Municipality of Anchorage

West Dimond Boulevard Upgrade
(Jodhpur Street to Sand Lake Road)

MOA Project 05-005
Draft Report

Traffic, Safety and Alternatives Analysis

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Prepared for:
Municipality of Anchorage
Project Management and Engineering

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Executive Summary

This Dimond Boulevard Upgrade project will upgrade West Dimond Boulevard and Jodhpur Street from Sand Lake Road to the Kincaid Park entrance to collector standards (project location shown in green in Figure 1 on page 1). This analysis evaluates how this segment will perform in the future under a no-action alternative and a range of feasible improvements. The results from this report will help develop the purpose and need for the project, and alternatives to accommodate future traffic and improve safety conditions.

This project is a Municipality of Anchorage project, managed by the Project Management and Engineering Division.

This report contains the following elements that are used to determine if the project's purpose and need are supported.

- Traffic volumes
- Crash analysis
- Pedestrian level of service (LOS) and safety analysis
- Road segment alternatives capacity and safety analysis
- Intersection alternatives capacity and safety analysis

The study period for this analysis is from a construction year of 2015 to a design year of 2035. The findings for each element of the study are summarized below.

Traffic Volumes

Projected Average Annual Daily Traffic (AADT) for road segments within the project area were obtained from the Anchorage Metropolitan Area Transportation Solutions (AMATS) traffic demand model for the year 2035. Annual traffic growth rates were calculated using the traffic demand model volumes and the historical volumes for each road segment. The growth rates for each segment were used to generate the construction and mid-life volumes. The following table presents forecasted AADT volumes for the Dimond Boulevard and Jodhpur Street segments. Projected turning movement volumes are under Appendix B.

			Projected Year AADTs		
Street	**Begin**	**End**	**2015**	**2025**	**2035**
Dimond Boulevard					
Dimond Boulevard	Jodhpur Street	Westpark Drive	1,325	1,701	2,184
Dimond Boulevard	Westpark Drive	Sand Lake Road	3,414	4,383	5,627
Dimond Boulevard	Sand Lake Road	Edinburgh Drive	5,089	7,029	9,709
Sand Lake Road					
Sand Lake Road	Dimond Boulevard	Kincaid Road	2,789	3,408	4,165
Jodhpur Street					
Jodhpur Street	Dimond Boulevard	Kincaid Road	430	448	467
Westpark Drive					
Westpark Drive	Dimond Boulevard	Kincaid Road	1,430	2,219	3,443

Crash Studies

The Sand Lake Road and West Dimond Boulevard intersection was found to have a high crash rate based on Alaska DOT&PF average population crash rates for the same intersection types and time period. These calculations were performed using the Rate Quality Control Method discussed in Appendix D. The Westpark Drive and West Dimond Boulevard intersection was analyzed, but had a low crash rate with low severity. Segment crash rates are not high within the project area. The majority of crashes were road departure crashes both along the road segment and also at the Sand Lake Road and West Dimond Boulevard intersection.

Pedestrian Crossing Alternatives

Pedestrian crossings of Dimond Boulevard include crossings at several unsignalized road and driveway approaches. This report examines the LOS for pedestrians at the unsignalized intersections. The pedestrian LOS was found to be at LOS B or better for all intersections with the exception of both the Sand Lake Road and the Westpark Drive intersections. To improve pedestrian LOS at the Sand Lake Road intersection, refuge islands or signalization should be provided. The crossing of West Dimond Boulevard at Westpark Drive will produce a LOS E on the east side due to the three lane crossing and high turning volume. The west side crossing will produce LOS A due to a shorter crossing and lower conflicting traffic volumes in the design year 2035.

Typical Section Alternatives

The Anchorage Municipal Code 21.85.020 “Improvement areas defined” indicates that the zoning for this area would classify the area as rural on the south side and urban on the north side of Dimond Boulevard. As such, both rural and urban collector design standards are compatible with this project and both 10- and 11-foot lane widths were examined for West Dimond Boulevard – Jodhpur Street corridor.

- Number of Lanes & Lane Configuration. A two-lane facility was found to provide an adequate LOS for the future traffic volume.

- Lane Width. Due to the difference in lane width criteria between urban and rural collectors, and the rural and urban zoning on the project, both 10- and 11-foot lane widths were examined for Dimond Boulevard. According to the procedures in the Municipality’s Design Criteria Manual, 10-foot travel lanes may be considered for the roadway west of Westpark Drive. If a rural typical section is used, then 11-foot lanes should be used. The lane width east of Westpark Drive should be 11 feet.

- Shoulder Width. A 4-foot shoulder is adequate for a rural section. A minimum of 3.5-foot shoulder is recommended for the urban section.

- Roadside Design (Rural Typical Section). A clear zone width of 20 feet that is free of obstacles should be provided if the design speed is 45 mph. If the design speed is 35 mph, then the clear zone width would be reduced to 14 feet.

Intersection Design Alternatives

The Sand Lake Road and Westpark Drive intersections are forecasted to have the largest decreases in LOS within the project area and within the project life.

Sand Lake Road / Dimond Boulevard Intersection Alternatives:

- No Action. The no action alternative is to leave the existing intersection in place with a single stop sign on the Sand Lake Road approach and free flow allowed on Dimond Boulevard. This alternative was found to produce a LOS of E (or >40 seconds of control delay per vehicle) between the years 2025 and 2035 for the traffic on Sand Lake Road. This would also produce a pedestrian LOS F for the crossing of West Dimond Boulevard on the east side of the intersection.

- Add a right turn auxiliary lane to the westbound approach. This option would provide LOS D in 2035 for the traffic on Sand Lake Road. Dimond Boulevard would remain free flow. This solution would not serve pedestrians well because the east unsignalized crossing of West Dimond Boulevard would become longer, increasing pedestrian delay.

- All-Way Stop Control. This alternative would place stop signs on all of the intersection approaches. All way stop control will only provide a LOS of E in the year 2035 unless a westbound right turn bay is added, in which case the resulting LOS is C in the year 2035. Pedestrians could cross easily with traffic yielding to pedestrians on all approaches.

- Modern Roundabout. This alternative would include the installation of a single lane roundabout. A roundabout will provide a LOS of B in the year 2035. Angle and road departure turning crashes would be reduced. Pedestrian refuge islands resulting in single lane crossings for each approach would make crossing easier during peak traffic conditions.

- Signalization. This alternative would place an actuated signal at the intersection. This alternative will provide a LOS of B to the year 2035. Angle crashes would be reduced. Pedestrian crossings would be signalized, making it easier to cross under peak traffic conditions on all approaches.

Westpark Drive / Dimond Boulevard Intersection Alternatives:

- No Action. If the existing configuration is left in place, the future LOS for the southbound approach would be LOS B. The existing right turn auxiliary lane onto Westpark Drive is a 10-foot wide lane, 90 feet long, with a 70-foot taper at a 7:1 taper rate. The existing lane does not provide adequate length for a vehicle to decelerate within the turn auxiliary lane and therefore, vehicles using this turn lane must decelerate within the through lane.

- Improve Right Turn Auxiliary lane. This alternative installs a right turn bay with a 12-foot width and adequate length for a vehicle to decelerate entirely within the turn bay. This improvement will provide a future safety improvement by reducing the probability of rear-end crashes by eliminating the need for vehicles to decelerate within the through lane.

- Convert to All-Way Stop Control. MUTCD 2009 all way stop warrants were not met for the design year. All way stop control is not a feasible alternative for this location.

- Convert to Roundabout. This alternative would convert the intersection to a modern roundabout. The 2035 LOS would be A for all approaches. Pedestrian refuge and single lane crossings would make crossing all sides of the intersection easier during peak traffic conditions for pedestrians.

- Convert to Traffic Signal. Installation of a traffic signal is not warranted at this intersection.

Other intersections in the study corridor will operate with a LOS B or better for the design life, and no alternative treatments are recommended at those locations.

WEST DIMOND BOULEVARD UPGRADE
Traffic, Safety, and Alternatives Analysis

1. Project Background

1.1 Project Description & Purpose of this Report

This traffic, safety and alternatives analysis identifies traffic conditions, safety issues, and feasible design alternatives associated with the Dimond Boulevard Upgrade project. This analysis evaluates how the segment of West Dimond Boulevard - Jodhpur Street between Kincaid Park entrance and Sand Lake Road (shown in green in Figure 1), will perform in the future under a no-action alternative. The results from this report will help develop the purpose and need for the project, and suggest alternatives to accommodate future traffic and improve safety conditions.

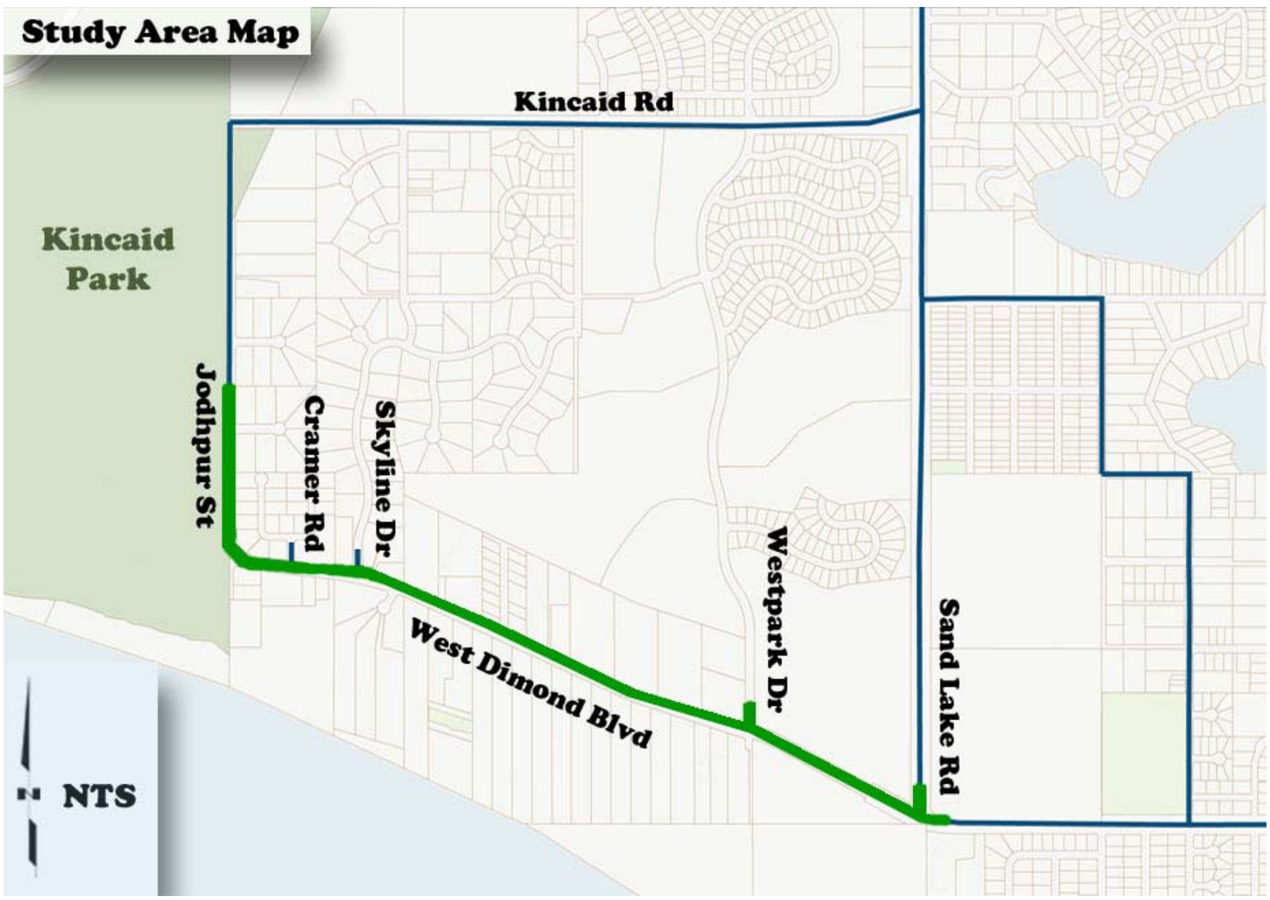


Figure 1 - Project Study Area

This project is a Municipality of Anchorage project, managed by the Project Management and Engineering Division.

