South Airpark Access Road
South Airpark Expansion

Ted Stevens Anchorage International Airport

Draft Traffic Impact Analysis Report

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Tables

Figures

ACRONYMS AND ABBREVIATIONS

These acronyms and abbreviations may be used throughout this document.

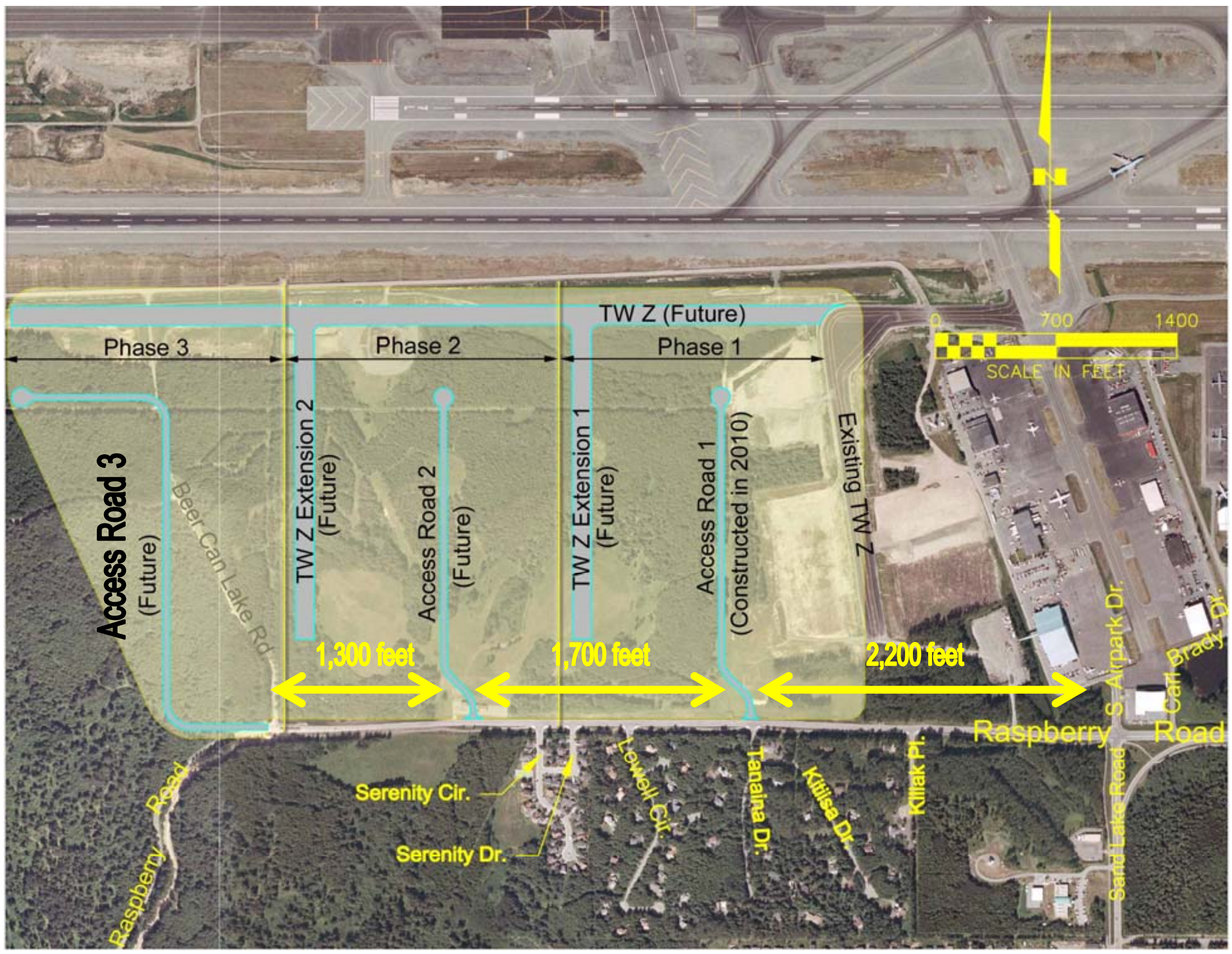
AADT, ADT	Average Annual Daily Traffic, Annual Daily Traffic
AAC	Alaska Administrative Code
AASHTO	American Association of State Highway and Transportation Officials
ADOT/ (&)PF, or DOT(/)(&)PF	Alaska Department of Transportation and Public Facilities
AMATS	Anchorage Metropolitan Area Transportation Solutions
ANC	Ted Stevens Anchorage International Airport
AWSC	All-way-stop-control (4 stop signs on all approaches)
CTWLTL or TWLTL	Continuous (or center)-two-way left turn lane
DD, DDHV	Direction al Distribution, DD Hourly Volume
EB, EBL,EBLT	Eastbound, eastbound left turn
FT.,ft.,Ft.	Feet or foot (length)
GDHS	Geometric Design of Highways and Streets (Reference)
HCM, HCM2000	Highway Capacity Manual 2000 (Reference)
HCS, HCS2000	Highway Capacity Software
Hr.,hr.,H., h.	Hour(s)
Hwy	Highway
ISD	Intersection Sight Distance
ITE	Institute of Transportation Engineers
K	% of AADT or ADT during peak hour
LOS	Level of Service (performance grade)
LRTP	Long Range Transportation Plan
LT, L	Left turn(s)
MOA	Municipality of Anchorage
MEV, MVM	Million Entering Vehicles, Million Vehicle Miles
Mph, MPH, mph	Miles Per Hour
MUTCD	Manual of Uniform Traffic Control Devices
NB, NBL, NBLT	Northbound, northbound left turn
NCHRP	National Cooperative Highway Research Program
OSHP	Official Streets and Highways Plan
pcu	Passenger car unit(s)
PHF	Peak Hour Factor
Ped	Pedestrian
Pkwy	Parkway
PSD	Pedestrian Sight Distance
PTR	Permanent Traffic Recorder
RIO	Right-in turns only
RIRO	Right-in, Right-out driveway

