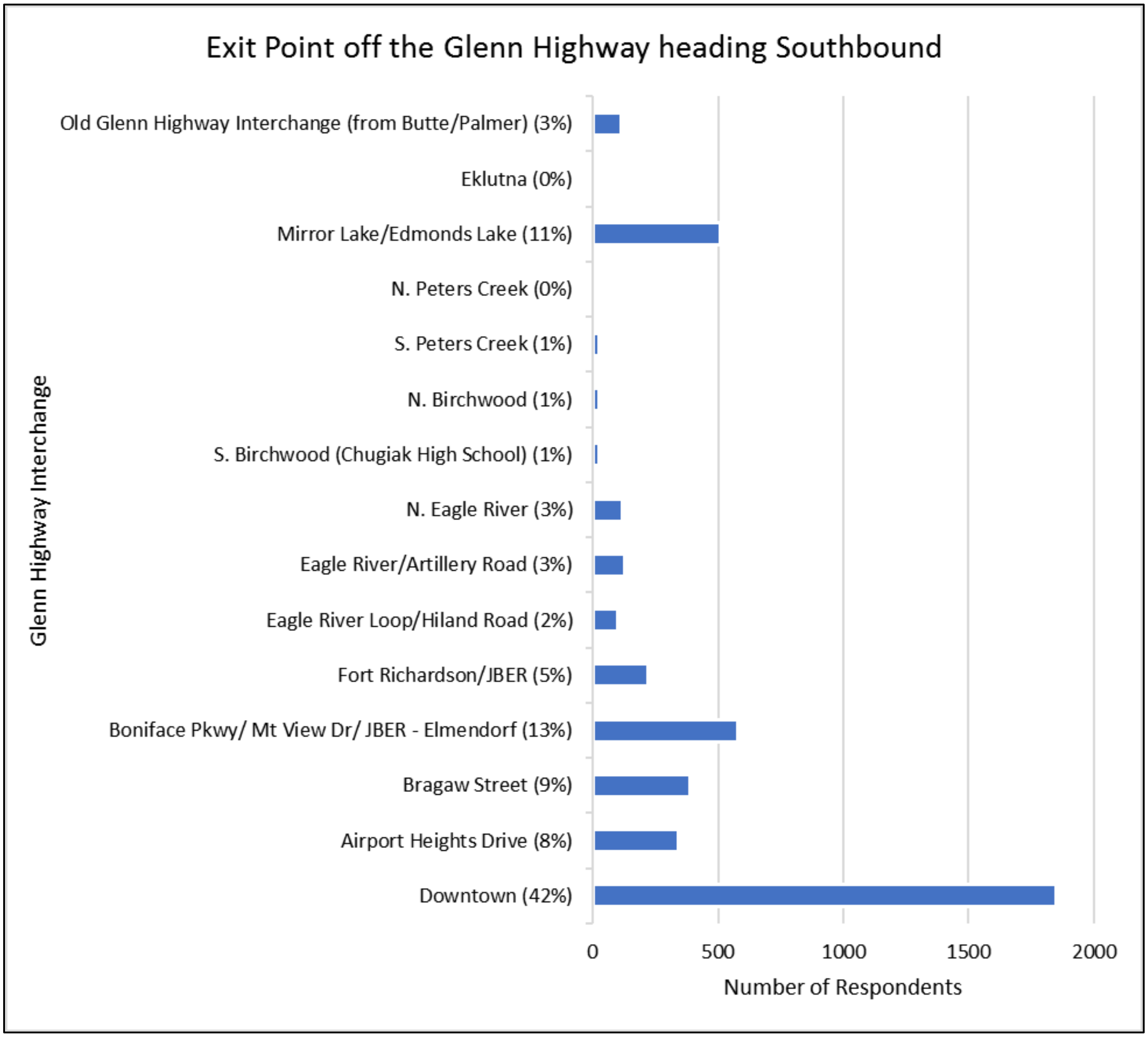

Figure 38: Exit Point Heading Southbound (Towards Anchorage)

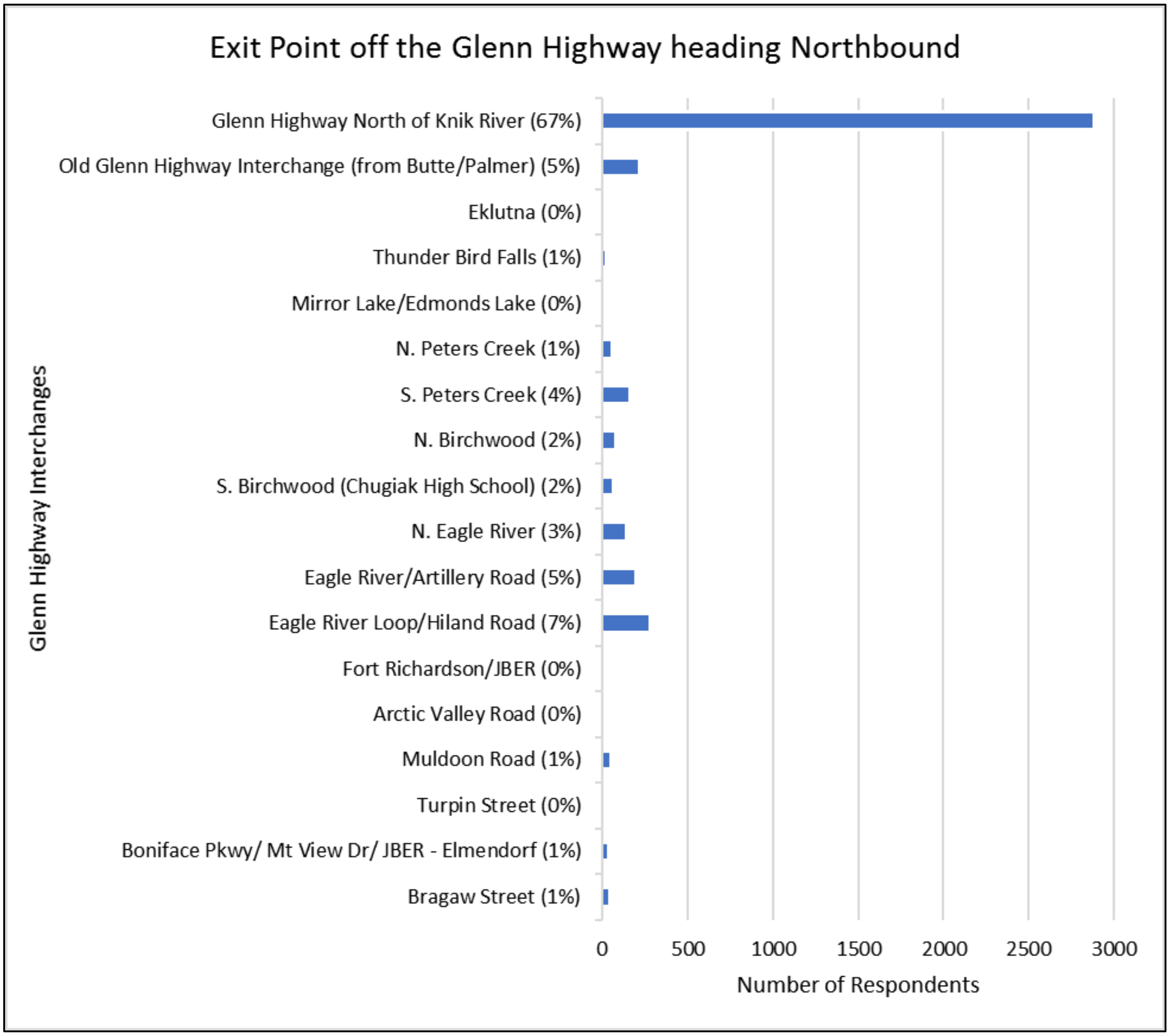

Figure 39: Exit Point Heading Northbound (Towards Mat-Su)

Heading southbound, 72% of respondents exit the highway in Anchorage, with the highest number exiting into downtown. Heading northbound, 15% exit the highway in Eagle River, with the highest number exiting at the Eagle River/Hiland Road interchange. However, 67% exit north of the Knik River Bridge.

Respondents were also asked to select the time of day (all that apply) of their typical travel on the Glenn Highway. Figure 40 shows the number of times each time-period was selected. Additionally, respondents were asked to select why they most commonly travel the Glenn Highway. Respondents could select work, visiting friends and family, shopping, school, or other. The majority of respondents answered that they use the Glenn Highway to travel to work, as shown in Figure 41. The peak travel times seem to correspond with work commute times, with a peak in the morning before 9 am and a peak in the evening after 4 pm.