The study period for this analysis is from a construction year of 2015 to a design year of 2035. The traffic and safety analysis contains the following elements that are used to determine if the project's purpose and need are supported.

- *Traffic Volumes*. The work includes past traffic volume data and intersection turning movement counts at key intersections along the project corridor. Future traffic volumes, both Average Annual Daily Traffic (AADT) and design turning movement volumes are forecasted for the study period. Past volumes apply to the crash studies and future volumes apply to capacity studies and the design designations.
- *Crash Studies*. The most-recent 10 years of crash data were collected and evaluated on the basis of both crash rate and type/contributing factor over-representation.
- *Pedestrian LOS and Analysis.* The pedestrian LOS and delay was calculated for unsignalized crossings.
- *Road Segment Alternatives.* Typical section alternatives were examined to determine the capacity, lane width, shoulder width, and roadside design.
- *Intersection Alternatives.* Alternatives for the intersections of West Dimond Boulevard with Sand Lake Road and with Westpark Drive were analyzed for capacity, LOS, and safety.

1.2 Existing Facility Description

1.2.1 Functional Classifications

Both DOT&PF and MOA have roadways that are within the project limits. West Dimond Boulevard between Sand Lake Road and Jodhpur Street, Westpark Drive, and local roads are Municipally-owned roadways. Sand Lake Road, Jodhpur Street, and Dimond Boulevard east of Sand Lake Road are owned by the State of Alaska. CDS logs for the Central Region and the Central Region *Annual Traffic Volume Report* were referenced for the DOT&PF system classification. The MOA functional classifications were found in the MOA, *Official Streets and Highways Plan*, August 1996 and 2011 Draft. The planned classification of Westpark Drive is a Class IB Neighborhood Collector by the MOA, where it was previously classified as a local road. The functional classifications for the system's components are summarized in the following table.

DOT&PF CDS Route	Road	DOT&PF Functional Class	MOA Functional Class
133700	Dimond Boulevard (west of Sand Lake Road)	Urban Collector	Residential Collector, Class I
133755	Sand Lake Road	Urban Collector	Minor Arterial, Class II
133772	Jodhpur Street	Urban Collector	Neighborhood Collector, Class IB
Not Listed	Westpark Drive	Not Listed	Neighborhood Collector, Class IB

Table 1 - Road Functional Classifications

Intersecting roadways that are not listed in Table 1 are classified as secondary (local) streets.

1.2.2 Existing Roadway

The existing roadway consists of a two-lane section of 10-foot paved lanes without shoulders along Jodhpur Street and the segment of Dimond Boulevard west of Westpark Drive. The road within this segment resembles a rural section with 2:1 fore and back slopes, shallow “V” shaped ditches, rolling terrain, and heavy vegetation on the road side.

East of Westpark Drive, Dimond Boulevard has 12-foot lanes (one lane each direction), 2-foot paved shoulders, 4-foot gravel shoulders, and level terrain.

There is continuous illumination between Westpark Drive and Sand Lake Road, with luminaires mounted on utility poles at 300-foot spacing. The rest of corridor to the west has intermittent lighting at driveways and intersections. All of the existing lighting is on the south side of the road.

No storm drain, public water, or sewer systems exist along the project corridor, except in the vicinity of the Sand Lake Road – West Dimond Boulevard intersection. Overhead telephone and electric lines exist throughout the right-of-way. The right-of-way width is typically 100 feet.

1.2.3 Intersections

There are 6 roads and 15 driveways that intersect Dimond Boulevard between Westpark Drive and Jodhpur Street, which equates to an approach density of 26 approaches per mile over this segment. All of the intersections are unsignalized, with stop control on the side streets and no control on the mainline (Dimond Boulevard or Jodhpur Street). Only 4 roads connect from West Dimond Boulevard to Kincaid Road (an east-west roadway to the north): Sand Lake Road, Jodhpur Street, Westpark Drive, and Skyhills Drive.

Westpark Drive has been developed to provide access to the Kincaid Estates Subdivision. A westbound 10-foot wide and 90-foot long auxiliary right turn lane has been added to West Dimond Boulevard at this intersection. The taper length into the turn bay is 70 feet or a 7:1 taper rate.

1.2.4 Trails

There are no existing trails along Dimond Boulevard and Jodhpur Street between Sand Lake Road and the park entrance. At the Sand Lake Road intersection, there is a multi-use pathway on the west side of Sand Lake Road and on the north side of Dimond Boulevard, east of the intersection. Westpark Drive has an asphalt sidewalk on the west side leading up to Dimond Boulevard.

1.2.5 Speeds

The posted speed on Jodhpur Street and West Dimond Boulevard west of Cramer Drive is 35 miles per hour (mph). East of Cramer Drive, the posted speed on West Dimond Boulevard is 45 mph. Sand Lake Road is posted at 50 mph.

Three speed studies (radar) were conducted within the project limits during February 2006 on Jodhpur Street, Sand Lake Road, and Dimond Boulevard. The Municipality of Anchorage (MOA) also conducted a speed study for West Dimond Boulevard in May 2006. Speeds were generally higher by about 4 mph in the summer months than in the winter months. The average of the mean speeds over the various measurement times and locations on West Dimond Boulevard was 42 mph and the average of the 85^{th} percentile speeds was 44 mph. The average mean speed for Sand Lake Road southbound was 50 mph and the average 85^{th} percentile speed was 55 mph. The MOA 24 hour speed study reports do not differentiate for speeds 65 mph and above. Table 2 presents the findings of the individual speed studies.

Roadway	Mean Speed (mph)	85th Percentile Speed (mph)	Highest Speed Recorded (mph)	Posted Speed (mph)
Jodhpur Street(Feb 2006, South of Kincaid Gate)	32	34	35	35
W. Dimond (Eastbound, Feb 2006, between Westpark & Sand Lake)	38	44	53	45
W. Dimond (Westbound, Feb 2006, East of Sand Lake Road)	40	47	57	
W. Dimond (Eastbound, MOA, May 2006, 24 hr, between Lori & Sommers)	45	50	>65	
W. Dimond (Westbound, MOA, May 2006, 24 hr, between Lori & Sommers)	44	48	>65	
Sand Lake Road (Southbound, Feb 2006, North of Dimond Boulevard)	48	53	59	50
Sand Lake Road (Southbound, MOA, June 2006, 24 hr, North of Dimond Boulevard)	51	57	>65	
Kincaid Road (Eastbound, MOA, May '06, 24 hr, between Lucy & Ingram)	44	49	>65	35

Table 2 - Speed Study Findings, February & May 2006

1.3 Planning and Land Use

Kincaid Estates is a residential housing project under development. This development will ultimately add up to 640 single-family residences and 80 duplex dwelling units to the area. As of January 2013, 353 homes have been constructed along Westpark Drive.

Two school sites have been acquired by the Anchorage School District in the vicinity of this project. Tract 8A and Lot 1 were purchased as an elementary school site. Tract 9A was purchased as a middle school site. The sites were purchased in 2008 and 2009 and are located west of Westpark Drive.

No significant development is expected on the south side of West Dimond Boulevard due to its proximity to Cook Inlet in the study area.

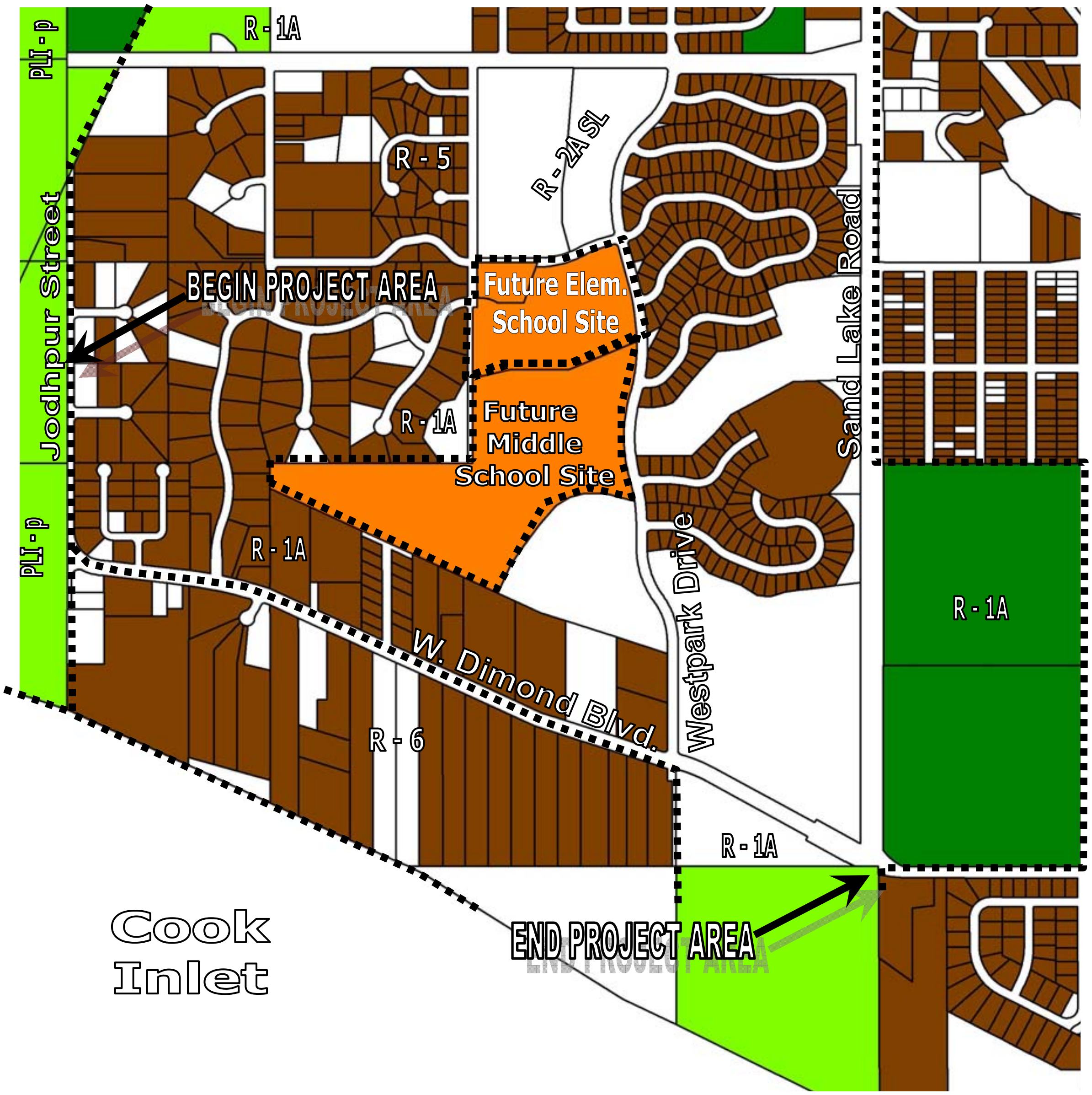
The 2007 Anchorage Pedestrian Plan lists a missing sidewalk along West Dimond Boulevard west of Sand Lake Road as a priority project in Southwest Anchorage.

The 2010 Anchorage Bicycle Plan lists a separate shared use path along West Dimond Boulevard west of Sand Lake Road as an intermediate term project with a construction year of 2013.

The South Coastal Trail Extension is currently in the MOA 2035 Metropolitan Transportation Plan (MTP) as an illustrative project that is not funded under the MTP and will be scheduled for construction after 2035.

Current land use adjacent to the project corridor consists of R-6 (suburban residential large-lot) and R-1A (single-family residential) zoned properties with the exception of the park land to the west of Jodhpur Street. The land west of Jodhpur Street is PLI-P (dedicated park) zoned and is part of Kincaid Park, which contains a motorcycle / ATV racetrack and a non-motorized trail system.

Figure 2 depicts the land use, zoning, and current development in the project area.



(Zoning boundary = dotted lines, Brown fill = developed residential land, White fill = undeveloped land)

Figure 2 - Land Use, Zoning, & Development in Project Area

2. Traffic Volumes

Historical volumes published by Alaska DOT&PF for each road segment are presented below. Projected Average Annual Daily Traffic (AADT) for road segments within the project area were obtained from the AMATS traffic demand model for the year 2035. The future school traffic is accounted for in the AMATS model. Annual traffic growth rates were calculated using the traffic demand model volumes and the historical volumes. The growth rates for each segment were used to generate the construction year and mid-life volumes. The graph below shows the segment projected AADTs for each year. Turning movement volumes for Westpark Drive were used to generate an AADT for that roadway since historical traffic counts were not available. A conservative 7.5% of AADT during the peak hour was used to convert the peak traffic hour to AADTs for Westpark Drive. Peak hour turning movement volumes are under Appendix A.