These acronyms and abbreviations may be used throughout this document.

Rd, RD	Road
RT, R	Right turn(s)
SB, SBL, SBLT	Southbound, southbound left turn
S, Sec	Second
Sf, SF	Square feet
SSD	Stopping Sight Distance
St, ST	Street
T, Th, Thru	Through
TRB	Transportation Research Board
TIA	Traffic Impact Analysis
TWSC	Two-way-stop-control (2 stopped approaches)
UCL	Upper Control Limit
v/c,V/C	Volume to Capacity Ratio
Veh,v	Vehicle(s)
Vol	Volume
WB, WBL, WBLT	Westbound, westbound left turn

EXECUTIVE SUMMARY

This is the Traffic Impact Analysis for the South Airpark Expansion of the Ted Stevens Anchorage International Airport. The development is on the north side of Raspberry Road, and to the west of the existing South Airpark. The development will be phased over time, with an opening year of 2010, and an assumed design year of 2027. The development is presented in the following exhibit.



Source- Background Photo: Google Earth; Improvements: ANC
Executive Summary Exhibit A- Proposed Development of South Airpark

This traffic impact analysis was conducted in accordance with Alaska Administrative Code and the Municipality of Anchorage's Traffic Department' Policy. Prior to meeting, the consultant met with ANC staff, the State of Alaska DOTPF Central Region Traffic and

Safety Engineer, and the Municipality of Anchorage Traffic Engineer. The work in the study included:

- Traffic Data Collection (Volume, Speed, Sight Distance)
- Review and assimilation of MOA and DOTPF Traffic Volume Information
- Planning Background assessment
- Traffic Forecasts using AMATS travel demand model and best practices
- Capacity Analyses of background conditions and conditions with site traffic.

Raspberry Road, to the west of Sand Lake Road, is a 2-lane collector street, constructed to current collector standards which include pedestrian and bicycle facilities. The posted speed is 35 mph, but the 85th percentile speed is about 45 mph. Minimum sight distance for stopping and intersections are satisfied for the 85th percentile speeds, except for one location where sight lines are blocked by landscape shrubbery (Table 17 on page 40). There is no abnormal crash history in the project study area.

This analysis includes an assessment of the proposed development's compatibility with Anchorage planning. It was determined that the expansion would be compatible with Anchorage planning, except that the traffic levels on Raspberry Road, west of Sand Lake Road will have AADT in excess of the recommended upper traffic AADT range of 10,000.

The full development will generate approximately 7,200 trips per day. The Average Annual Daily Traffic (AADT) volume impact on Raspberry Roads is as follows.