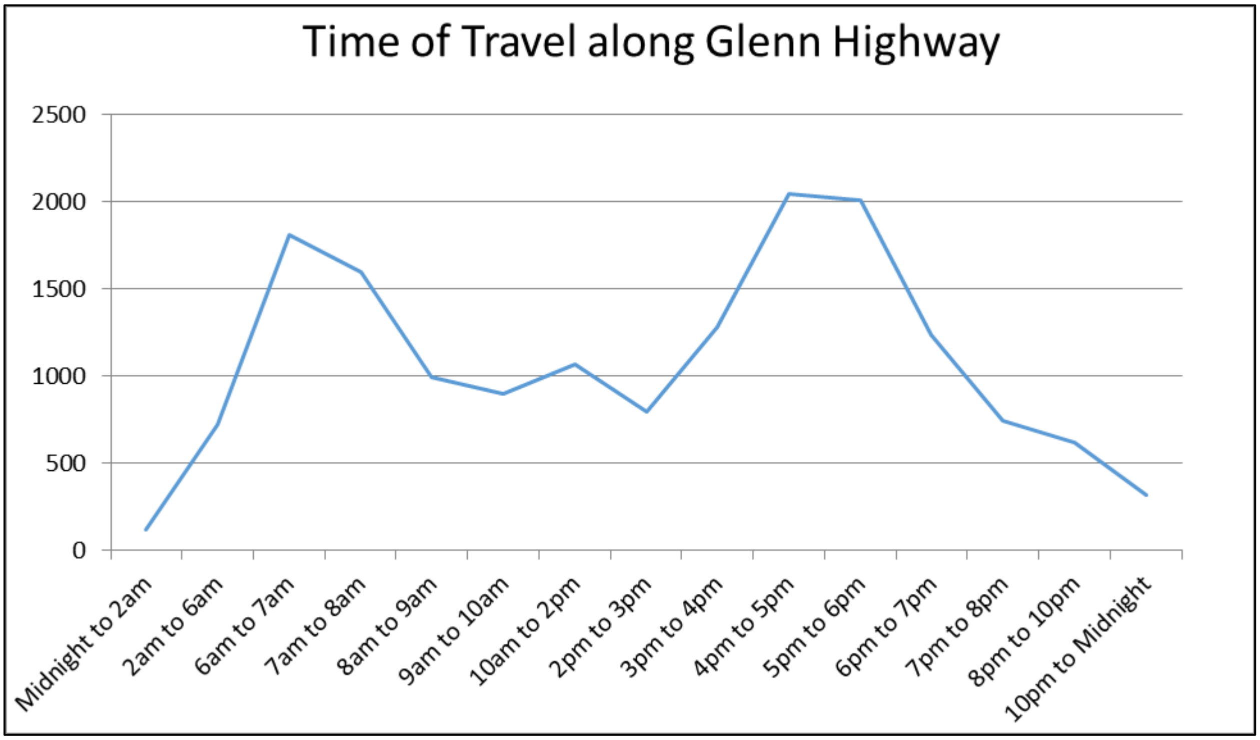

Figure 40: Time of Travel

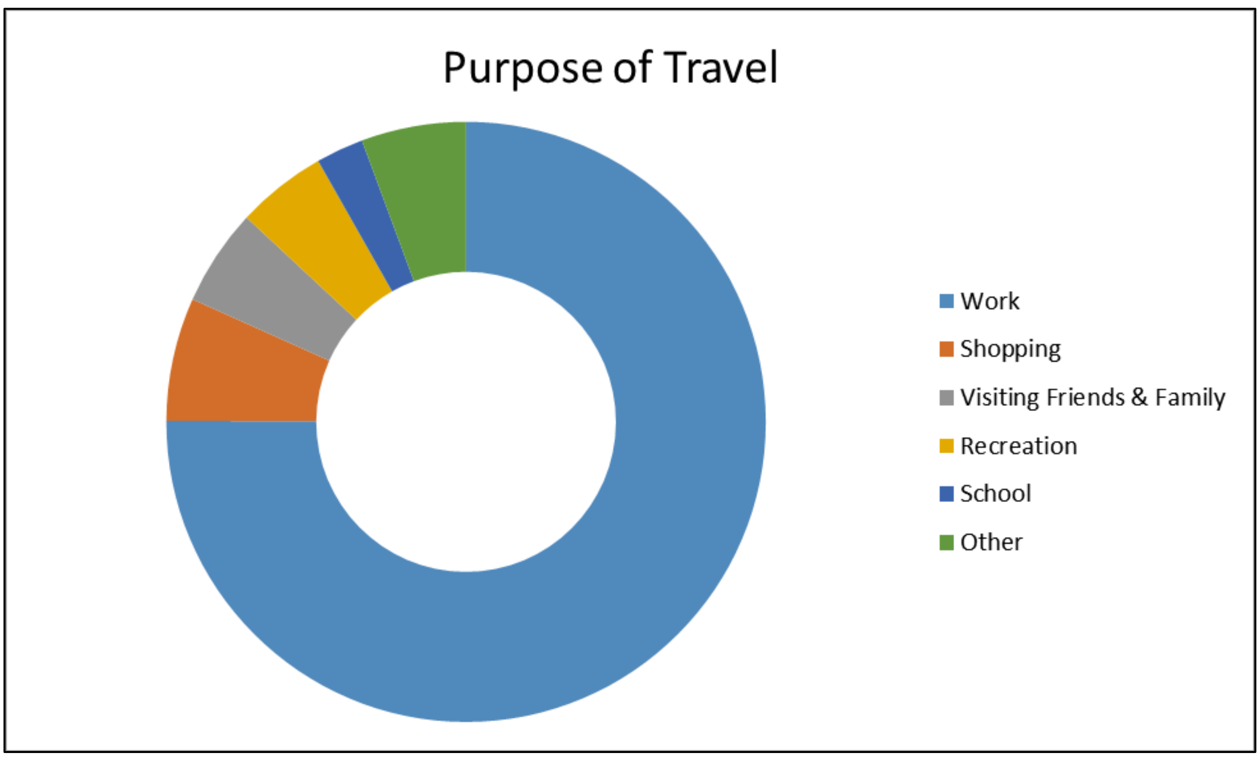

Figure 41: Purpose of Travel

2.5.2.2 How Survey Respondents Get Information

In addition to understanding how and why respondents use the Glenn Highway, the online survey asked where users get information about the traffic conditions. The choices available were: Glenn Highway Traffic Report Facebook Page, Radio, 511, Nixle, Twitter, and Other, as seen in Figure 42. There were 7,074 responses to this question, as respondents were able to select all that apply.

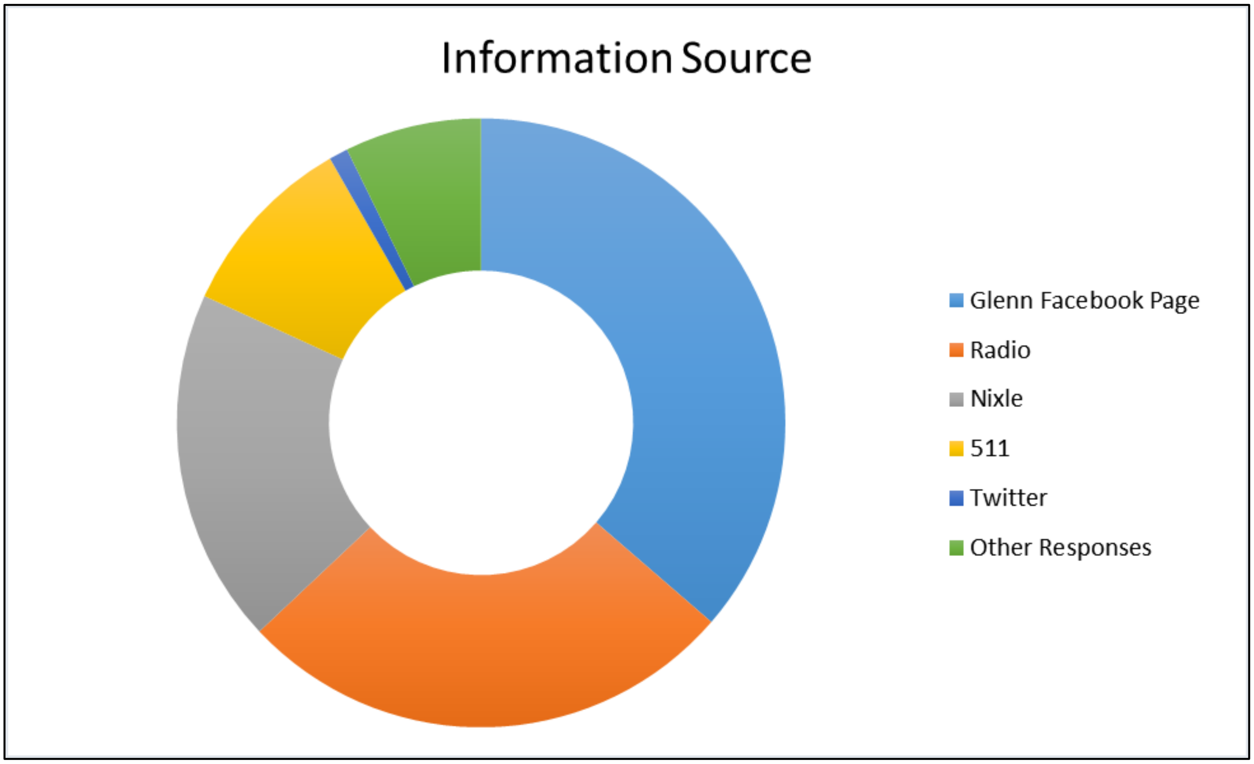

Figure 42: Public Information Sources for Glenn Highway Traffic Conditions

Respondents were also asked to describe/expand on the method they use: what radio stations, what feeds, explain other sources, and leave a comment. Some commenters expressed reliability of the traffic information sources they use. According to respondents, the top four radio stations for traffic information are AM 750, AM 650, FM 106.5, and FM 104, as shown in Table 38. Some of the 'Other' responses included, Waze App, word of mouth from friends, family, co-workers, texts, phone calls, Google, and television, as shown in Figure 43.

Table 38: Radio Station for Traffic Information

Radio Station	Responses
AM 650	99
AM 700	20
AM 750	113
FM 91.1	66
FM 92.1	24
FM 97.3	24
FM 98.9	37
FM 99.7	40
FM 100.5	42
FM 100.9	48
FM 101.3	71
FM 103.1	65
FM 104.1	94
FM 106.5	95
FM 107.5	72
Other Stations	144
Total	1054