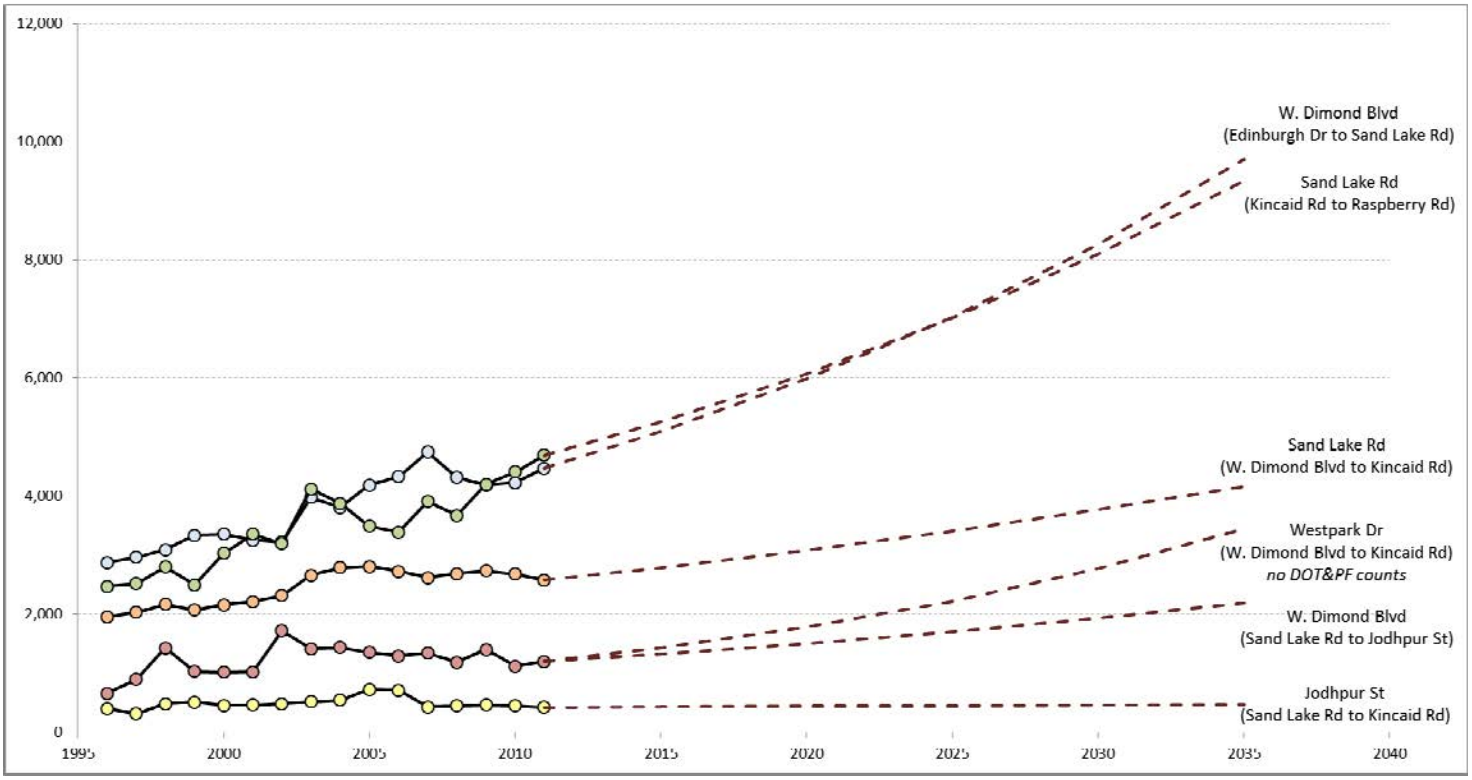


Figure 3 - Projected AADT vs. Year

2.1 Existing AADT

Average Annual Daily Traffic (AADT) volumes were obtained from the DOT&PF's 2000 through 2011 *Central Region Annual Traffic Volume Report*. Values from these reports are tabulated in Table 3 below. These historical traffic volumes are used for evaluation of the crash history and projection of future traffic volumes.

Street	Begin	End	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
West Dimond Boulevard														
West Dimond Boulevard	Sand Lake Road	Jodhpur Street	1012	1023	1715	1412	1433	1350	1292	1338	1182	1398	1116	1199
West Dimond Boulevard	Edinburgh Drive	Sand Lake Road	3353	3254	3221	3978	3804	4188	4329	4743	4312	4184	4228	4472
Sand Lake Road														
Sand Lake Road	West Dimond Boulevard	Kincaid Road	2159	3353	3194	4120	2786	2806	2727	2618	2683	2734	2677	2574
Jodhpur Street														
Jodhpur Street	West Dimond Boulevard	Kincaid Road	454	464	480	518	540	726	710	426	448	460	450	423

Table 3 - AADT Traffic Volumes, 2000 to 2011

2.2 Existing Intersection Turning Movements

Turning movement data was acquired in February and March of 2006 at the Skyhill Road and Sand Lake Road intersections with West Dimond Boulevard. The Westpark Drive and West Dimond Boulevard intersection was counted in January of 2013. See Appendix A for the existing turning movement diagrams.

2.3 Future AADT

Table 4 summarizes AADT forecasts for construction (2015), mid-life (2025), and design year (2035).

			Projected Year AADT's		
Street	**Begin**	**End**	**2015**	**2025**	**2035**
Dimond Boulevard					
West Dimond Boulevard	Jodhpur Street	Westpark Drive	1,325	1,701	2,184
West Dimond Boulevard	Westpark Drive	Sand Lake Road	3,414	4,383	5,627
West Dimond Boulevard	Sand Lake Road	Edinburgh Drive	5,089	7,029	9,709
Sand Lake Road					
Sand Lake Road	West Dimond Boulevard	Kincaid Road	2,789	3,408	4,165
Jodhpur Street					
Jodhpur Street	West Dimond Boulevard	Kincaid Road	430	448	467
Westpark Drive					
Westpark Drive	West Dimond Boulevard	Kincaid Road	1,430	2,219	3,443

Table 4 - Future AADT

West Dimond Boulevard was divided into two segments between Jodhpur Street and Sand Lake Road at the Westpark Drive intersection. This division was made to examine the difference in traffic volumes between these two segments.

2.4 Future Intersection Turning Movements

Peak hour turning movement counts were taken using a manual count board in February and March of 2006 and January of 2013. The turning movement counts were used to convert the projected AADT to future turning movement counts using 10% of daily traffic occurring in the design hour and the methodology described in NCHRP Report 255 Traffic Data for Highway Planning and Design.

Appendix A shows construction year (2015), mid-life year (2025) and design year (2035) turning movement volumes generated using the methodology described above.

2.5 Traffic Design Designations

The following table summarizes traffic design designations that should be used for alternative evaluation. Equivalent Single Axle Loads are not presented here, as they will depend upon the roadway lane configurations.

	Construction Year	Mid-Life Year	Design Year
	2015	**2025**	**2035**
West Dimond Boulevard, Kincaid Park entrance to Westpark Drive			
Average Daily Traffic (ADT)	1,325	1,701	2,184
Design Hour Volume (DHV) %	10%	10%	10%
Peak Hour Factor (PHF)	0.80	0.80	0.80
Directional Distribution Percent	41/59	41/59	41/59
Percent Commercial Trucks	8%	8%	8%
West Dimond Boulevard, Westpark Drive to Sand Lake Road			
Average Daily Traffic (ADT)	3,414	4,383	5,627
Design Hour Volume (DHV) %	10%	10%	10%
Peak Hour Factor (PHF)	0.80	0.80	0.80
Directional Distribution Percent	41/59	41/59	41/59
Percent Commercial Trucks	8%	8%	8%

Table 5 - Traffic Design Designations

3. Crash Analysis Element

Crash information was provided by the Central Region Traffic and Safety Section of DOT&PF and by the Municipality of Anchorage, Traffic Department for 2000 to 2009. There were 22 crashes during this period including 1 fatality. These were sorted into intersections and segment locations; however, the single crash at Westpark Drive intersection is included in both analyses. Segments also include minor intersections to match the method DOT&PF uses to determine the segment population rates.

3.1 Crash Rates

Crash rate calculation methods are presented in Appendix D - Crash Rate and Over-Representation Methods and Calculations. Table 6 and Table 7 summarize the intersection and segment rates. Only the Sand Lake Road and Westpark Drive intersections are listed because they are higher level collectors (not local roads) in the MOA OS&HP.

Intersection and segment statewide population rates were obtained from the Central Region Traffic and Safety Section. These population rates are the 2000-2009 averages for the comparable facilities. When calculating the Westpark Drive intersection crash rate, the average AADT only for West Dimond Boulevard (reported west of Sand Lake Road) was used, resulting in the calculation of a crash rate as higher than the actual crash rate. The average annual daily traffic (AADT) volumes were not available for Westpark Drive from 2000 to 2009. As the resulting crash rate was below the state-wide average, it can be concluded that the actual crash rate is below the state-wide average.

Both tables present the upper control limit (UCL) for the facilities. This computed value signifies the threshold such that crash rates that exceed the UCL are statistically significant (critical). The Sand Lake Road intersection was found to have a crash rate above the statewide average and above the UCL critical value.

Intersection	Intersection Crashes 2000 to 2009	Average Entering AADT 2000 to 2009	Million Entering Vehicles (MEV)	Crashes / MEV	Control	State Populations	UCL @ 95.00% Confidence	Above Average?	Above Critical?
W. Dimond Boulevard and Sand Lake Road	14	4,085	14.910	0.939	Stop	0.527	0.870	yes	yes
W. Dimond Boulevard and Westpark Drive	1	1,316*	4.818*	0.208*	Stop	0.527	1.175	no	no
Total Intersection Crashes	15								

*AADT data for Westpark Drive was not available. See discussion above for further details.

Table 6 - Intersection Crash Rates, 2000 to 2009, West Dimond Boulevard, Jodhpur Street to Sand Lake Road

Segments	Segment Crashes 2000 to 2009	Segment Length (Miles)	Average AADT 2000 to 2009	Million Vehicle Miles (MVM)	Crashes / MVM	State Populations	UCL @ 95.00% Confidence	Above Average?	Above Critical?
W. Dimond Boulevard* - Sand Lake Road to Jodhpur Street	7	0.993	1,316	4.766	1.469	2.417	3.693	no	no
Jodhpur Street - W. Dimond Boulevard to Kincaid Park entrance	1	0.255	523	0.486	2.056	2.417	7.112	no	no
Total Segment Crashes	8								

*includes single crash at Westpark Drive intersection

Table 7 - Segment Crash Rates, 2000 to 2009, West Dimond Boulevard, Jodhpur Street to Sand Lake Road

3.2 Crash Severity and Contributing Factors

Table 8 through Table 11 present the crash profiles for the intersections and segments.

Crash Type	Number	%
Sand Lake Road and West Dimond Boulevard Intersection		
Angle	6	43%
Single vehicle roadway departure crash, attempting to negotiate intersection turn	7	50%
Single vehicle roadway departure crash, attempting to decelerate	1	7%
Westpark Drive and West Dimond Boulevard Intersection		
Angle	1 (also included under Segment)	100%

Table 8 - Intersection Crash Types, 2000 to 2009

Crash Type	Number	%
Sand Lake Road to Kincaid Park Entrance		
Angle	1 (also included under Intersection)	12.5%
Single vehicle roadway departure crash	4	50%
Moose	2	25%
Bicycle	1	12.5%

Table 9 – Segment Crash Types, 2000 to 2009

Typical contributing factors for these roadside departure crashes include alignment, lane and shoulder widths, and road conditions. All of the roadside departure crashes involved single vehicles ending up in the ditch or impacting objects off of the roadway such as light poles, mailboxes or trees. For the West Dimond Boulevard segment (from Westpark Drive to Kincaid Park Entrance), this type of crash represented 50% of the crash population. For the Sand Lake Road and West Dimond Boulevard intersection, this type of crash represented 57% of the crash population from 2000 to 2009. It should be noted that at this intersection, all but one of these types of crashes occurred when vehicles were attempting to make a turning maneuver, ending with a loss in control. Time of year, roadway condition, and lighting were investigated as possible causes. No relationship could be established between the road conditions and the roadside departure crashes that occurred.