- In 2010, the expected AADT would be the sum of the background AADT of about 3,100 and ½ of the expected Phase 1 traffic, or about 1,200; for a total of 4,300 vehicles per day.
- In 2017, Phase 1 would be complete, with a total site traffic volume of 2,400 vehicles, and the background traffic would be about 3,400, which would result is about 5,800 vehicles.
- In 2027, Phase 1 through 3 would be completed, and total expansion site-generated AADT would be 7,200 vehicles. Raspberry background traffic AADT would be about 3,800, or the AMATS volumes shown in Figure 9. Total AADT in 2027 is estimated to be 11,000 vehicles per day between Access Road 1 and Sand Lake Road. The AADT segment volume between Access Roads 1 and 2 is estimated to be around 8,600 vehicles daily. The segment volume between Access Roads 2 and 3 would be around 6,200 vehicles per day.

Background traffic turning movement peak hour volumes for 2009, 2010, 2017, and 2027 are attached under Appendix E. Background traffic and site traffic turning movement peak hour volumes for 2010, 2017, and 2027 are presented under Appendix F.

Capacity analyses of the study determined three locations where traffic impacts would require mitigation.

Sand Lake Road-Raspberry Road-South Airpark Drive is a two-way stop sign controlled intersection that currently has a poor level of service (LOS). Site traffic will degrade operations to the extent that requires mitigation. Three alternatives were considered.

- The minimum alternative includes an eastbound left-turn lane at this intersection. This is primarily a proactive safety measure that will have little or no affect in mitigation of LOS deficiencies for the northbound and southbound stop approach vehicles. It would reduce the potential rear-end collisions between left-turning vehicles that are stopped while waiting for gaps through the oncoming traffic and following through vehicles. To a small extent, it would reduce the delay of the eastbound through vehicles and overall intersection delay, but it should be recognized that operations with site traffic and without the turn lane are LOS C or better.
- Without site traffic, a traffic signal may be warranted in 2018. With 2010 Phase 1 site traffic combined with the increasing background traffic, volume signal warrants are forecasted to be satisfied in 2015. Once signalized, the LOS will be C or better (acceptable) through 2027.
- A modern roundabout, double circulatory lanes, would provide good operations (C or better) through 2027.

The southbound approach of the Raspberry Road-Tanaina Drive-Access Road 1 intersection under stop sign control will have a poor LOS in 2027 upon completion of the 3rd phase of the development. There are no apparent feasible engineering solutions to correct the poor LOS on the southbound approach. However, all impact traffic is generated by the development, and tenants may be able to implement travel demand management measures to reduce their delays. Also, a southbound right turn lane would reduce delay for any traffic turning right, but would not improve overall approach LOS. As an alternative, a frontage road that is parallel to Raspberry Road and connects to South Airpark Drive at the Sand Lake Road-Raspberry Road-South Airpark Drive intersection would eliminate all access road connections to Raspberry Road. All inbound and outbound site traffic would use the intersection by way of the north leg of the intersection. Operations would be satisfactory (LOS C or better) with these traffic patterns caused by the frontage road.

The southbound approach of Carl Brady Drive intersection with Raspberry Road will have poor LOS by 2017. Engineering options are limited, but an installation of a signal at the Sand Lake Road-Raspberry Road-South Airpark Drive intersection will create usable turning gaps for the southbound left-turn traffic.

Some or all of these issue areas would benefit from workers changing travel modes from auto to bike, pedestrian or transit. To that end, the study area was evaluated to determine if unmarked crossings near each Access Road would have good sight distance and opportunities to cross through vehicles gaps in order to facilitate pedestrian and bicycle travel. Each location appears to be satisfactory as an unmarked crossing.

1 INTRODUCTION

1.1 Project Description and Location

This Traffic Impact Analysis addresses future expansion of the Airpark facilities on the south side of the Ted Stevens Anchorage International Airport. The project location is presented in the following figure.