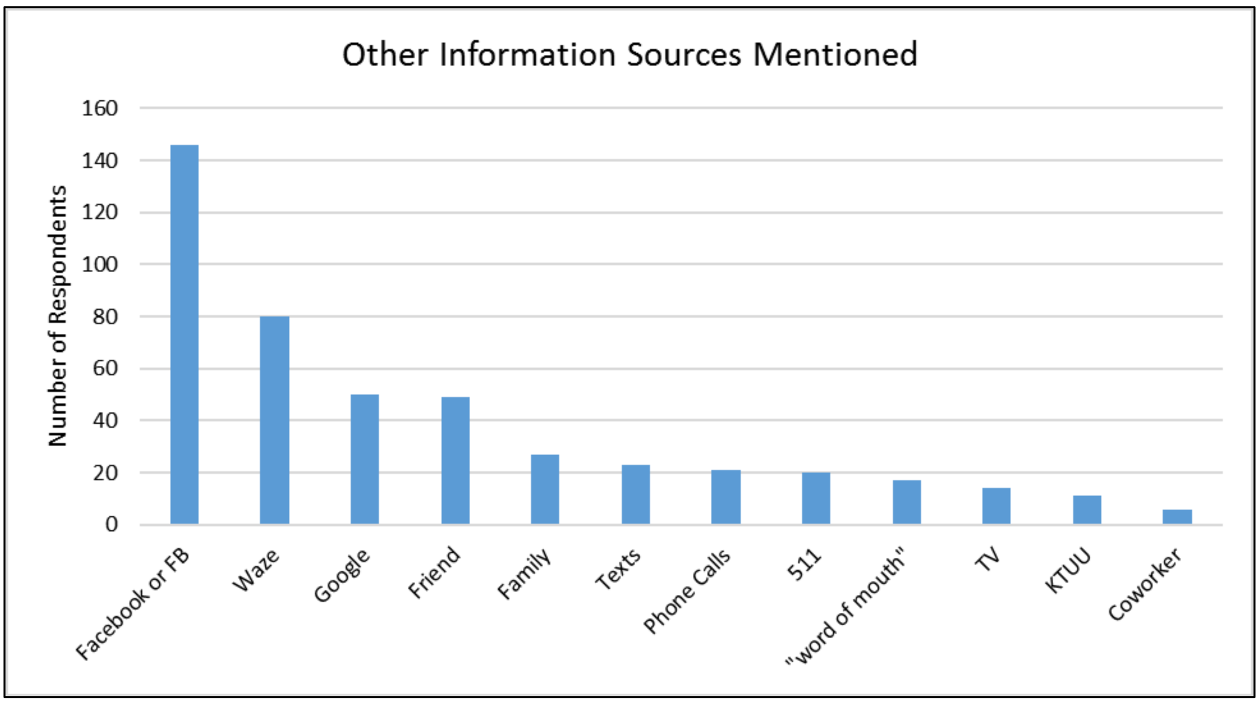

Figure 43: Other Information Sources Mentioned

2.5.2.3 How Much Flexibility Do Respondents Have in Their Travel Time?

When there is an incident on the Glenn Highway, travel is suspended or slowed along the corridor. If users are made aware that travel is slowed or stopped, the users with flexibility can change their travel time. However, the users without flexibility are going to be using the corridor regardless; this group will be minimum desired to be accommodated on alternate routes.

The survey asked users if they are able to change their time of travel based on traffic conditions. Users were to select an option that best describes their flexibility in the morning and the evening. Figure 44 and Figure 45 show how many of the respondents might be able to change their travel times if they had information about the Glenn Highway traffic conditions.

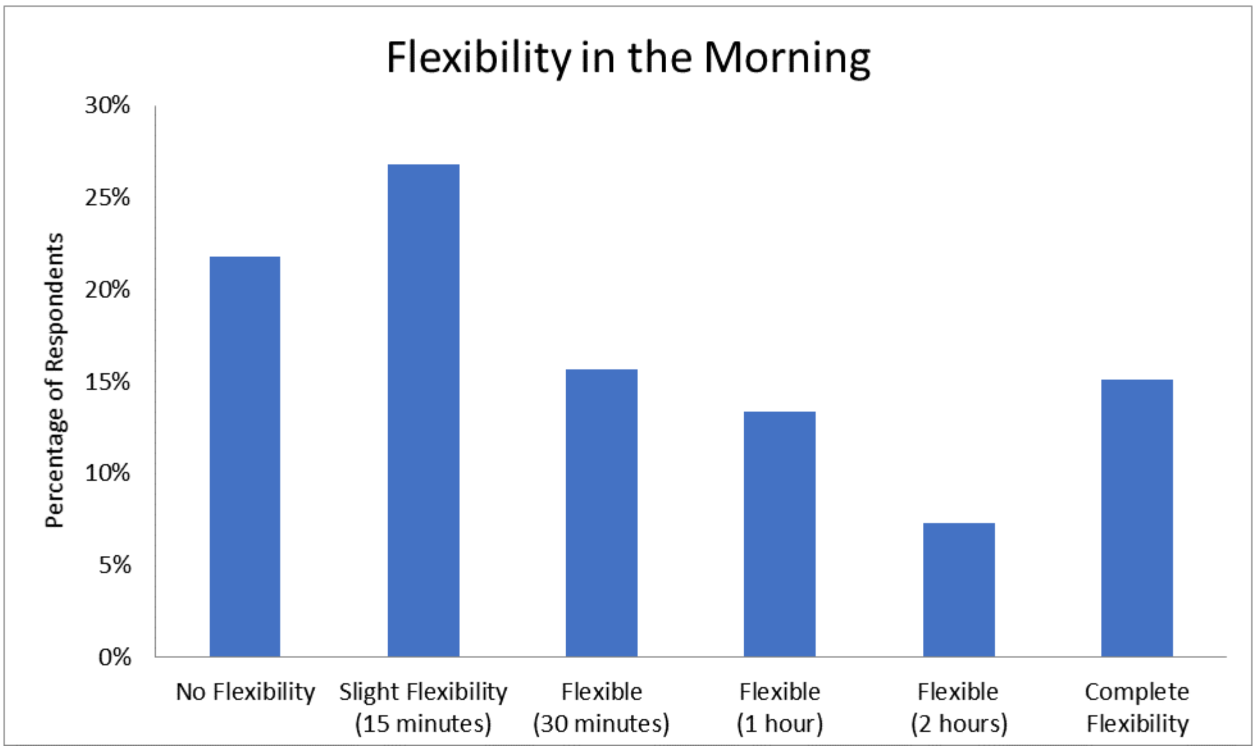

Figure 44: Flexibility of Travel in the Morning

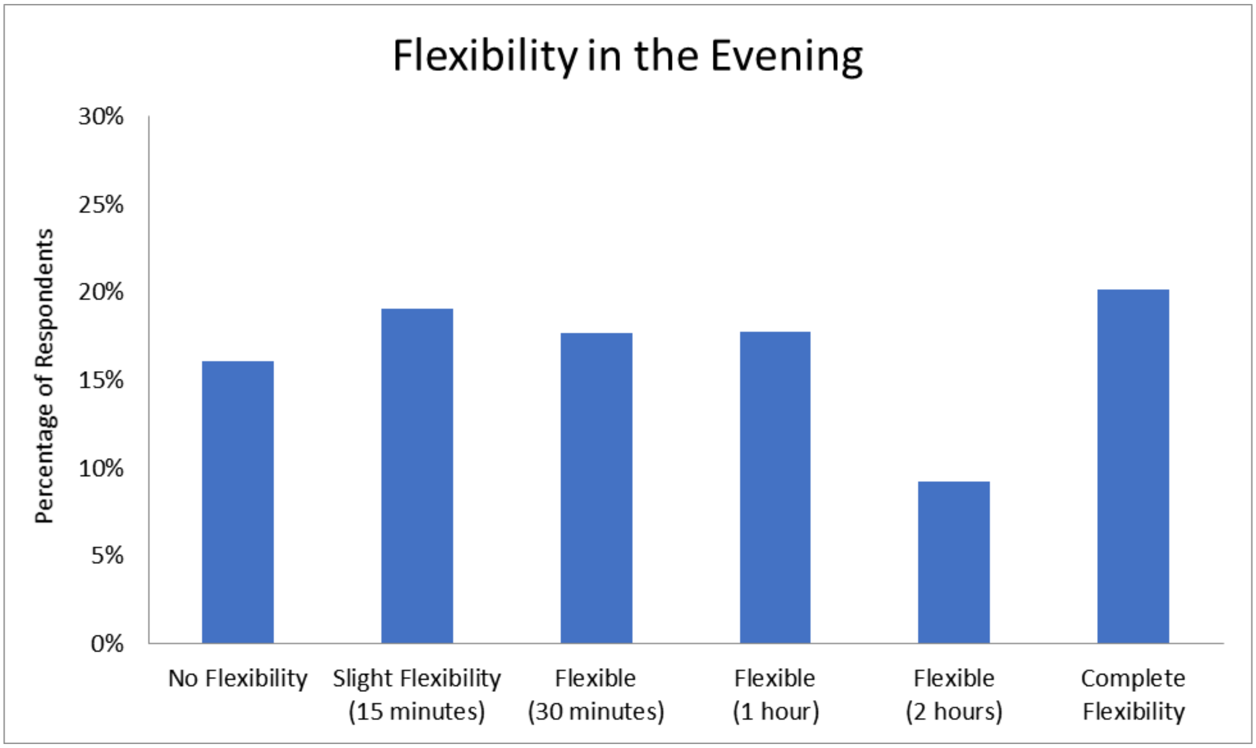

Figure 45: Flexibility of Travel in the Evening

In the morning, about 50% of respondents have no or slight flexibility, and 15% have complete flexibility. In the evening, 35% of respondents have no or slight flexibility and 20% have complete flexibility.

2.5.2.4 Travel Mode Choices

Public transportation can help reduce congestion and travel time for all by reducing the number of vehicles traveling in a corridor. Currently, most respondents travel in single passenger vehicles as their main mode of transportation, while 28% of respondents either use buses, van pooling, or carpooling, as shown in Figure 46.