Severity	Number of Crashes (K)	%	MOA Population %	Test	P(≥K) (Poisson)	Statement of Significance
Sand Lake Road and West Dimond Boulevard Intersection						
Fatality	0	0%	0.31%	Poisson	N/A	Not calculated
Minor Injury	5	36%	26.25%	Poisson	30.796%	No statistical evidence that minor injury crashes exceed population levels.
Westpark Drive and West Dimond Boulevard Intersection						
Fatality	0	0%	0.31%	Poisson	N/A	Not calculated
Minor Injury	0	0%	26.25%	Poisson	N/A	Not calculated

Table 10 - Intersection Crash Severity Levels, 2000 to 2009

Severity	Number of Crashes (K)	%	MOA Population %	Test	P(≥K) (Poisson)	Statement of Significance
Sand Lake Road to Kincaid Park Entrance Segment						
Fatality	1	13%	0.31%	Poisson	2.439%	Fatality crashes are highly significant.
Minor Injury	2	25%	26.25%	Poisson	62.039%	Minor Injury crashes are not significant.
Property Damage	5	63%	71.21%	Poisson	67.229%	Property Damage crashes are not significant.

Table 11 - Segment Crash Severity Levels, 2000 to 2009

In 2005, there was a fatal motorcycle crash on Dimond Boulevard reported to be 800 feet west of the Sand Lake Road intersection with excessive speed cited as a contributing factor. The location of this accident was reported by homeowners to be about 1,500 feet west of the Sand Lake Road intersection. The motorcyclist crossed the centerline of the road, went air born, and impacted the ditch. The driver was pronounced dead at the scene. The presence of a fatal crash in the project corridor was found to be statistically significant given the low number of total crashes on the roadway segment (that is, we would not expect a fatality with this low number segment crashes. Measures which reduce vehicle speeds on West Dimond Boulevard are likely to result in reduced crash severity.

3.3 State Policy on Improving Unsignalized Intersections

Alaska DOT&PF has a set of criteria to determine which intersections are eligible for improvements (State of Alaska Memo dated March 13th, 2012 - subject: 2012 central region unsignalized intersections). Alaska DOT&PF uses a 5-year crash history to evaluate intersections in need of improvement, where this report uses a 10 year crash history for analysis. Table **13** presents the 5-year crash history and 10-year crash history and evaluation by the Alaska DOT&PF criteria. This intersection related crash criteria includes angle crashes as well as vehicles making turning maneuvers. The roadside departure crashes at the Sand Lake Road and West Dimond Boulevard intersection occurred when vehicles were attempting to make a turning maneuver and were included as intersection related crashes below. The volume criteria must be satisfied for the major and minor roadways in order to be considered. The volume criteria are checked in Table 12.

DOT&PF Improvement Criteria for Unsignalized Intersections - Volume	**Criterion**	**Current Year (2009)**		**Design Year (2035)**	
		Value	**Satisfied?**	**Value**	**Satisfied?**
Sand Lake Road and West Dimond Boulevard Intersection					
Greater than 1350 vehicles per day on minor roadway	highest leg AADT	2734	yes	4165	yes
Greater than 5400 vehicles per day on major roadway	both approaches' AADT	2791	no	7668	yes
Volume criteria met?	>1350 vpd and >5400 vpd		no		yes

*2011 estimated AADT - used to show volume criteria currently not met.

Table 12 - Unsignalized Intersection Volume Criteria – Current Year (2009) and Design Year (2035) Volumes

DOT&PF Improvement Criteria for Unsignalized Intersections - Crashes	Criterion	5 year crash history		10 year crash history	
		Value	Satisfied?	Value	Satisfied?
Sand Lake Road and West Dimond Boulevard Intersection					
One or more severe crashes in a five year period	Major or Fatal Crashes	0	no	0	no
Five or more angle/turning crashes in a 12 month period	Angle/Turning Crashes	3	no	5	yes
Crash criteria met?	1 or more severe crashes and 5 or more angle/turning crashes in 12 months		no		no

Table 13 **- Unsignalized Intersection Crash Criteria - Five Year and Ten Year History.**

3.4 Geometric Elements and Crash Locations

Sight distance measurements were taken at each of the unsignalized intersections in the study area, as shown in Table 14. The most significant intersection sight obstructions are the horizontal curve at West Dimond Boulevard's western most end and the eastern-most crest vertical curve in the project area. However, all intersections meet stopping sight distance requirements.

Intersection	Sight Distance to the East	East Sight Distance Obstruction	Sight Distance to the West	West Sight Distance Obstruction
Cramer Dr.	300' *	Down Slope	312' *	Curve in Road
Skyhills Drive.	995'	Crest of Hill	430'	Crest of Hill
Bluffwood Circle	408'	Trees	368'	Trees
Sommers Place	592'	Crest of Hill	853'	Crest of Hill
Westpark Drive	814'	Crest of Hill	1,060'	Crest of Hill
Sand Lake Road	1,500'	Curve in Road	721'	Crest of Hill

* Intersection in 35 mph zone. Stopping Sight Distance (SSD) is 250 ft. for 35 mph and 360 ft. for 45 mph

Table 14 - Existing Intersection Sight Distance

3.4.1 Horizontal Elements

Sand Lake Road is the only one major intersection within the project limits. Sand Lake Road intersects a horizontal curve on Dimond Boulevard, with the western leg of West Dimond Boulevard being skewed 60-degrees to Sand Lake Road (see Figure 4).

Figure 4 - Dimond Boulevard & Sand Lake Road Intersection

3.4.2 Vertical Elements

The eastern-most crest curve restricts sight distance near Cramer Drive as shown in Table 14.

4. Pedestrian LOS Analysis and Alternatives

Collector roadways will typically have pedestrian facilities as shown in Figure 5 on page 22 and Figure 6 on page 23. These facilities include a multi-use path on one side or a sidewalk on one side and a multi-use pathway on the other.

There will be considerable residential development in the area over the design life, with increasing demand for pedestrian and bicycle facilities. A new elementary school and a new middle school are planned for the area to serve the future residential development and growth. One safety and capacity element of the pedestrian/bike system will be the crossing of West Dimond Boulevard at the Westpark Drive and Sand Lake Road intersections, especially if only a single side pathway is provided for West Dimond Boulevard with this project. As such, crossings are evaluated in detail below.

4.1 Unsignalized Pedestrian Crossing Level of Service

HCM 2010 Chapter 19 presents a methodology for computing LOS at unsignalized facilities. This report focuses on the pedestrian gap acceptance model outlined in HCM 2010, unsignalized crossing methodology. Pedestrian delay and LOS were computed according to the methodology outlined in Appendix E - HCM 2010 Unsignalized Pedestrian Crossing Level of Service.

HCM 2010 Exhibit 19-2 provides pedestrian crossing LOS based on delay. This is summarized in Table 15 as follows.

LOS	Average Delay per Pedestrian	HCM 2010 Comments on Risk
A	<5 seconds	Usually no conflicting traffic
B	≥5 and ≤10 seconds	Occasionally some delay due to conflicting traffic
C	>10 and ≤20 seconds	Delay noticeable to pedestrians, but not inconveniencing
D	>20 and ≤30 seconds	Delay noticeable and irritating, increased likelihood of risk taking
E	>30 and ≤45 seconds	Delay approaches tolerance level, risk-taking behavior likely
F	>45 seconds	Delay exceeds tolerance level, high likelihood of risk taking

Table 15 - Pedestrian Crossing LOS Definitions

4.2 Crossing Locations

The following table shows the values used to calculate the pedestrian LOS for cross street locations along Dimond Boulevard.

Crossing Street (perpendicular) to pedestrian travel➔		West Dimond Boulevard east side	West Dimond Boulevard west side	West Dimond Boulevard east side	West Dimond Boulevard west side
Parallel Street to pedestrian travel➔		Sand Lake Road	Sand Lake Road	Westpark Drive	Westpark Drive
Pedestrian walking speed	$S_p =$	3.5	3.5	3.5	3.5
Crosswalk (unmarked) length	L =	28	28	36	24
Pedestrian startup & end time	$t_s =$	2	2	2	2
Number of pedestrian rows	N =	1	1	1	1
Gaps per minute	=	1.08	3.20	1.74	4.47
Average pedestrian delay, sec	$d_p =$	57.3	14.0	32.5	5.0
Pedestrian Level of Service	LOS =	F	C	E	A

Table 16 - 2035 Pedestrian Level of Service

The Sand Lake Road and West Dimond Boulevard and Westpark Drive and West Dimond Boulevard intersections have traffic volumes levels and crossing distances that result in less than desirable pedestrian LOS. Median refuges or signals are corrective measures for these low levels of service.

Table 16 indicates that the crossing West Dimond Boulevard on the west side of the intersection of Sand Lake Road provides a much higher level of service. The higher LOS is due to less conflicting traffic and a shorter crossing distance. The east side crossing of Sand Lake Road and West Dimond Boulevard will produce a low LOS in 2035. Pedestrian refuge or signalization would improve LOS for this crossing.

The Westpark Drive and West Dimond Boulevard intersection was also examined for pedestrian LOS. The existing right-turn bay at Westpark Drive produces a LOS E crossing of Dimond Boulevard on the east side because of the high right-turn traffic and the longer crossing distance. If a crossing for West Dimond Boulevard is provided at this intersection, some mitigation will be necessary for the east side of the intersection.

5. Road Segment Typical Section Alternatives

Different aspects affecting the typical section design are considered below including capacity, LOS, lane width, shoulder width, and roadside elements (clear zones and slopes).

5.1 Segment Capacity and LOS

The project has characteristics of both an uninterrupted flow facility and an interrupted flow facility. Uninterrupted flow is evaluated as a two-lane highway and interrupted flow is evaluated as signalized or unsignalized intersections.

Appendix C- Capacity Analysis Definitions and Input Parameters and Assumptions has an overview of the capacity analysis methods, and the specific parameters used for each type of analysis.

AASHTO's GDHS Exhibit 2-32 presents design year LOS guidelines for facilities on this project:

- Collector Roads (intersections included) - AASHTO states that rural collectors should have a LOS C or better in level terrain conditions. This guideline also recommends LOS D or better for urban collectors in urban and suburban settings, which will apply to this project as this area becomes more urbanized.
- Local Roads (intersections included) - The minimum LOS for these local roads may be D.

5.2 Capacity Analysis

A capacity analysis is the first step in determining if the existing lane configuration will be adequate for future traffic volumes. West Dimond Boulevard was evaluated as a two-lane highway under the forecasted traffic load. The results of the analysis are presented in the table below.

Segment	Begin	End	PFFS	LOS
West Dimond Boulevard	Sand Lake Road	Westpark Drive	78.2	C
West Dimond Boulevard/Jodhpur Street	Westpark Drive	Kincaid Park entrance	88.9	B

Note: Percent Free Flow Speed (PFFS) performance measure is shown for information only. The reported LOS represents the measure of performance to be used for evaluation

Table 17 - Two-Lane Highway Segment Existing Conditions Operational Performance for 2035.

The existing two-lane roadway with 10-foot wide lanes is adequate to provide a desirable LOS throughout the project life.

5.3 Lane Width

The Anchorage Municipal Code 21.85.020 “Improvement areas defined” indicates that the zoning for this area would classify the area as rural on the south side and urban on the north side of West Dimond Boulevard. As such, either rural or urban collector design standards are compatible with this project.

Collector roadways typical sections from the MOA DCM are reproduced in Figure 5 and Figure 6 below.