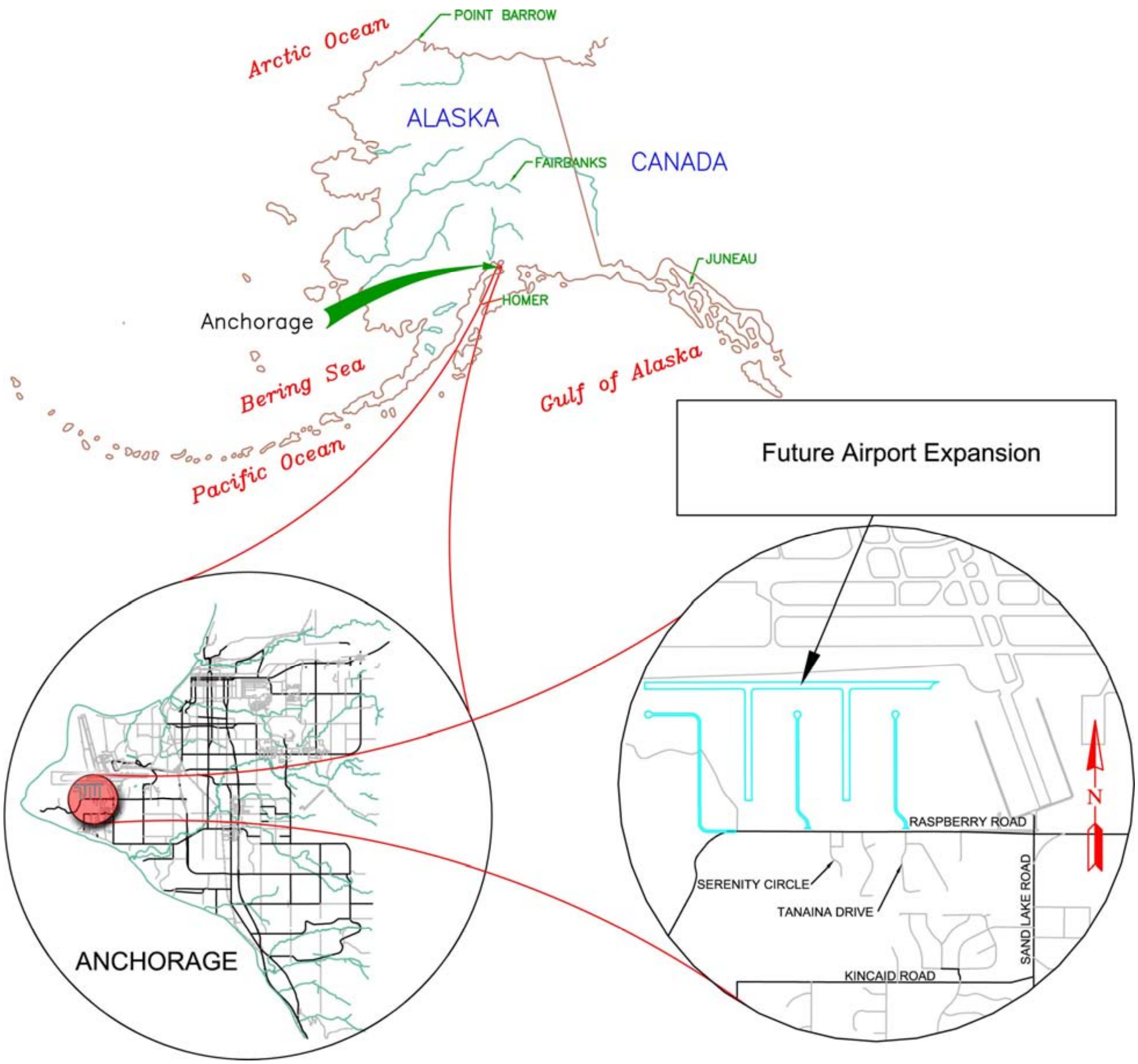
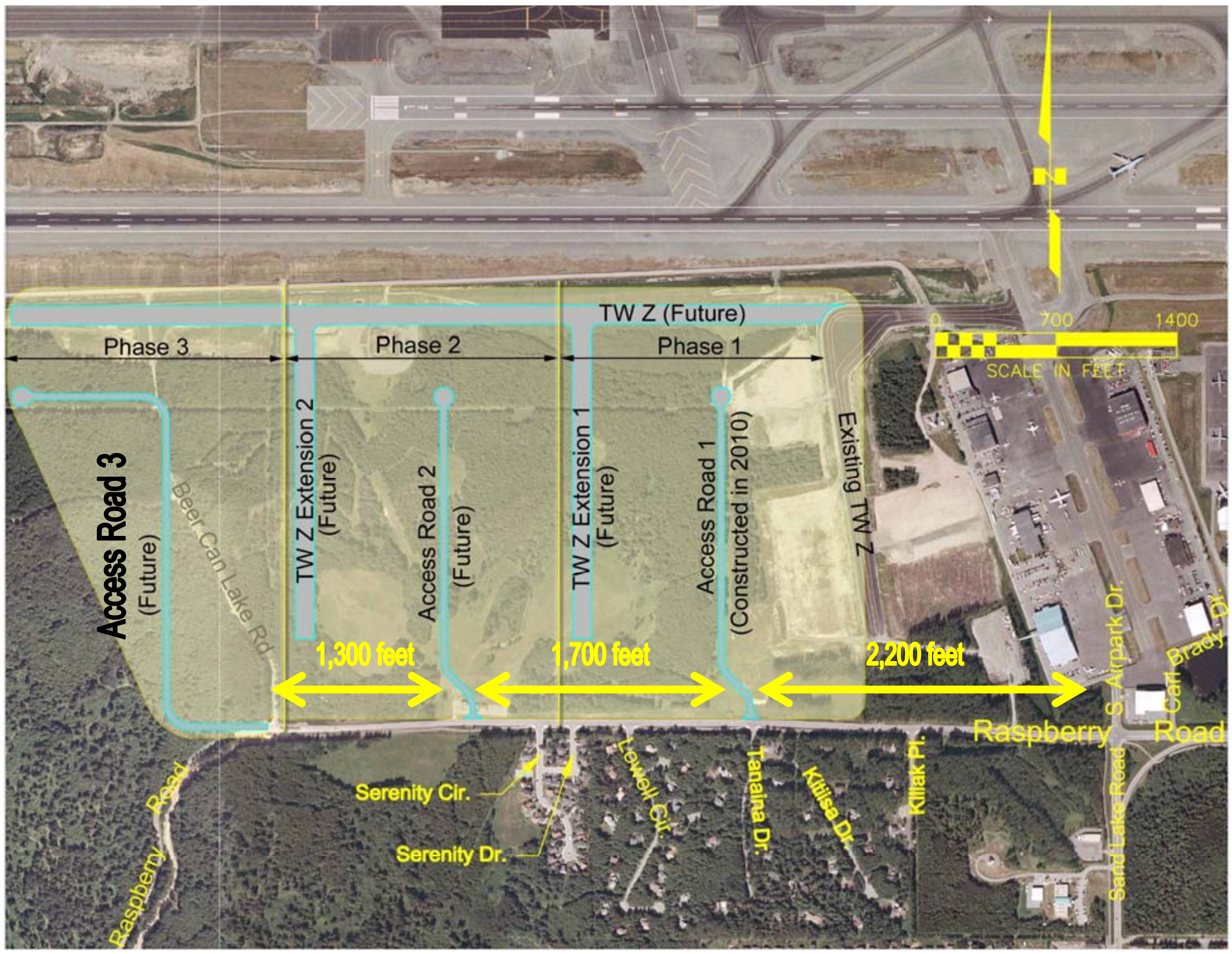