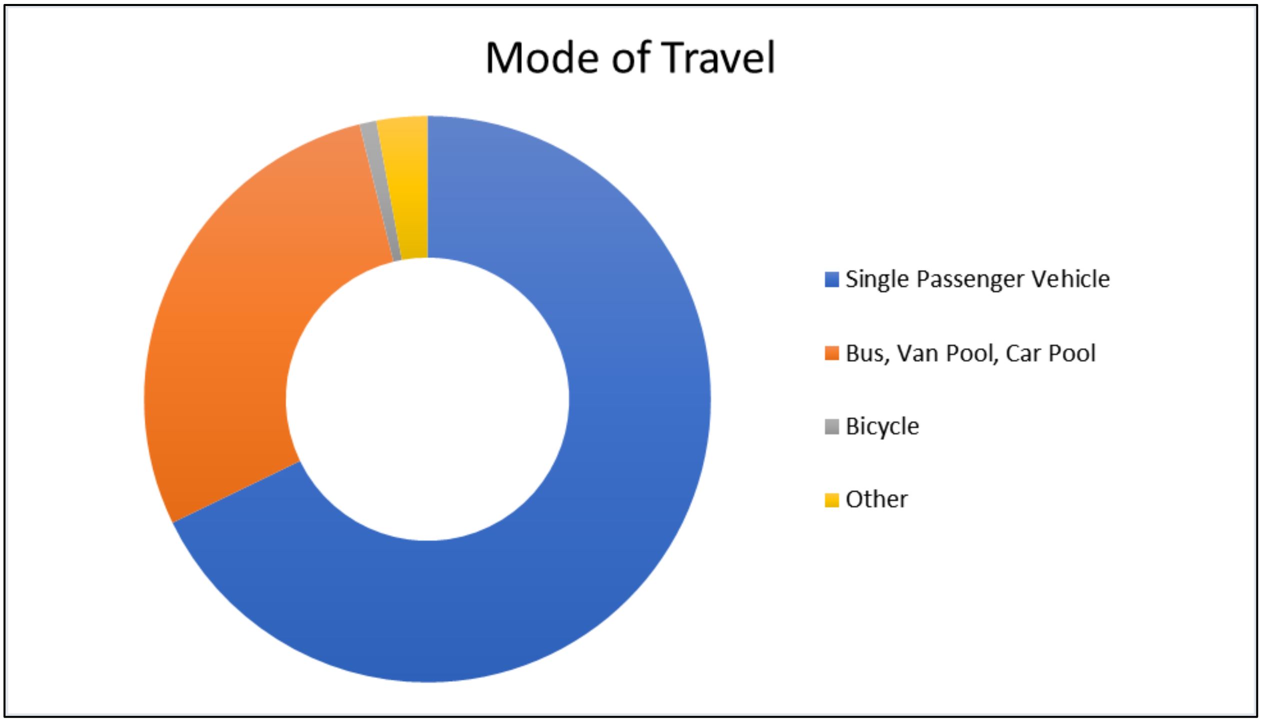

Figure 46: Mode of Travel

The survey asked users what would encourage them to use a different mode of transportation. There were about 2,800 comments, of which a third of the comments mentioned that there is nothing that would encourage them to take a different mode of transportation, or that another mode wouldn't be possible with their schedules, etc. The most common responses were:

- Availability of commuter train
- Reliability and variability of public transportation schedules
- Secure and free parking
- Monetary incentives
- Buses

2.5.2.5 Problem Area Concerns and Suggestions

The online survey also included an interactive map where participants were asked to place icon markers to indicate locations where they feel there is an issue or where they would like to make suggestions. Participants were encouraged to provide comments about the concern or suggestion. The icon markers available were: Congestion, Safety Concern, Weather/Road Conditions, Suggestion, Wildlife Concern, and Other. More than 10,400 map markers were placed. The number of map markers placed for each category is shown in Figure 47.

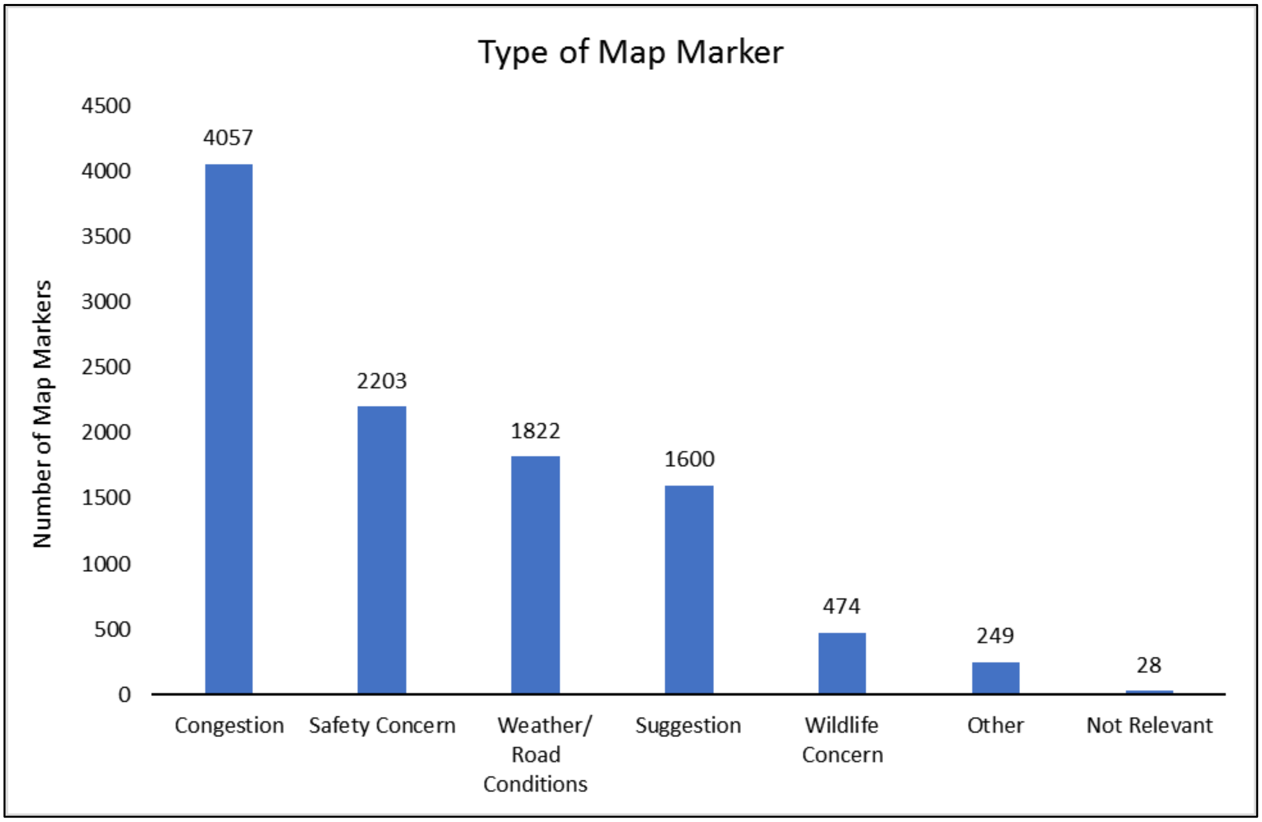

Figure 47: Type of Map Marker Used

Approximately 52% of icon markers had comments. These comments were reviewed and organized into 20 different categories. This enabled easier evaluation of problem areas by type of comment. Figure 48 shows the number of comments for each category. The categories in blue represent concerns, the categories in yellow represent suggestions, and green represents categories that contain both concerns and suggestions.

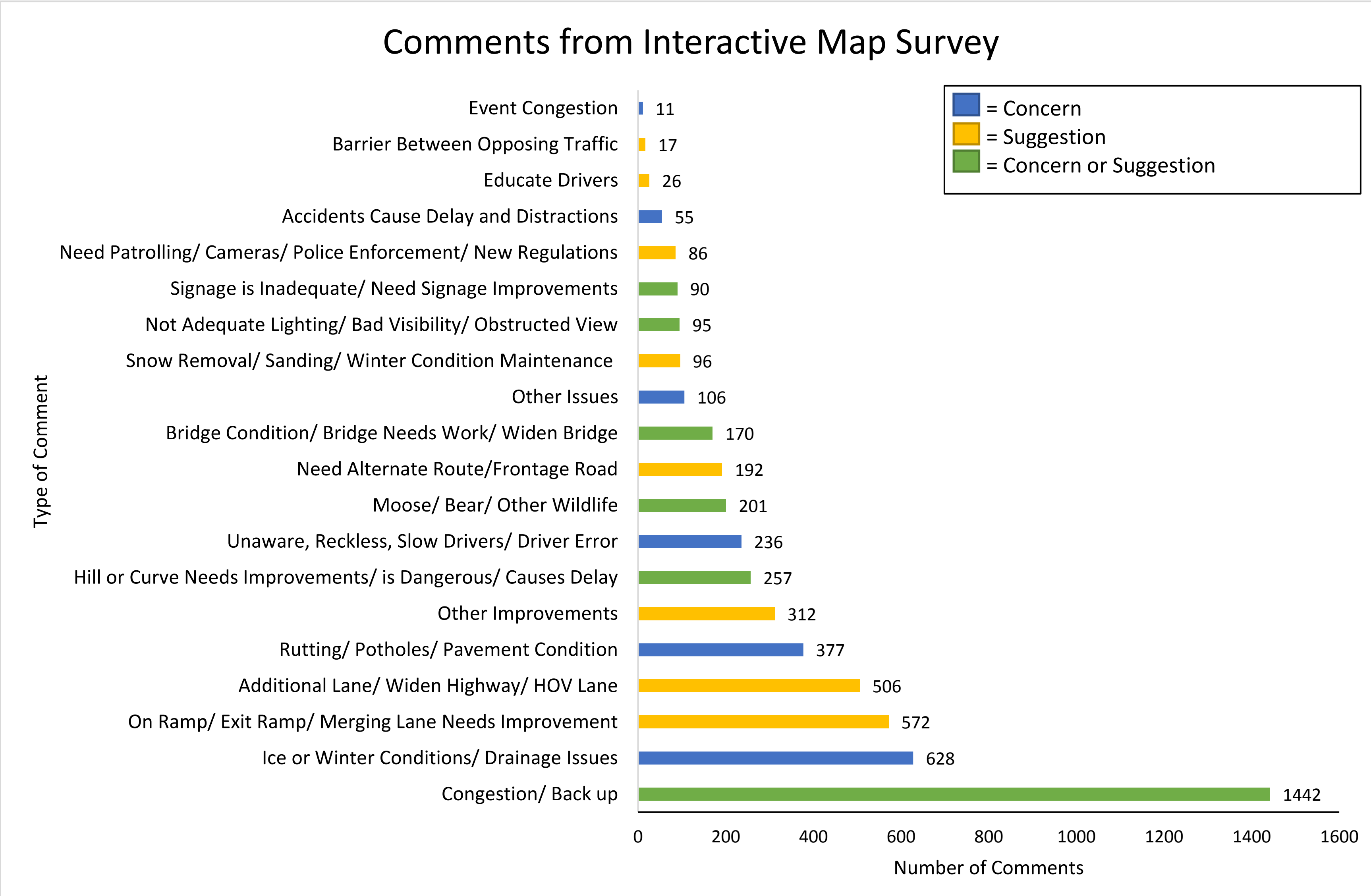

Figure 48: Type and Frequency of Comments on the Survey Map

Congestion was cited more than twice as often as any other concern. Other common concerns included issues related to water or ice (including drainage), issues related to merge or diverge points (on-ramps, exit-ramps, merging lanes), pavement conditions, dangerous hills and curves, unsafe drivers, and wildlife. The most frequent suggestions were on-ramp improvements, additional lanes, carpool and bidirectional lanes, hill and curve improvements, alternate routes and frontage roads, winter and road maintenance, lighting and visibility improvements, and more police enforcement or new regulations.