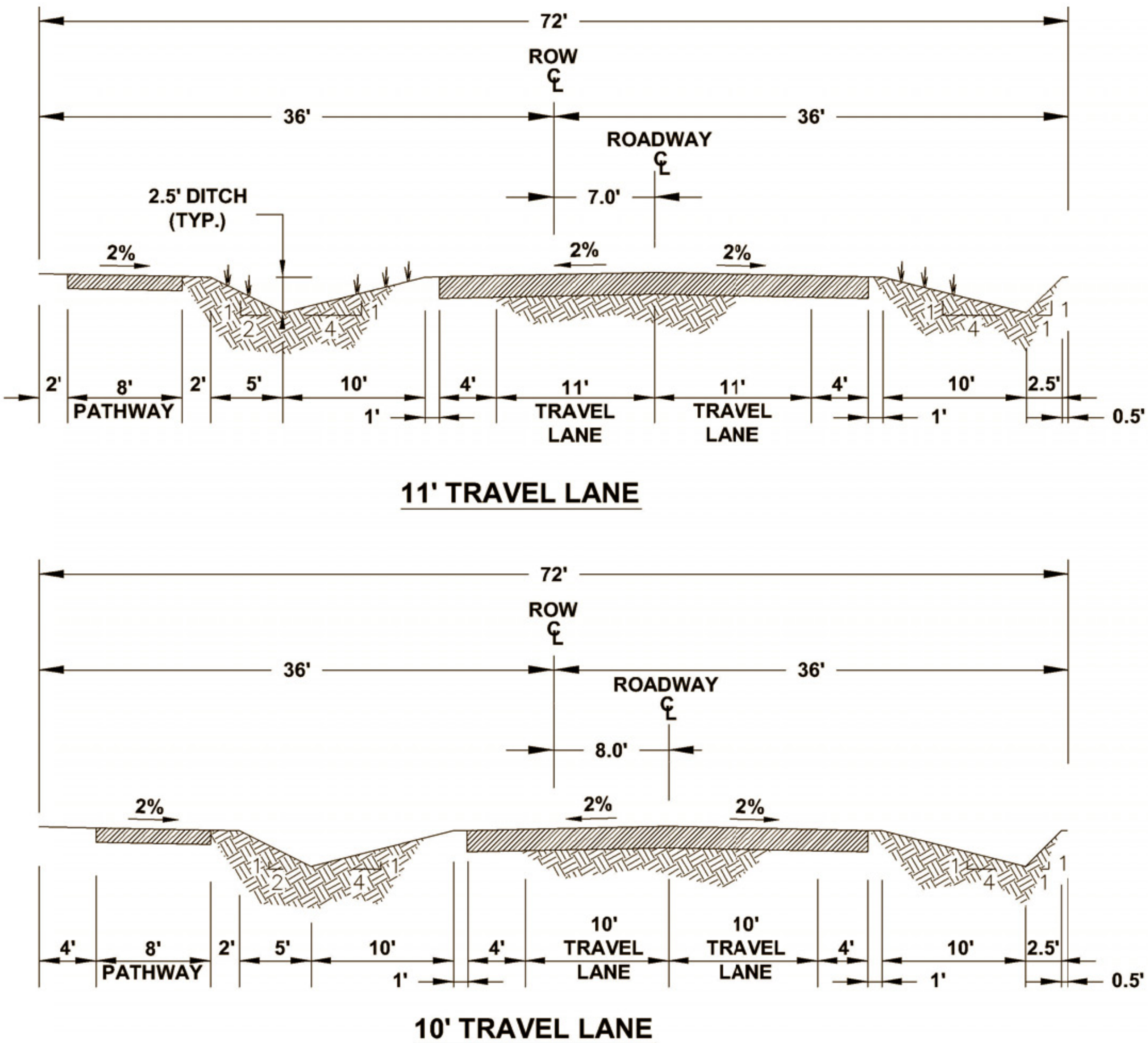


Figure 5 - Rural Collector Typical Sections (MOA DCM Table 1-15)

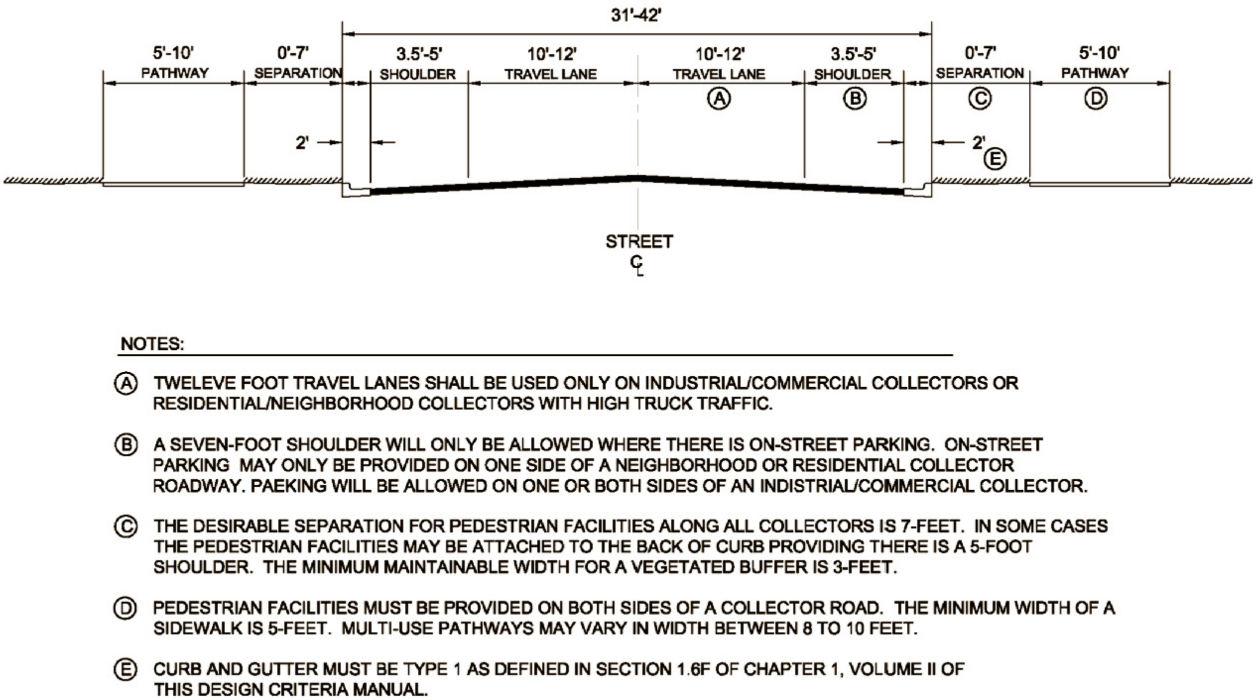


Figure 6 - Urban Collector Typical Section (MOA DCM Table 1-12)

The DCM presents a method to determine the lane width, either 10 feet or 11 feet, for an urban collector roadway segment given the roadway's AADT and peak traffic percentage. The following presents the results of this analysis on West Dimond Boulevard.

Segment – West Dimond Boulevard	
PK Traffic Factor, K	10%
West of Westpark Drive AADT	5,700
East of Westpark Drive AADT	2,200

Table 18 – West Dimond Boulevard Collector Roadway Width Variables

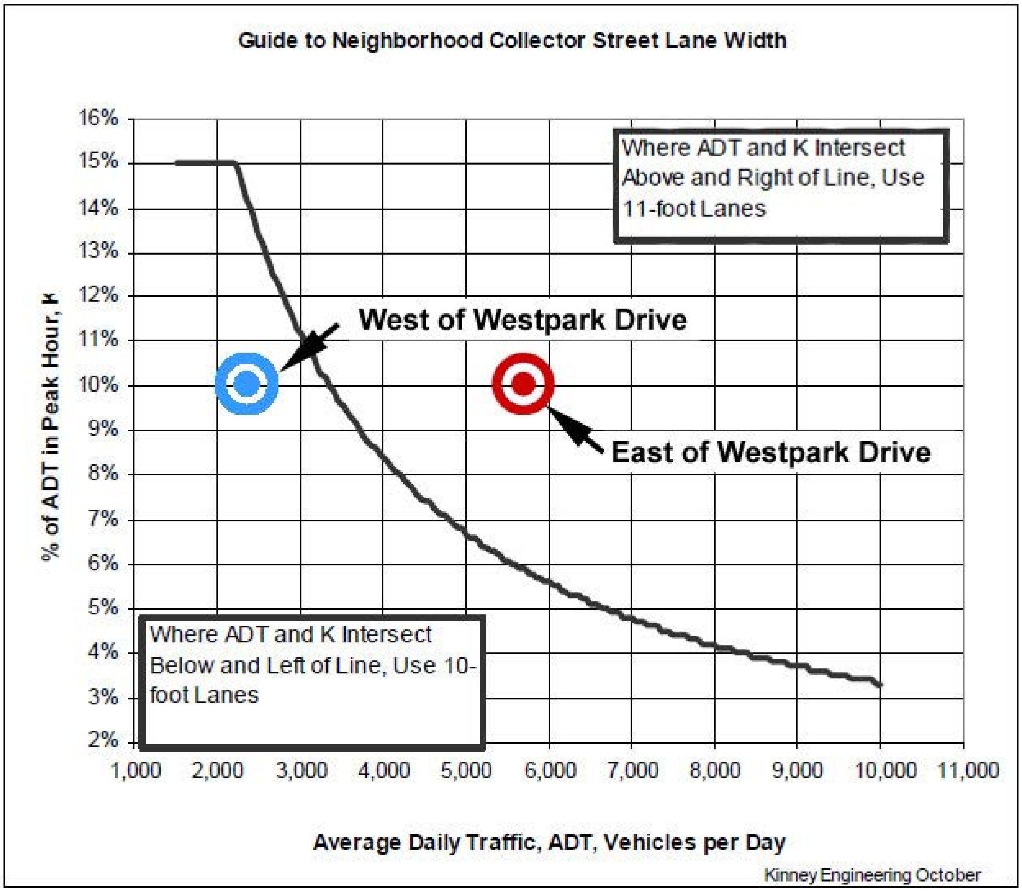


Figure 7 – Urban Collector Lane Width Guide - ADT vs. % of ADT in 2035 Peak Hour, K

The minimum lane width should be 11 feet (using either rural or urban sections) for the segment between Sand Lake Road and Westpark Drive. For the segment between Kincaid Park entrance and Westpark Drive, a 10 foot lane width would accommodate truck traffic with the probability of heavy vehicles passing each other being less than 5% (the basis of lane width selection). However, the MOA Design Criteria Manual only allows 10-foot lanes for rural collectors with less than 2,000 AADT. The segment between the Westpark Drive and Sand Lake Road should be a minimum of 11- foot lane widths. The segment between the Kincaid Park entrance and Westpark Drive should have 10- or 11-foot lanes depending on whether an urban or rural typical section is selected. Both typical sections would provide an improvement for pedestrians traveling along West Dimond Boulevard by adding sidewalks or a shared use path.

5.4 Shoulder Width

Shoulders provide important operational and safety functions for several travel modes. These functions include:

- Additional recovery area for vehicles that leave the travel way

- Breakdown or temporary staging/parking area
- Utilitarian bicycle travel lane
- Additional area to mitigate effects of snow and ice accumulation and to facilitate temporary snow storage and efficient snow removal.

Rural typical section shoulders should be 4 feet wide per the typical section shown in Figure 5 above.

Urban typical section shoulders may be 3.5 feet wide if the 7-foot separation is provided between the curb and the edge of a pathway.

5.5 Roadside Design

Roadsides that have a clear zone width that are free from obstacles are desirable. Urban sections typically do not address clear zones.

The DCM does not specify clear zone requirements, but the *Alaska Preconstruction Manual* offers guidance on clear zones. For 45 mph, with volume ranges shown in Table 1130-2, the minimum clear zone (including the shoulder and traversable slopes) is 20 feet. The minimum clear zone for a 35 mph design speed is 14 feet.

The design speed of West Dimond Boulevard should be 45 mph for the urban typical section or 35 mph is the rural typical section is used as shown in Figure 5 - Rural Collector Typical Sections (MOA DCM Table 1-15).

The MOA rural typical section has a 15-foot clear zone from the edge of travel way to ditch invert, which is considered an obstacle. For the rural collector with a 45 mph design speed, the typical section should be modified so that the ditch invert is traversable by substituting a 6:1 backslope for the 2:1 backslope; or by moving the ditch invert to 20 feet from the edge of travel way.

6. Intersection Alternatives

Intersections with West Dimond Boulevard identified as having the highest future traffic volume and safety concerns are Sand Lake Road and Westpark Drive. Sand Lake Road is classified as a Class II minor arterial and Westpark Drive is classified as a Class IB neighborhood collector. All other intersecting roads are classified as local roads with low volumes. Intersection alternatives for Sand Lake Road and Westpark Drive are examined below.

6.1 Sand Lake Road Intersection

The Sand Lake Road and West Dimond Boulevard intersection performance is analyzed under this section for several alternatives: no action, added westbound right-turn bay, all-way stop, roundabout, and signalization. The capacity and safety performance results are presented below.