Figure 1- Location and Vicinity Map

1.2 Proposed Development

Ted Stevens Anchorage International Airport (ANC) has plans to develop airport land to the north of Raspberry Road, between existing Taxiway Zulu and its adjoining facilities and Kincaid Park. This development would expand South Airpark and combine the current facilities with proposed facilities under that name.

The proposed expansion is conceptually presented in the following figure.



Source- Background Photo: Google Earth; Improvements: ANC
Figure 2- Proposed Development of South Airpark

Access Road 1 is under design and is expected to be constructed by 2010. It is located approximate 2,200 feet from the Raspberry Road/Sand Lake Road intersection and will align with Tanaina Drive. According to the ANC engineering staff, the remainder of the proposed South Airpark development would occur in 3 phases, each with 1 or 2 projects, over then next 30 years.

Depending upon market conditions, the ANC engineering staff estimates that the proposed Taxiway Z Extension 1 may be constructed within 10 years, or by 2019. During the next 10 years, both sides of access road 1 may be developed, but aircraft oriented leases would be restricted to the east side of access road 1 until the proposed Taxiway Z Extension 1 is completed.

A second phase of development would include the Access Road 2 and Taxiway Z Extension 2, and depending upon market conditions, may be completed by 2029. Access Road 2 would be located about 1,700 feet to the west of the Access Road 1.

The last access road and peripheral lease lot development is forecasted to be completed by 2039, which again is dependent upon market conditions. Access Road 3 would be located at least 1,300 feet west of Access Road 2.

The ANC provided no specific plans as to the type of tenants that will occupy the future development. However, they expect that the tenants and the development density would be similar to the profile of the current South Airpark occupants. Appendix B has a summary and location of the current occupants in the existing South Airpark facility.

Also, since the development is not fully known, it can be assumed that the traffic generated by the expansion will be similar to, and scaled in proportion to the current development. It is assumed that each of the new access roads described above and shown in Figure 2 will generate the same traffic volumes observed on the combined South Airpark Drive, Carl Brady Drive, and UPS driveway.