The interactive map helped identify specific problem areas and general issues with the Glenn Highway corridor. Categorizing each comment allowed KE to evaluate if common problems or suggestions were recurring in certain areas.

Appendix I: is a KMZ file that can be imported into a mapping program to view the location and type of the map markers and comments that were placed by survey participants.

2.5.2.5.1 Congestion

Congestion was the most reiterated concern with approximately 4,500 markers and 1,450 comments. Congestion issues that were often identified were:

- traffic exceeds capacity
- slow or improper merging
- drivers staying in the left lane blocking the ability to pass
- on-ramp and exit-ramp design
- distractions along the road side
- accidents that cause delay because there are no alternative routes

Areas that were identified by the public to have the highest congestion were:

- Artillery Road/ Eagle River interchange (highest)
- North Eagle River Access Road interchange
- Eagle River southbound bridge
- Eagle River Loop interchange
- Fort Richardson interchange
- Muldoon Road interchange
- Airport Heights intersection

Common suggestions included:

- Adding another lane or widening the highway
- Adding a bidirectional lane that allows more traffic to head southbound in the morning and then northbound in the evening
- Extending merging lanes
- Connecting an alternate route or adding frontage roads to allow less congestion during a non-reoccurring event such as an accident
- Clearing away an accident quickly after the event to prevent further slowing down
- Develop better public transportation, including commuter rail
- Acceleration lane signal

- Metered merging

2.5.2.5.2 Ice and Winter Conditions

The second highest concern was ice and winter conditions, including areas that have drainage issues that cause ice during freezing temperatures. Areas that were identified by the public to have the worst ice and winter conditions were:

- Knik River bridge
- Curve north of Eklutna interchange and Eklutna hill
- Eagle River southbound hill
- Between Mirror Lake and South Peters Creek
- Between South Peters Creek and North Birchwood

To mitigate the effect of winter conditions, respondents suggested:

- outlawing studs
- using chemical spray
- cutting back brush on shaded highway areas
- improving road drainage issues
- sanding and snow removal

2.5.2.5.3 On-Ramp/ Exit-Ramp/ Merging Lanes

On-ramps, exit-ramps, and merging lanes that were identified by the public as needing improvements were:

- South Peters Creek southbound on-ramp – uphill, short, and poor visibility
- Eagle River/ Artillery Road – on-ramps, merging lanes, and exit-ramps
- Eagle River/ Highland Road southbound on-ramp – needs merging lane improvements
- Fort Richardson/ JBER
- Muldoon Road

2.5.2.5.4 Additional Lanes/ Widen Highway

The public commented that additional lanes are needed to improve the capacity of the highway and lessen congestion and improve safety. These ideas include, a high-occupancy vehicle (HOV) lane, bidirectional lane, and extending merging lanes. Recommendations were mainly between the South Birchwood interchange and the Eagle River bridge.

2.5.2.5.5 Road Conditions

Another common concern and cause of congestion and safety issues are the road conditions. There were a lot of comments about rutting, potholes, and broken pavement and suggestions to do more frequent road maintenance and pavement upkeep.

Areas that were identified by the public to have the worst road conditions were:

- Knik River bridge (outside of project limits)
- Eklutna Flats

2.5.2.5.6 Hill and Curve Improvements

The following hills and curves were pinpointed as needing improvements:

- Curve north of Eklutna interchange
- Hill and curve north of the Eagle River bridge
- Southbound Eagle River bridge
- S-curves
- Muldoon curve

2.5.2.5.7 Wildlife Concerns

Areas that were identified by the public to have the most wildlife/vehicle collisions and wildlife concerns were:

- North of Knik River bridge (outside the project area)
- Eklutna Flats
- Between North and South Birchwood interchanges
- S-curves

- Fort Richardson/ JBER interchange

Animal overpasses or fencing were proposed to help reduce the amount of wildlife that gets onto the highway. Better lighting was also recommended to reduce the amount of wildlife/vehicle collisions.

2.5.2.5.8 Other Topics/ Suggestions

- Offer education opportunities for drivers about merging and passing regulations
- Increase law enforcement/ implement new regulations/ add traffic cameras
- Install signs that show the current condition of the highway
- Construct the Knik Arm Bridge as an additional route
- Add more emergency turnouts/ highway crossings
- Install additional signs
    - Suggestions: Signs for 'Passing only in Left Lane', 'Stay Right', 'Don't Text and Drive'
- Move dynamic message sign location
- Widen shoulders
- Add guardrails
- Change speed limits (some suggested higher some lower)
- Construct raised medians
- Adapt highway for reversible lanes (lanes in which traffic can travel both directions depending on certain conditions)
- Create another entrance to JBER from Eagle River
- Extend the Old Glenn Highway
- Lay reflective paint for striping and/or better markings
- Post vertical clearance of bridges far ahead of each bridge
- Move disabled vehicles off road and roadside quickly proceeding an accident

2.5.2.6 Areas Represented

KE asked survey respondents to enter their home and destination zip codes when using the Glenn Highway, as well as their most common access points and exit points, in order to verify the geographic range of participants in the online survey.

As shown previously in Figure 36 and Figure 39, 60% to 70% of the respondents indicated that they access the highway in the morning from north of the project area and exit the highway in the evening to north of the project area. Figure 49 and Figure 50 look only at how participants access and exit the highway from within the study area. Figure 49 compares participants' most common southbound access points to the 5-year-average AADT for each access point on-ramp. Figure 50 compares participants' most common exit points to the corresponding 5-year-average AADT for the exit-ramps. The figures compare the AADT distribution of traffic to the distribution of survey participants among the interchanges. Participants who access or exit the Glenn Highway north of the Knik River bridge are not represented.

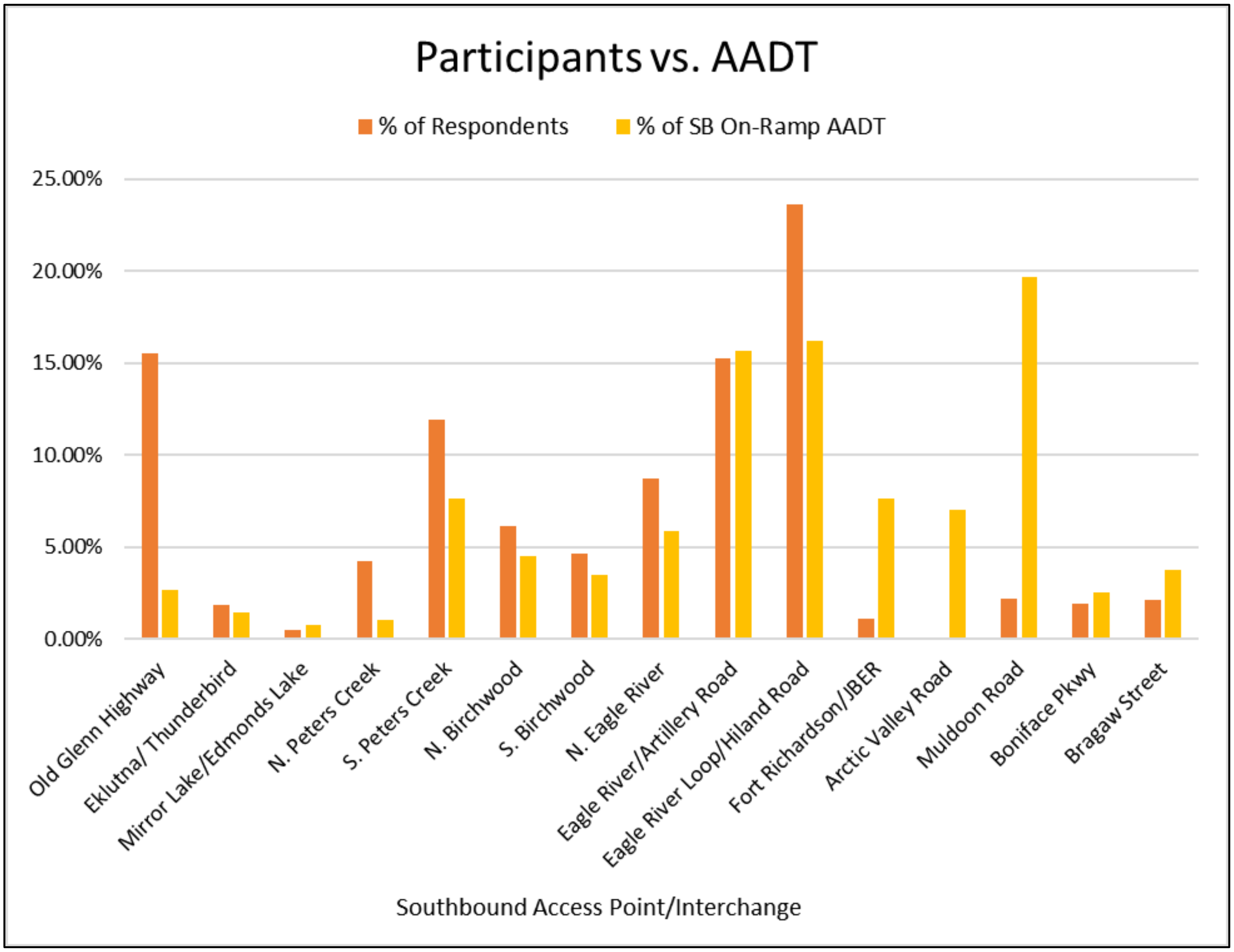

Figure 49: Southbound Access to Glenn Highway (Participants vs. AADT)

For the majority of southbound on-ramps the distribution of AADT versus survey participant distribution were similar. Compared to the AADT averages, the Eagle River interchanges are well-represented. The relative lack of respondents getting on at the JBER, Arctic Valley Road, and Muldoon Road interchanges is expected, given that the advertising for the survey focused on areas with longer commutes (Eagle River and the Mat-Su Valley).