6.1.1 No-Action

The Sand Lake Road and West Dimond Boulevard intersection under the "No-Action" alternative would introduce excessive delay to the southbound movement. Table 19 shows the capacity under the existing configuration for the design year 2035. Pedestrians would also experience a LOS F for crossing West Dimond Boulevard, as reported in Section 4.

Existing Two-way Stop Control Performance		**Volume to Capacity, (v/c)**	**Delay, sec/vehicle**	**LOS**
2015 Movement	Eastbound Left	0.01	8.2	A
	Southbound Left & Right	0.33	14	B
2025 Movement	Eastbound Left	0.01	8.6	A
	Southbound Left & Right	0.50	19.4	C
2035 Movement	Eastbound Left	0.01	9.2	A
	Southbound Left & Right	0.80	44.4	E

Table 19 - HCM 2010 Two-way Stop Control 2015, 2025, & 2035 PM Peak Capacity and LOS

The eastbound and westbound through movements under two-way stop control are assumed to be free-flow and experience no delay due to stop or yield behavior at this intersection. Therefore their delay is not computed.

6.1.2 Add Westbound Right Turn Lane

Adding a right turn lane was analyzed as an alternative using NCHRP Report 457 figure 2-6 *Guideline for determining need for a major-road right turn bay at a two-way stop-controlled intersection*. Under this methodology, a right turn lane will be needed by 2015 using the projected turning movements and an 85th percentile speed of 47 mph. The 85th percentile speed was obtained from the speed studies conducted by the MOA for the westbound approach to the intersection.

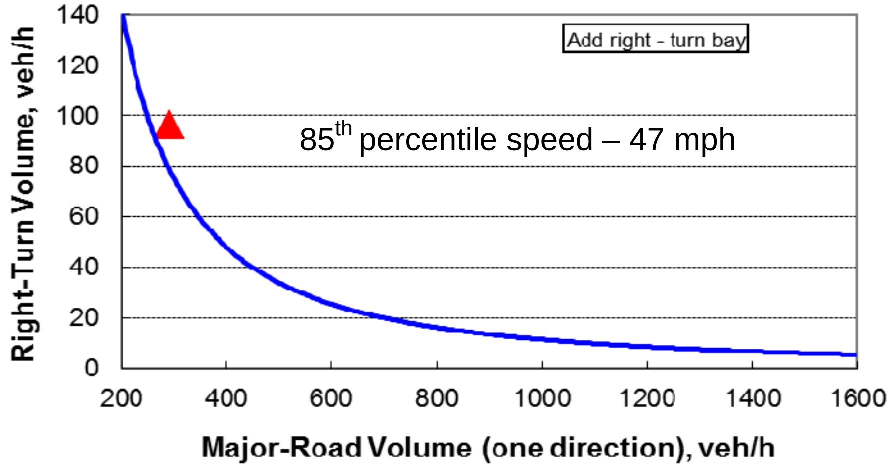


Figure 8 – Westbound Right-Turn Lane Analysis for Sand Lake Road and Dimond Boulevard, 2015 PM Peak.

Table 20 summarizes performance measures for two-way stop operation in the PM peak hour with the addition of the westbound right turn lane.

Two-way Stop Control Performance with Right Turn Lane		Volume to Capacity, (v/c)	Delay, sec/vehicle	LOS
2015 Movement	Eastbound Left	0.01	8.2	A
	Southbound Left & Right	0.31	13.1	B
2025 Movement	Eastbound Left	0.01	8.6	A
	Southbound Left & Right	0.45	16.9	C
2035 Movement	Eastbound Left	0.01	9.2	A
	Southbound Left & Right	0.69	30.4	D

Table 20 - HCM 2010 Two-way Stop Control 2015, 2025, 2035 PM Capacity with Right-turn lane improvement

Adding a right turn lane to the westbound approach would improve the design year LOS to D for the southbound movement. However, this solution would not serve pedestrians well because the east unsignalized crossing of West Dimond Boulevard would become longer, increasing pedestrian delay.

6.1.3 All-Way Stop Sign Control

The MUTCD 2009 provides guidelines for determining where all-way stop signs might be appropriate for an intersection. Inputs include number of correctable crashes in a year, intersection minor approach delay, major street hourly traffic volumes and minor street hourly traffic, pedestrian and bicycle volumes.

Table 21 summarizes the MUTCD 2009 All-way Stop warrants for the 2015 through 2025.

Intersection	Condition C.1 & C.2	Condition C.3 (70% of values, >40mph)	Condition D
Sand Lake Road / W. Dimond Blvd	Not Satisfied	Satisfied by 2035	Not Satisfied

Table 21 - 2009 MUTCD All Way Stop Control Warrants

All Way Stop warrants were met between 2025 and 2035 for Sand Lake Road and West Dimond Boulevard.

Table 22 summarizes performance measures for all-way stop operation in the 2035 evening peak hour with the current lane configuration. A right turn lane is projected to be needed for the westbound approach; therefore performance was also analyzed with an added right turn lane in Table 21.

All-way Stop Control Performance		Volume to Capacity, (v/c)	Delay, sec/vehicle	LOS
2015	Critical Movement: Westbound	0.47	11.7	B
	Intersection		10.9	B
2025	Critical Movement: Westbound	0.69	18.0	C
	Intersection		15.2	C
2035	Critical Movement: Westbound	1.04	67.7	F
	Intersection		45.1	E

Table 22 - All-Way Stop 2035 PM Peak Hour Operational Performance

All-way Stop Control Performance With Right Turn Auxiliary lane		Volume to Capacity, (v/c)	Delay, sec/vehicle	LOS
2015	Critical Movement: Westbound	0.33	10.1	B
	Intersection		9.9	A
2025	Critical Movement: Westbound	0.47	12.5	B
	Intersection		11.7	B
2035	Critical Movement: Westbound	0.71	20.5	C
	Intersection		16.9	C

Table 23 - All-Way Stop 2035 PM Peak Hour Operational Performance with Right Turn Auxiliary lane

Overall intersection operations would be unacceptable with a LOS E in 2035 during the evening peak hour. A westbound right turn auxiliary lane would need to be added, which would result in an intersection LOS C in 2035.

In summary, all-way stop control would require changing the lane configuration. LOS C would result in moderate delay for all movements if the intersection lane configuration is changed. Nevertheless, this solution would serve pedestrians well because all approaches would be required stop and yield to pedestrians.

6.1.4 Modern Roundabout

The MUTCD describes roundabouts as good alternatives to signals, offering good operational performances, as well as crash reduction. NCHRP 672 Roundabouts: An Informational Guide, Second Edition cites that roundabouts can reduce vehicular speeds and signify a change in the driving environment to drivers, which would be a corrective measure for higher severity crashes. The HSIP Handbook cites a 30% reduction in all crashes after roundabouts are installed at a 3-leg approach intersection.

Table 24 summarizes roundabout performance measures for the 2035 evening peak hour. These calculations were performed with HCS 2010 software using HCM 2010 methodology for roundabout LOS.

Sand Lake Roundabout Performance		Volume to Capacity, (v/c)	95th % queue length, vehicle(s)	Delay, sec/vehicle	LOS
2015	**Eastbound**	0.17	0.6	6.0	A
	Westbound	0.36	1.6	7.3	A
	Southbound	0.24	0.9	6.9	A
	Intersection			7.0	A
2025	**Eastbound**	0.23	0.9	6.9	A
	Westbound	0.50	2.8	9.4	A
	Southbound	0.32	1.4	8.7	A
	Intersection			9.0	A
2035	**Eastbound**	0.31	1.3	8.4	A
	Westbound	0.68	5.7	14.2	B
	Southbound	0.46	2.4	12.3	B
	Intersection			13.2	B

Table 24 - Roundabout Operational Performance Measures, 2035 Evening Peak Hour

The roundabout would reduce the road departure crashes where motorists were attempting to turn at the intersection which was 50% of the crash population as they would be slowed before attempting the turning maneuver. It would also reduce the angle crashes which accounted for 43% of the crash population. In addition, pedestrian LOS improves under this alternative due to shorter pedestrian crossing distances (one lane at a time with the splitter island as a refuge).

6.1.5 Signalization Alternative

Cal-Trans has a methodology for signal warrants based on future AADT that is presented in the California MUTCD 2012 edition (an amended FHWA MUTCD 2009). The method uses projected future average annual daily traffic (AADT) as the input variables and estimates whether the intersection with projected future AADT would meet the MUTCD Signal Warrant 1, Condition A- Minimum Vehicular Volume; Condition B- Interruption of Continuous Traffic; and the combination of warrants allowed in MUTCD 2009 procedure.

Projected future AADT was obtained using the AMATS travel demand model. The 70% volume level thresholds were used for the project because the design speeds for both roads at the intersection are over 40 mph.

This warrants methodology was applied to the Sand Lake Road intersection. Table 25 summarizes the results of the future signalization warrant analysis.

Intersection	A- Minimum Vehicular Volume	B- Interruption Of Continuous Traffic	Combination of Warrants (80% of A & B)
Sand Lake Road / w. Dimond Blvd	Between 2025 to 2035	Not satisfied	Between 2025 to 2035

Table 25 - CalTrans Signal Warrants for Sand Lake Rd & Dimond Blvd Intersection

Design assumptions for capacity calculations, assuming a signal is installed include:

- 350-foot westbound right-turn lane- For deceleration and storage per PCM, length computed with NCHRP 279 procedures
- Permissive eastbound left-turn phasing - DCM procedures
- Single lane for southbound and eastbound movements
- The signal would be fully actuated, uncoordinated, and would use ITE pedestrian timing

	2015 Construction Year	2025 Mid-Life Year	2035 Design Year
Cycle Time	60 seconds	60 seconds	60 seconds
HCM Control Average Delay	8.3 seconds per vehicle	10.4 seconds per vehicle	11.4 seconds per vehicle
HCM Intersection Volume to Capacity Ratio	0.31	0.39	0.52
Level of Service	A	B	B

Table 26 - 2035 Signalized Intersection Performance at Sand Lake Road & Dimond Blvd

In summary, the future signal warrants were satisfied and the signal will operate with LOS B in 2035. The signal would not likely reduce the road departure crashes which were prevalent. It would likely reduce the angle crashes which accounted for 43% of the crash population. Signalized pedestrian crossings would make the crossings easier under peak traffic conditions and reduce pedestrian risk-taking behavior.

6.2 Westpark Drive Intersection Alternatives

The Westpark Drive and West Dimond Boulevard intersection is analyzed in this section for the no-action, improved right-turn auxiliary lane, and roundabout alternative. The signal and all-way stop warrants were also checked. The capacity and safety are analyzed below.

6.2.1 No-Action

The future intersection capacity is shown in Table 27 below. It can be seen that in 2035 the intersection provides a LOS B or better for all movements.

Existing Two-way Stop Control Performance		**Volume to Capacity, (v/c)**	**Delay, sec/vehicle**	**LOS**
2015 Movement	Eastbound Left	0.01	7.7	A
	Southbound Left & Right	0.06	9.4	A
2025 Movement	Eastbound Left	0.01	7.8	A
	Southbound Left & Right	0.09	9.8	A
2035 Movement	Eastbound Left	0.01	8.5	A
	Southbound Left & Right	0.23	12.4	B

Table 27 - Westpark Drive 2035 LOS and Capacity Analysis Existing Condition

The existing right turn auxiliary lane onto Westpark Drive is a 10-foot wide lane, consisting of a 90-foot lane and a 70-foot taper at a 7:1 taper rate. The existing lane length does not provide adequate length for a vehicle to decelerate within the turn auxiliary lane; therefore, vehicles will decelerate within the driving lane. Pedestrians will experience LOS E when crossing West Dimond on the east side of the intersection, as described in Section 4. The west side crossing will provide LOS A.

6.2.2 Right Turn Auxiliary lane Improvements

The existing right turn auxiliary lane was analyzed as using NCHRP Report 457 figure 2-6 *Guideline for determining need for a major-road right turn bay at a two-way stop-controlled intersection*. Under this methodology, a right turn lane will be needed by 2025 using the projected turning movements.

The existing right turn auxiliary lane does not allow for all deceleration to occur in the turn auxiliary lane and taper. Improvements to the existing right turn auxiliary lane would decrease the likelihood of rear-end crashes, while providing similar performance to that shown in Table 27. Recommended turn auxiliary lane lengths are shown in Table 28. These lengths were calculated using NCHRP 279 *Intersection Channelization Design Guide*.