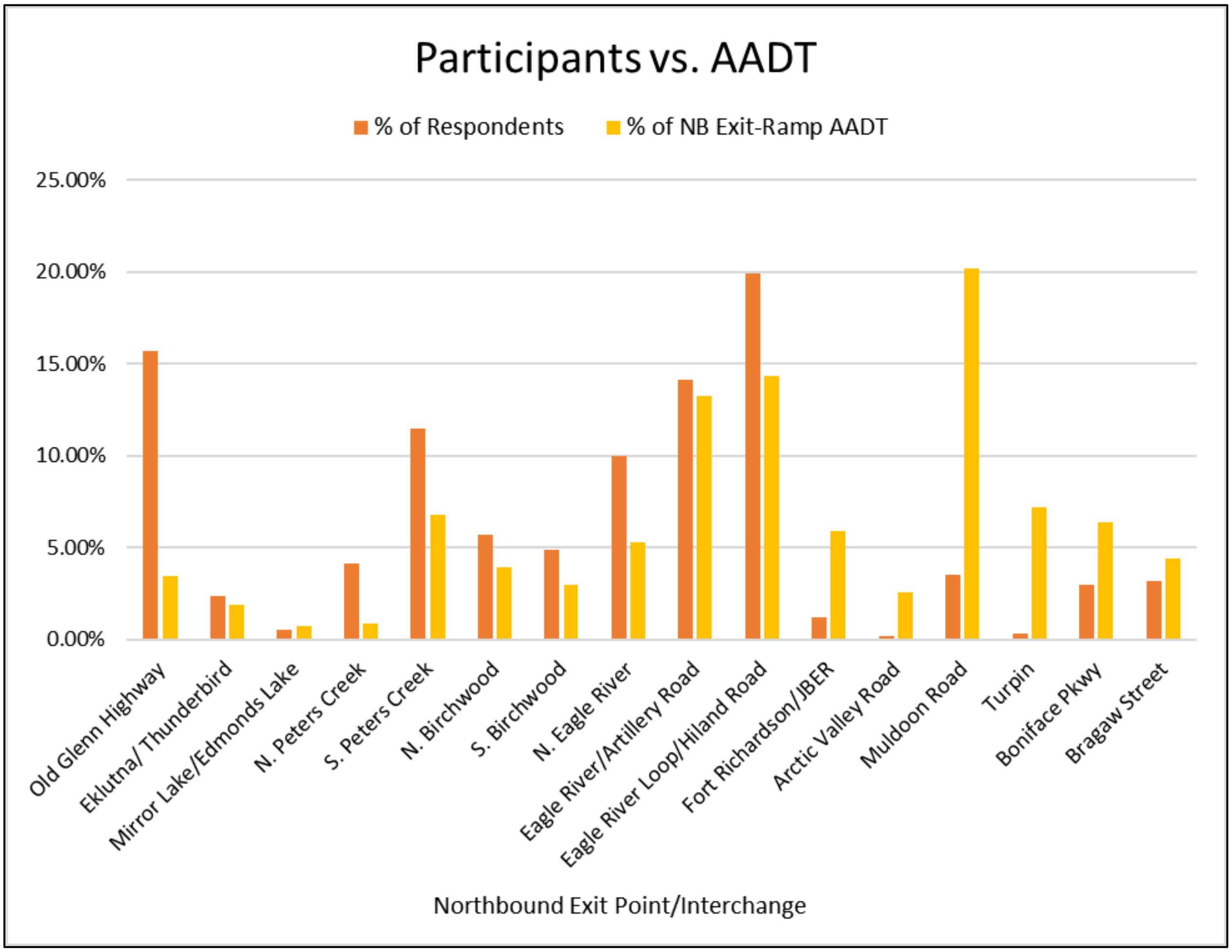

Figure 50: Northbound Exit from Glenn Highway (Participants vs. AADT)

According to the AADT averages, the majority of interchanges were represented well. As with the previous graph, the relative lack of respondents exiting at the JBER, Arctic Valley Road, and Muldoon Road interchanges is expected, given that the advertising for the survey focused on areas with longer commutes (Eagle River and the Mat-Su Valley).

The final question on the survey asked for ‘home’ zip code and ‘destination’ zip code when traveling the Glenn Highway within the project limits, as shown in Figure 51 to Figure 54. There were 4,981 participants in the online survey of which 59% entered their start of travel zip code and 51% entered their destination zip code.

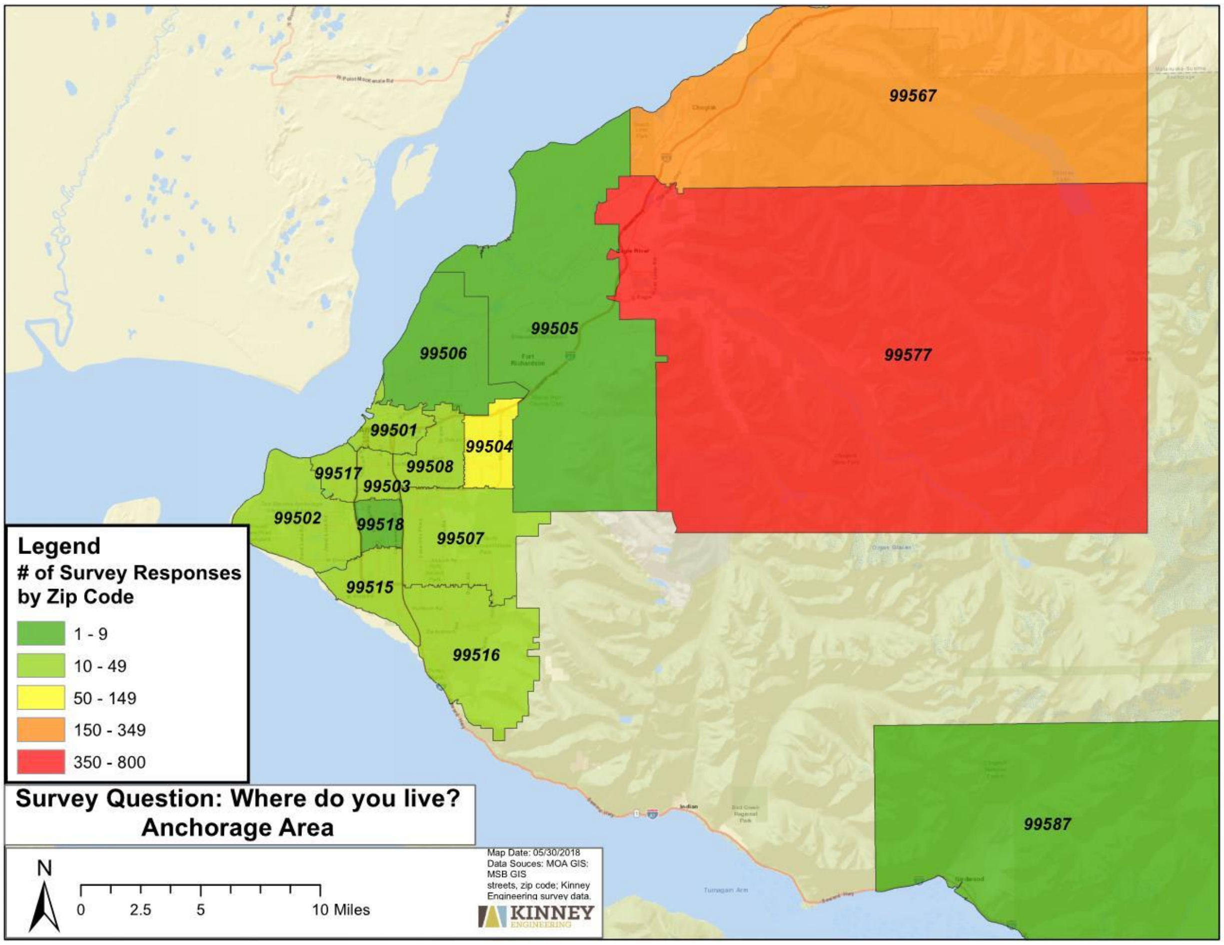

Figure 51: Home Zip Code Distribution of Survey Respondents who live in Municipality of Anchorage

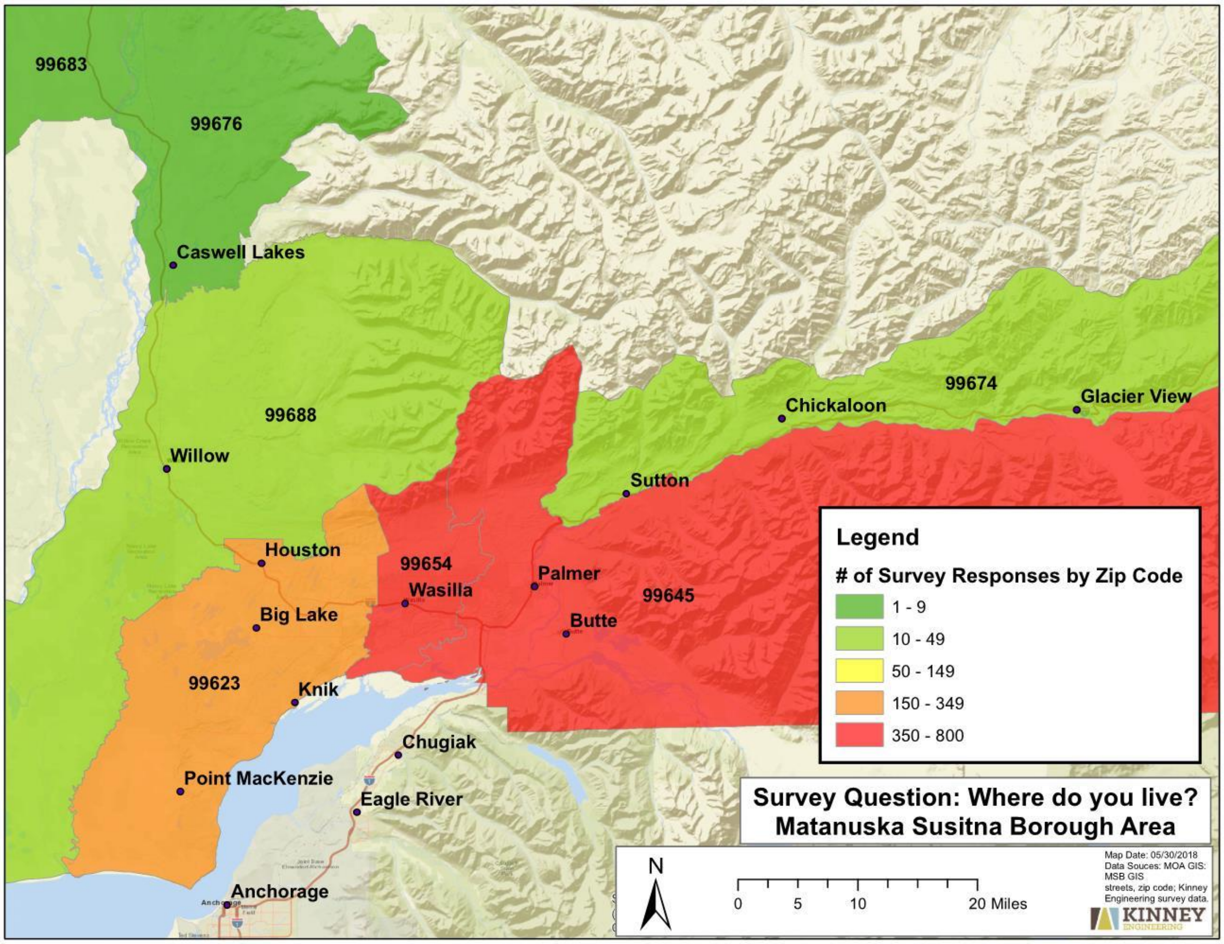

Figure 52: Home Zip Code Distribution of Survey Respondents who live in Mat-Su Borough

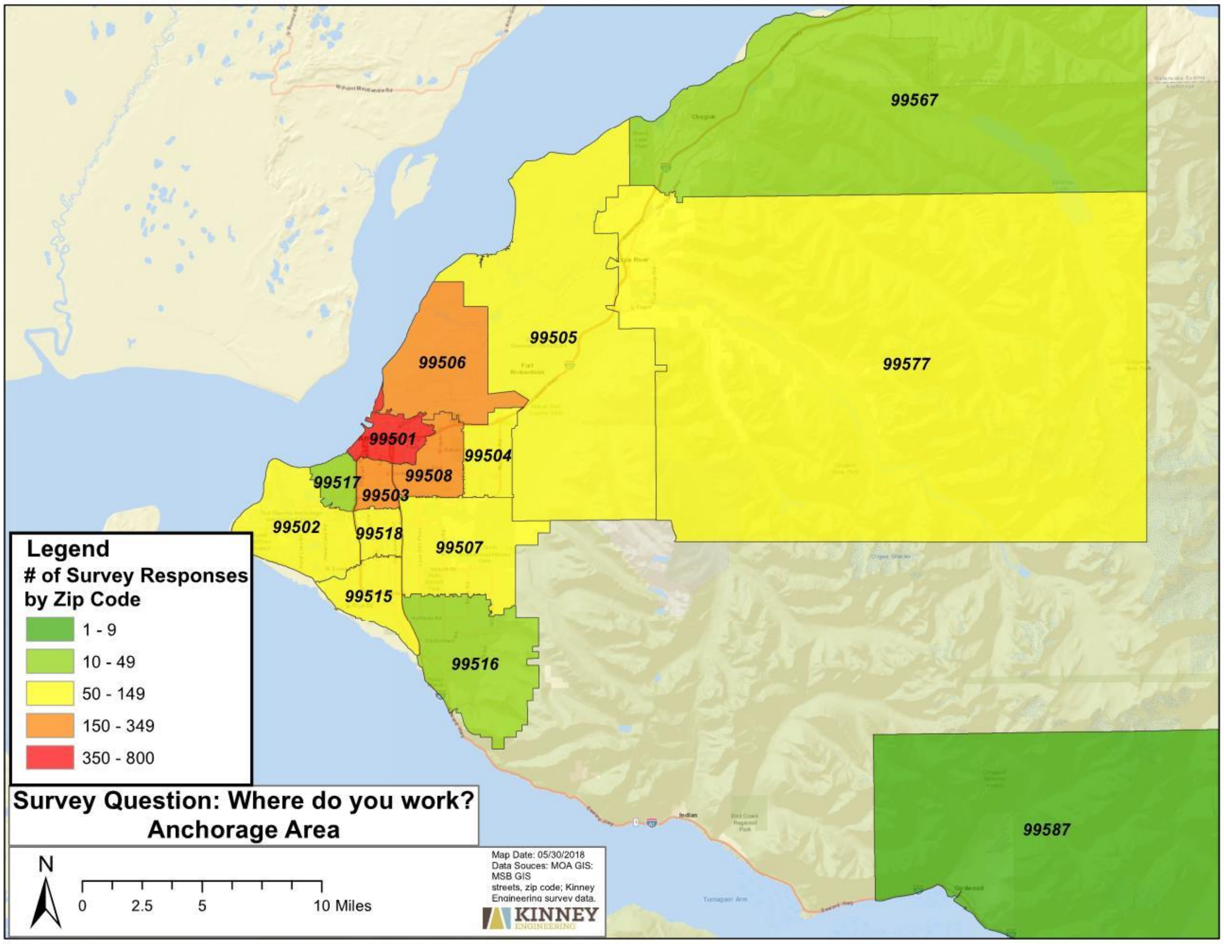

Figure 53: Destination Zip Code Distribution of Survey Respondents who travel to Municipality of Anchorage

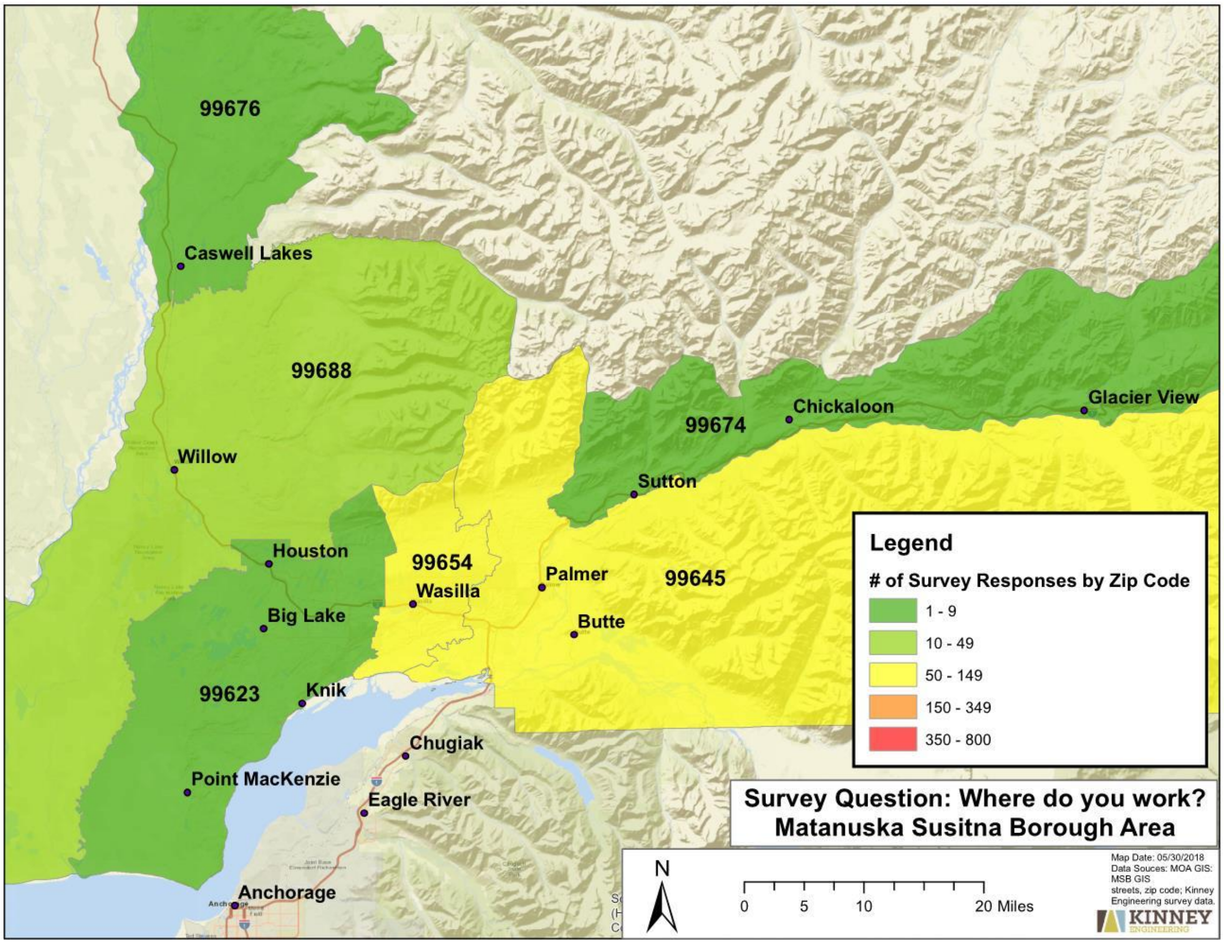

Figure 54: Destination Zip Code Distribution of Survey Respondents who travel to Mat-Su Borough

The largest group of respondents were from people who use the Glenn Highway to travel daily to work, heading southbound towards Anchorage in the morning and northbound towards Mat-Su in the evening. Similarly, the zip code distribution maps show that most of the participants in the survey start their trips in northeast Anchorage, Eagle River, Chugiak, Big Lake area, Wasilla, Butte, and Palmer and end their trips in downtown or mid-town Anchorage.