Westpark Drive and West Dimond Boulevard Westbound Right Turn Auxiliary Lane Dimensions		
Dimension		Notes
Minimum Lane Length	160 ft.	10 mph speed reduction in through lane
Desirable Lane Length	330 ft.	all deceleration occurs in fully developed lane

Minimum & Desirable Taper Rate	12:1	based on approach speed of 45 mph

Table 28 - Minimum and Desirable Westbound Right Turn Auxiliary lane Dimensions at Westpark Drive

Installation of a full westbound right-turn auxiliary lane would decrease the likelihood of rear-end collisions at this intersection because the speed differential between vehicles would be reduced in the driving lane. Pedestrians will still experience LOS E when crossing West Dimond Boulevard on the east side of the intersection, as described in Section 4, while the west side crossing will still provide LOS A.

6.2.3 All-Way Stop Sign Control

The MUTCD 2009 provides guidelines for determining where all-way stop signs might be appropriate. Table 27 summarizes the MUTCD 2009 All-way Stop warrants for the 2015 through 2035 for Westpark Drive and West Dimond Boulevard intersection.

Intersection	Condition C.1 & C.2	Condition C.3 (70% of values, >40mph)	Condition D
Westpark Drive / W. Dimond Blvd	Not Satisfied	Not Satisfied	Not Satisfied

Table 29 - MUTCD 2009 All Way Stop Control Warrants at Westpark Drive

All-way stop warrants were not met for Westpark Drive and West Dimond Boulevard for the design year 2035. All-way stop control should not be installed at this location.

6.2.4 Modern Roundabout

The Alaska DOT&PF HSIP Manual cites a 30% reduction in intersection related crashes when converting a two-way-stop control intersection to a roundabout (at three-leg intersections). The corridor from Sand Lake Road to the Kincaid Park entrance (which includes Westpark Drive) was analyzed in *Section 3 Crash Analysis* of this report*.* The corridor did not exceed the upper-critical limit, or in other words, the total crashes were within or below the predicted frequency. The Westpark Drive intersection was also analyzed separately in *Section 3 Crash Analysis.* There was one crash at the intersection during the analysis period. This was a property damage only crash involving two vehicles impacting at an angle. The crash rate for the intersection was below the upper-critical limit and the statewide average as well.

Operationally, NCHRP 672 cites that intersections with a high percentage of left turns are especially good roundabout candidates when they are under their capacity.

Table 30 summarizes the LOS, delay, and 95th percentile queue length for a roundabout in 2015, 2025, and 2035. A roundabout would provide capacity and LOS similar to the existing two-way stop controlled intersection at this location.

Westpark Roundabout Performance		Volume to Capacity, (v/c)	95th % queue length, vehicle(s)	Delay, sec/vehicle	LOS
2015	Eastbound	0.06	0.2	4.0	A
	Westbound	0.29	1.2	6.4	A
	Southbound	0.06	0.2	4.3	A
	Intersection			6.0	A
2025	Eastbound	0.08	0.2	4.2	A
	Westbound	0.37	1.7	7.4	A
	Southbound	0.10	0.3	4.8	A
	Intersection			6.7	A
2035	Eastbound	0.10	0.3	4.4	A
	Westbound	0.47	2.6	9.0	A
	Southbound	0.16	0.6	5.6	A
	Intersection			8.2	A

Table 30 - LOS and Capacity Analysis Westpark Drive Intersection

6.2.5 The planned schools and residential development along Westpark Drive is expected to increase pedestrian and bicycle activity at the Westpark Drive and West Dimond Boulevard intersection. The traffic calming and low severity crashes associated with roundabout intersections may be desirable at this location. The roundabout will operate with LOS A in 2035 and would provide short pedestrian crossings with refuge. Signalization Alternative

MUTCD 2009 signal Warrant 1, Condition A- Minimum Vehicular Volume; Condition B-Interruption of Continuous Traffic; and the combination of warrants were checked using the Cal-Trans Traffic Signal Warrants with projected future AADT. A summary of the signal warrants is shown in the Table 31 below.

Intersection	A- Minimum Vehicular Volume	B- Interruption Of Continuous Traffic	Combination of Warrants (80% of A & B)
Westpark Dr / W. Dimond Blvd	Not satisfied	Not satisfied	Not satisfied

Table 31 - CalTrans Signal Warrants for Westpark Dr & W. Dimond Blvd Intersection

Future traffic signal volume and crash warrants were not met at this location. A traffic signal should not be installed.

Appendix A - Turning Movement Counts, winter 2006 and 2013

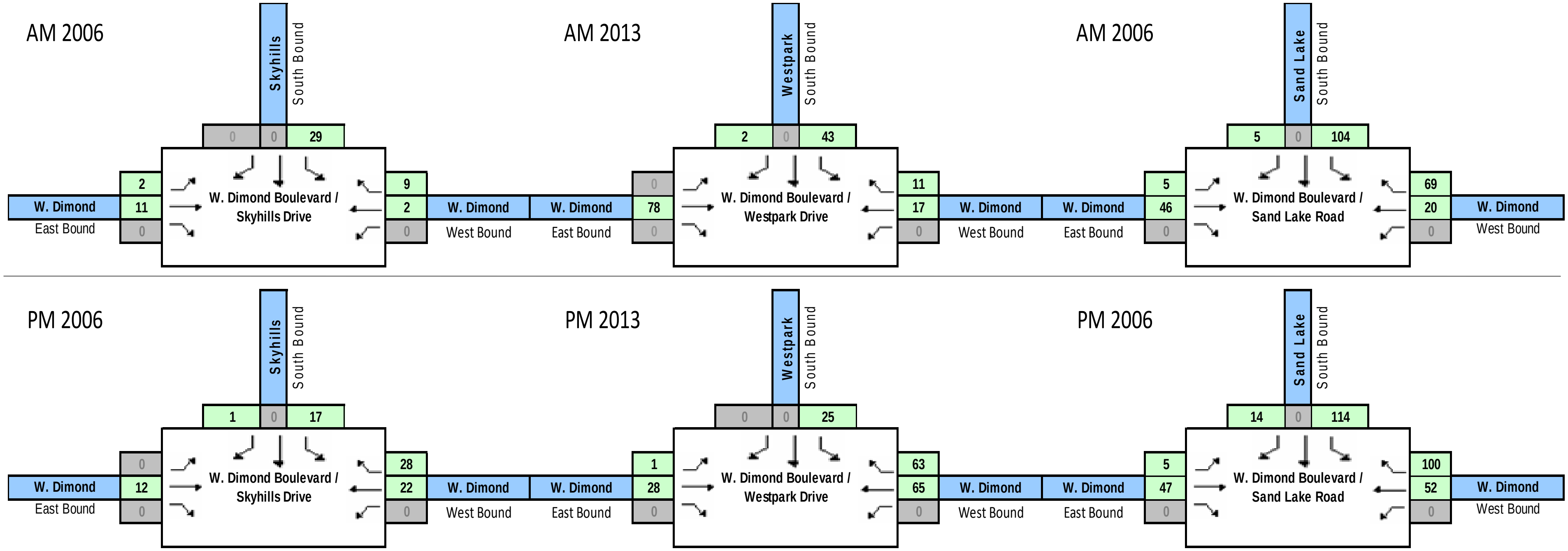


Figure A-1 – 2006 and 2013 Peak Hour Turning Movement Counts - Dimond Blvd & Skyhills Drive, Westpark Drive, and Sand Lake Road Intersections

Appendix B - Design Hour Intersection Turning Movements 2015, 2025 & 2035

and Projected AADT for 2015, 2025 & 2035

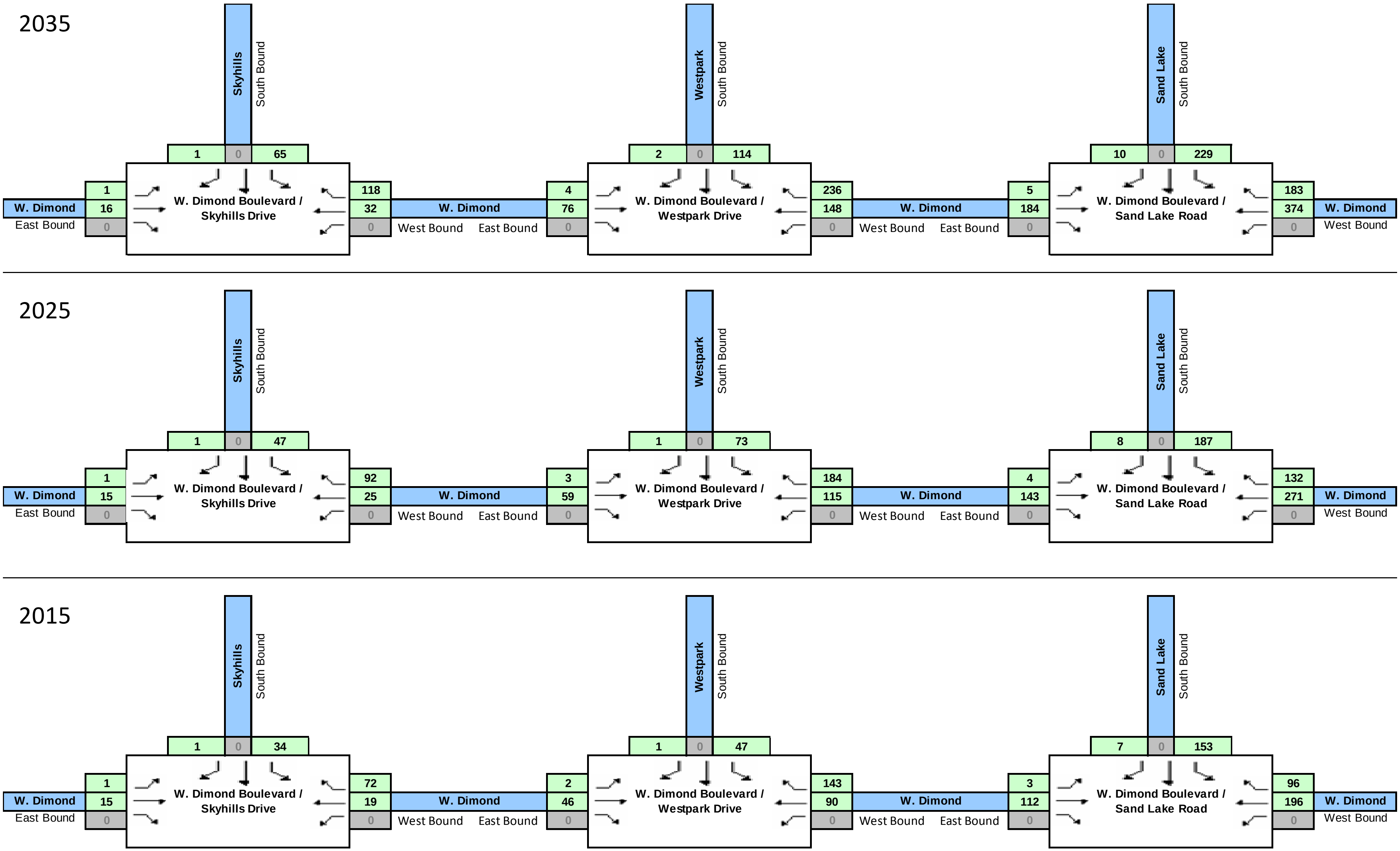


Figure B-1 - Projected P.M. Turning Movements

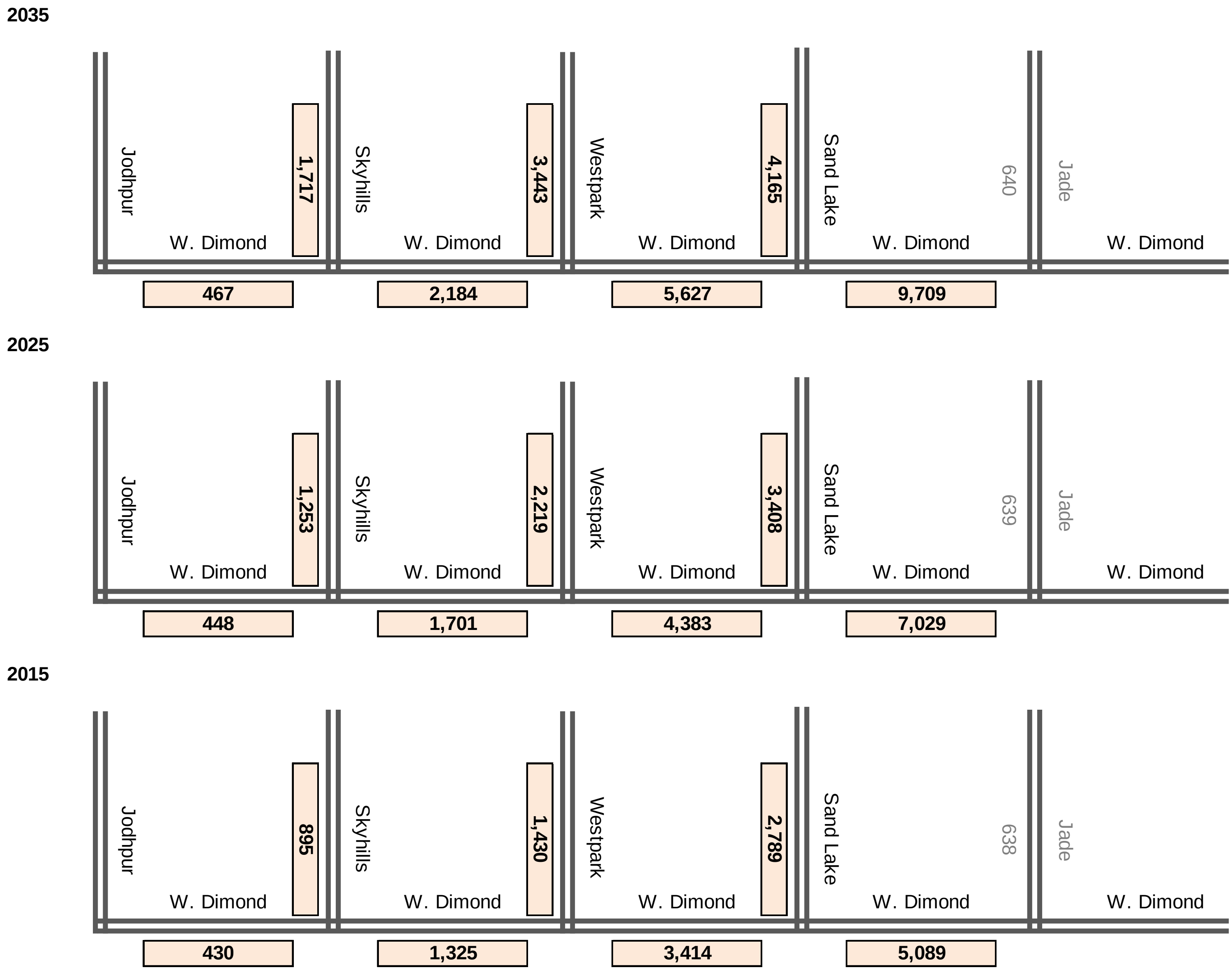


Figure B-2 – Projected AADT for 2015, 2025 and 2035

Appendix C- Capacity Analysis Definitions and Input Parameters and Assumptions

Intersection Evaluations

Intersection capacity analysis was performed in accordance with the procedures outlined in Transportation Research Board Highway Capacity Manual 2010 (HCM) for interrupted flow facilities, using Synchro Version 7, distributed by Trafficware. Uninterrupted flow facilities were evaluated with Highway Capacity Software 2010 by McTrans.

The methodology for unsignalized intersections only computes LOS for the minor movements of the intersection, which include the minor street approaches under stop control, or major movements that must yield to oncoming traffic, such as left-turning traffic. Unsignalized LOS is defined as follows (HCM 2010 Exhibit 19-1):

- LOS A: ≤10 seconds of control delay per vehicle
- LOS B: >10 and ≤15 seconds of control delay per vehicle
- LOS C: >15 and ≤25 seconds of control delay per vehicle
- LOS D: >25 and ≤35 seconds of control delay per vehicle
- LOS E: >35 and ≤50 seconds of control delay per vehicle
- LOS F: >50 seconds of control delay per vehicle

Appendix D - Crash Rate and Over-Representation Methods and Calculations

The crash rate calculations uses equations found in the *Highway Safety Improvement Program Handbook* (HSIPHB) by ADOT&PF, and NCHRP Report 162 from Transportation Research Board, *Methods for Evaluating Highway Safety Improvements* by John C. Laughland, *et al.,* National Research Council, Washington, D.C. 1975. These formulae appear in many other references as well.

Segment crash rates are calculated as:

Equation D-1. $R = \frac{1{,}000{,}000 \times A}{365 \times N \times ADT \times L}$, where

R= Crash rate for the intersection expressed as crashes per million vehicle miles (MVM),
A= Frequency of crashes in the study period,
N= Number of years of data,
ADT= Segment Average Annual Daily Traffic (AADT) volumes, both directions (average over study period),
L= Segment length, miles.

Rate analysis is especially useful when there is a population of facilities to which we can compare the study area. Rates are a good indicator of the individual's risk in being involved in a crash when using the facility because rates consider the motorist's exposure by volume and length of road. ADOT&PF has developed statewide populations for segments and intersections, and provides this data in the HSIPHB and supplements and the 2001 *Traffic Accident Report,* May 2003 (*Traffic Accident Report* is published annually by DOT&PF).

We can calculate crash rates using Equation D-1 to compare the facility to the corresponding State of Alaska average crash rate population. However, by only comparing the rate of the facility under analysis to an average rate, we may erroneously infer that those facilities with higher than average rates are problem areas.

Instead, we would like to establish an upper limit, or *critical* rate that is our threshold of concern. The Rate Quality Control Method establishes an upper control limit (UCL) to determine if the facility's crash rate, as calculated in Equation D-1, is significantly higher than crash rates in facilities with similar characteristics. The UCL or critical rate is determined statistically as a function of the statewide average crash rate for the facility category (i.e., highway or intersection) and the vehicle exposure at the location being considered. UCL is calculated with the following equation:

Equation D-2. $$UCL = R_a + Z \times \sqrt{\frac{R_a}{M}} + \frac{1}{2 \times M},$$

The variables in this equation are:

R_a= Average crash rate for the population in crashes per MVM (road segments);
M= Facility exposure in MVM for roadway section, using N, ADT, and L stated above and computed as:

Equation D-3. $$M = \frac{365 \times N \times ADT \times L}{10^6}$$

Z= Normal Distribution Transformation Variable (usually 1.64 for a 95% confidence level)

Segments with rates that exceed the UCL are inferred to be well above the population average at the confidence level reflected in the selection of the "Z" variable, and would therefore have significant crash experience.

Where there are sufficient numbers of crashes, hypothesis testing compares each intersection's crash types and factors to the intersection and crash type population statistics. This can determine if the proportion of the crash type or contributing factor exceeds the populations, and whether these types or factor should be the focus of countermeasures. Populations for crash types are available from the Municipality of Anchorage. Environmental factors and severity population percentages are published in the annual State of Alaska Department of Transportation and Public Facilities *Alaska Traffic Accidents*.

In hypothesis testing, the null hypothesis, H_o, states that the attribute of the intersection that we are interested in, for example proportion of collisions of a certain type, or proportion of damage type crashes, are less than or equal to state populations. The alternative hypothesis, H_a, states that the intersection's proportions exceed the comparative populations.

The crashes are binomially distributed samples. Normal distribution provides a reasonable approximation to binomial probabilities when the sample is sufficiently large. If so, then the standardized value is calculated as:

Equation D-4. $$Z = \frac{\hat{p} - p}{\sqrt{p(1-p)/n}}$$

Where:

Z = Normal Distribution Transformation Variable, the value within the normal distribution curve;
$\hat{p}$ =Sample proportion;
p = Population proportion; and
n = Number of crashes at location.

The large-sample assumption is checked by testing whether $np \geq 5$, and $n(1-p) \geq 5$.

A p-value (not to be confused with $\hat{p}$ or p) is determined by the area (probability) between the z-value and the tail within the standard normal distribution curve. The p-value is the probability of a Type-I error in hypothesis testing. That is, the p-value is the probability that we reject the null hypothesis, H_o, in this case simply stated that "This intersection crash attribute proportion is less than or equal to the proportion of the control population", when H_o is true. A low p-value, usually 0.05 or less indicates that there is strong statistical evidence favoring the alternative hypothesis, H_a, or we could say, "This intersection attribute proportion exceeds the control population proportion".

If an intersection does not have enough crashes to meet the large sample assumption; that is $np < 5$, or $n(1-p) < 5$; we use the Poisson distribution to check crash significance. If K is the number of crashes under examination then the probability that there are less than K crashes is:

Equation D-5. $P(<K) = P(0 \quad acc) + P(1 \quad acc) + ... + P((K-1) \quad acc)$.

In this case, the Poisson probability formula estimates the probability of discrete numbers of crashes, and the probability that there are less than K crashes is calculated as:

Equation D-6. $P(<K) = \sum_{i=0}^{i=K-1} (e^{-np}(np)^i)/i!$

Where:
K = number of occurring crashes of type, severity or environmental factor;
e = Base of natural logarithms;
p = Population proportion; and
n = Number of crashes at location.

If the probability of K crash of type or contributing factor is calculated to be extremely low, say 5% or less, and K crashes occur, we infer that the crash trend is statistically significant.

Appendix E - HCM 2010 Unsignalized Pedestrian Crossing Level of Service

HCM 2010 Chapter 19 presents a pedestrian gap acceptance model for unsignalized crossing roadway crossings. The critical gap required for a single pedestrian (or row) crossing of a street can be computed using the following equation:

$$t_c = \frac{L}{S_P} + t_s$$

Equation E-1

Where:
t_c= critical gap for single pedestrian crossing (seconds)
L= width of crossing (feet)
S_P= walking speed (fps)
t_s= startup time (sec)

The Institute of Transportation Engineers' *A Program for School Crossing Protection* and *Traffic Engineering Handbook* recommends a value of 3.5 fps for Sp and a value of 3 seconds for t_s to be used in equation 1. The critical gap for "N" rows of pedestrians can be determined using Equation 2. The equation uses 2 seconds for the startup time between rows.

$$t_G = t_c + 2(N - 1)$$

Equation E-2

Where:
t_G= =critical gap for group (seconds)
N= spatial distribution of pedestrians (rows)

Equation 3 presents the pedestrian delay. HCM 2010 based this equation on pedestrian delay work in Gerlough & Huber 1975 Special Report 165 *Traffic Flow Theory A Monograph*.

$$d_p = \frac{1}{v}\left(e^{vt_G} - vt_G - 1\right)$$

Equation E-3

Where:
d_P= average pedestrian delay (seconds)

v= vehicular flow rate (vehicles per second)

HCM 2010 Exhibit 19-2 provides pedestrian crossing LOS based on delay. This is summarized in Table 15 as follows.

LOS	Average Delay per Pedestrian	HCM 2010 Comments on Risk
A	<5 seconds	Usually no conflicting traffic
B	≥5 and ≤10 seconds	Occasionally some delay due to conflicting traffic
C	>10 and ≤20 seconds	Delay noticeable to pedestrians, but not inconveniencing
D	>20 and ≤30 seconds	Delay noticeable and irritating, increased likelihood of risk taking
E	>30 and ≤45 seconds	Delay approaches tolerance level, risk-taking behavior likely
F	>45 seconds	Delay exceeds tolerance level, high likelihood of risk taking

Pedestrian Crossing LOS Definitions

The HCM 2010 unsignalized pedestrian crossing delay model has several practical applications. In addition to the intended use of providing a level of service (LOS) for unsignalized crossings, it can be used to estimate the frequency of acceptable gaps for pedestrian crossings, signal warrant criteria for signals that are primarily aimed to serve pedestrians or to serve school crossings. As such, it may be used as a substitute for field gap studies, at least at some decision levels such as concepts or planning level analysis.

The HCM 2010 unsignalized crossing model uses street traffic volumes flow rate, $\boldsymbol{v}$, as an independent variable to predict delay. Detailed traffic volume forecasts are generally part of project development, and the designer could use future traffic volumes to estimate future unsignalized pedestrian delay, LOS, and crossing opportunities. This would allow the designer to estimate if, and when, crossing treatments (signals, crossing refuges) may be required during design life of project.

Appendix F - References

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