2.6 Existing ITS Asset Inventory

This section provides a brief discussion and a list of the various ITS assets deployed on the Glenn Highway study corridor. Most of the existing ITS assets are field-based elements, i.e., technologies that are deployed in the field, along the roadside. These field elements are primarily controlled by an operator to either disseminate information to the travelers or collect information from the roadway to make better operational decisions.

Figure 55 shows a map with the existing ITS assets deployed along the Glenn Highway, between MP 0 (Airport Heights/Mountain View Drive) and MP 29.1 (Old Glenn Highway). Table 39 provides the location and the number of ITS assets. The assets are described in the sections that follow.

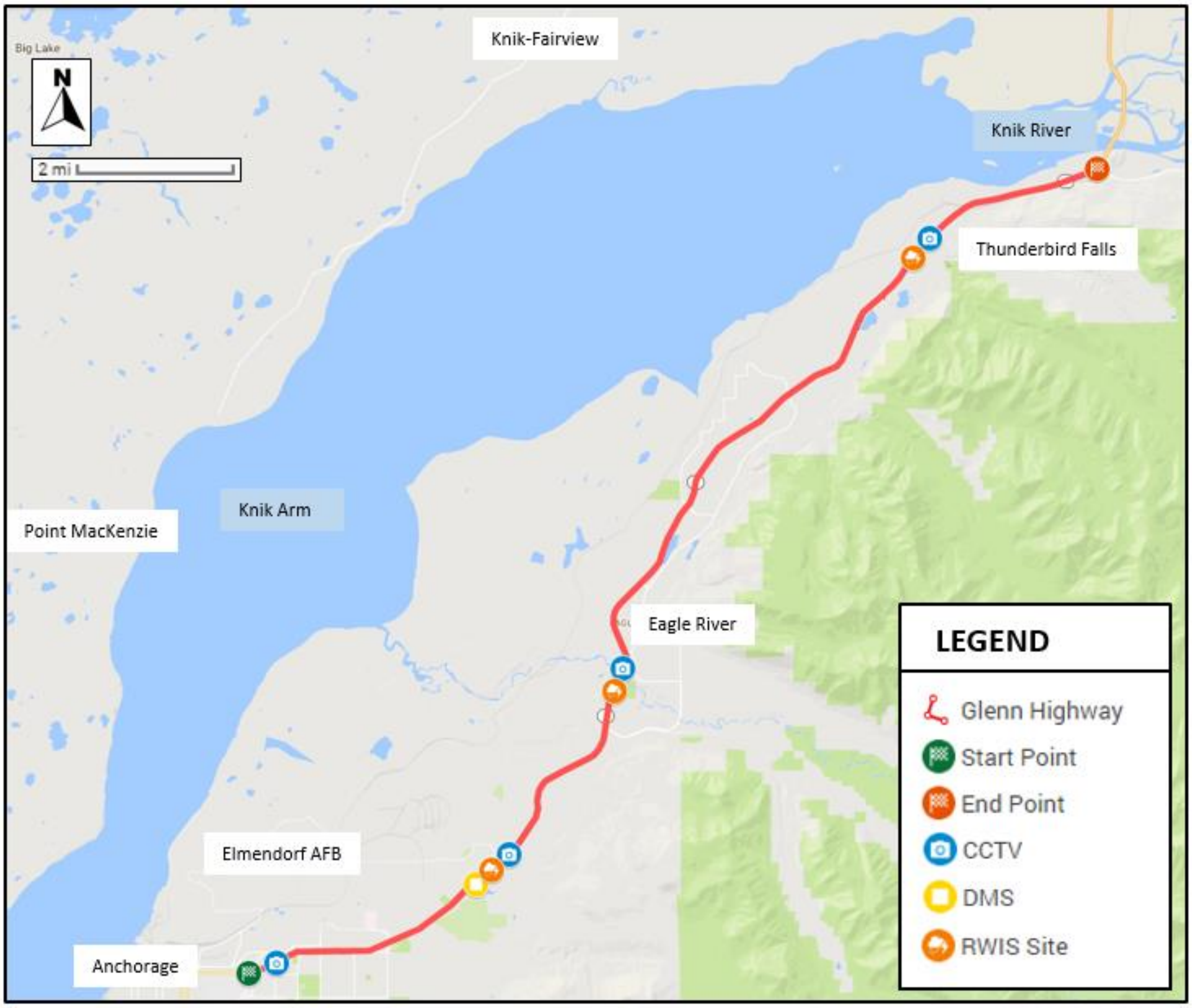

Figure 55: ITS Assets along Glenn Highway Study Corridor

Table 39: List of ITS Assets along Glenn Highway Study Corridor

Asset Name	Number of Units	Location	Mile Post
CCTV Camera	4	Glenn Hwy @ Bragaw	-
		Glenn Hwy @ S Curves	9.9
		Glenn Hwy @ Eagle River Bridge	12.8
		Glenn Hwy @ Thunderbird Falls	24.0
CMS	1	Glenn Hwy @ Fort Rich	7.0
RWIS (ESS)	3	Glenn Hwy @ S Curves	9.9
		Glenn Hwy @ Eagle River Bridge	12.8
		Glenn Hwy @ Thunderbird Falls	24.0
Start Point	-	Glenn Hwy @ Mountain View Dr/Airport Heights Dr	1.0
End Point	-	Glenn Hwy @ Old Glenn/Palmer	29.1

2.6.1 CCTV Cameras

CCTV cameras provide operators with real-time images of traffic on regional roadways to make better operational decisions. The cameras currently deployed along Glenn Highway provide information on prevailing weather conditions on the roadway. These cameras automatically capture still images one to four times an hour. The images are stored on Alaska Department of Transportation and Public Facilities (DOT&PF) servers for a period of two days. There are a total of four cameras on the Glenn Highway study corridor, as follows:

- Glenn Highway at Bragaw Street
- Glenn Highway at S Curves (MP 9.9)
- Glenn Highway at Eagle River Bridge (MP 12.8)
- Glenn Highway at Thunderbird Falls (MP 24.0)

In addition to the RWIS equipped cameras, DOT&PF is deploying infrared illuminators (IR) and IR sensitive cameras to capture night-time images. This will help maintenance and operations staff to view camera images at night.

Anchorage Police Department and Anchorage Fire Department have voiced their interest specifically in the expansion of traffic camera coverage, which can be used to assess incidents in real-time and determine appropriate levels of response. The Municipality of Anchorage (MOA), signal section, is considering installing cameras on traffic signal mast arms or other locations closer to the signalized intersections. These cameras would assist in traffic management to verify the proper traffic signals operations, and the impact of traffic when the traffic signal timing patterns are changed in response to the real-time conditions.

2.6.2 Changeable Message Signs (CMS)

The DOT&PF owns and maintains one permanent CMS on the study area. This CMS is located close to mile post 7, just south of the Fort Rich gate. It is primarily used to provide traveler information and improve decision making during adverse weather conditions. Additionally, there are two other CMS in Anchorage region, which can be used to provide roadway and weather-related information to commuters. One of the two signs is located on the Seward Highway, while the other is a permanent CMS located at the Port of Anchorage, used essentially for commercial vehicle purposes. Per an agreement between DOT&PF, Alaska State Troopers (AST), and Anchorage Police Department (APD), APD staff operates the two CMS on the Glenn and Seward Highways.

The DOT&PF Maintenance and Operations division owns and operates 15 portable CMS in and around the Anchorage and Fairbanks regions. These signs are temporary and are mostly used to provide information in construction and work zones within these regions.

2.6.3 Roadway Weather Information Systems

DOT&PF operates a network of road weather stations strategically located along the highway system. There are a total of 49 Environmental Sensor Stations (ESS) along the major transportation corridors across the state, of which three ESS are located along the Glenn Highway study corridor. The ESS locations along the Glenn Highway are listed below:

- Glenn Highway at S curves (MP 9.9)
- Glenn Highway at Eagle River Bridge (MP 12.8)
- Glenn Highway at Thunderbird Falls (MP 24.0)

The information collected from the RWIS is used to improve the safety on the roadways and support statewide maintenance operations. The RWIS collects information on the following:

- Air temperature
- Atmospheric station pressure
- Dew point temperature
- Pavement temperature
- Precipitation accumulation and occurrence
- Relative humidity
- Snow depth/stream water level
- Sub surface temperature at 17 inches
- Wind speed and direction

Data from RWIS is pulled every 15 minutes and stored on DOT&PF servers in Anchorage and Juneau. Maintenance and operations staff can view RWIS data through an internal website. The data is also posted on an FTP site for posting on an external website for public use. DOT&PF shares RWIS data with the National Weather Service, the Federal Aviation Administration, the University of Alaska, and the Elmendorf Air Force Base (AFB).

2.6.4 Traveler Information System

DOT&PF owns, operates and maintains a statewide traveler information system called 511 Travel-in-the-Know. The system provides real-time traveler information to commuters via a 511website and text or email notifications. The following information is available through the Alaska 511:

- Highway construction, maintenance activities, and future planned events
- National weather service and forecasts
- Route and regional reports
- Information on: road closures, driving conditions, major accidents, natural disasters, etc.
- CCTV cameras, CMS, and mile marker locations

For information regarding crashes and lane closures on roadways including Glenn Highway, DOT&PF receives alerts from the Anchorage Police Department (via Nixle) and automatically posts all alerts pertinent to the highway system to 511.

The computer acquisition and reporting system (CARS) feeds the 511 system. CARS allows quick entry of events and information to disseminate traveler information on a near real-time basis. Following are the CARS program partners in Alaska:

- DOT&PF M&O, construction, and bridge design
- Alaska State Trooper
- Palmer Police Department
- Measurement Standards and Commercial Vehicle Enforcement
- National Weather Service
- Alaska Marine Highway
- U.S. Customs and Border Protection
- Municipality of Anchorage – Anchorage Police Department, Water & Waste Utilities, street maintenance, and construction
- Denali National Park
- Yukon Roads Departments

Authorized CARS agencies can enter and update information as needed. This information is then plotted within a geographic information system (GIS) system for spatial understanding. Past events and patterns can also be analyzed through information entered into CARS. CARS automatically ingests National Weather Service (NWS) forecasts to display on the 511 Travel-in-the-Know website.