1.3 Traffic Impact Analysis Issues

A traffic impact analysis of this development is prepared to determine operational and traffic safety impacts of the increased traffic generated by the development on the existing roadway system. Those roads that will experience the highest development impacts are within jurisdiction of the Municipality of Anchorage (including Raspberry Road, and all local streets); and within jurisdiction of the State of Alaska (Sand Lake Road, all access roads into the airport). Therefore, this traffic impact analysis (TIA) report includes issues that both agencies have brought forth, and will be conducted in accordance with both of the agencies requirements for TIA reports.

1.3.1 Traffic Impact Analysis Code and Policy Requirements

The Municipality of Anchorages' platting, zoning, or building permit processes may require a building permit. Also, a driveway or street connection to State of Alaska roadway may require TIA analysis under the Alaska Administrative Code *17 AAC 10.060. Driveways not part of highway construction.*

DOTPF's requirements for TIA are stated under Alaska Administrative Code *17 AAC 10.070. Traffic impact analysis* and *17 AAC 10.075. Traffic impact mitigation.* The Municipality of Anchorage Traffic Department published a 12-11-06 Policy on Traffic Impact Analysis, which largely follows AAC10.070. The following are some of the key points of the requirements, presented in the context of this development's primary issues.

- The State will not require a TIA for developments that generate 100 trips per hour or less. The Municipality may require an abbreviated TIA for developments of less than 100 trips. As will be demonstrated in this TIA, the proposed South Airpark Expansion generates well over 100 trips per its peak hour. As such, a full TIA is required by both agencies.

- The Municipality requires the analysis to address traffic in a horizon year that is 10 years after the facility is opened. The design condition then is the base traffic 10 years in the future combined with site traffic. The State requires a design year of 10 years after the opening year when the facility generates more 250 trips in its peak hour, otherwise the opening year would the design year. The South Airpark development will generate well over 250 peak hour trips at full operation, so a design year of 10 years in the future is required.

- Alaska Administrative Code *17 AAC 10.070. Traffic impact analysis* states that a traffic impact analysis must address (text from 17 AAC 10.070):

    - *Intersections on highways where traffic on any approach is expected to increase as a result of the proposed development by at least five percent of the approach's capacity;*
    - *Segments of highways between intersections where total traffic is expected to increase as a result of the proposed development by at least five percent of the segments' capacity;*
    - *State highways and intersections where the safety of the facilities will deteriorate as a result of the traffic generated by the development;*
    - *Each driveway or approach road that will allow egress from or ingress to a highway for the proposed development;*
    - *Parking and circulation routes within the proposed development, to the extent necessary to ensure that traffic does not back up onto a highway; and,*
    - *Pedestrian and bicycle facilities that are part of the highway facilities to which a permit applicant seeks access.*

    The Municipal Policy indicates that the study area will be determined in a scoping meeting for the development's TIA, and at a minimum includes that the site driveways and nearest signals in each direction. The Municipal policy indicates that additional intersections may be required for analysis by the reviewing agencies based on 17 AAC 10.070.

- MOA and DOTPF requires the level of service after a development to be within the following operational standard (text copied from 12-11-06 Municipality of Anchorage Traffic Department Traffic Impact Analysis Policy):

  1) *LOS C, if the LOS during opening year is LOS C or better; or*

  2) *LOS D, if the LOS during the opening year is LOS D or poorer; however, if the LOS is poorer than D, a lower LOS is acceptable if the operation of the roadway does not deteriorate more than 10 percent in terms of delay time or other appropriate measure of effectiveness from the LOS before the development's opening date.*

  3) *If a roadway has unacceptable LOS without traffic generated by the development, either at the opening date of the development or in the design year of the development, a developer shall make improvements to the roadway so the operation of the roadway does not deteriorate more than 10 percent in terms of delay time or other appropriate measures of effectiveness with the addition of the traffic generated by the development at the opening date of the development or in the design year.*

1.3.2 Scoping Meeting

The Municipality TIA guidelines call for an initial scoping meeting in which agency requirements are further refined. The meeting for this traffic impact analysis was held on September 16, 2009 at the Municipality of Anchorage Traffic Department Offices, and included the Municipal Traffic Engineer, the DOT&PF Central Region Traffic and Safety Engineer, and Kinney Engineering, LLC staff. The agenda and actions are summarized under Appendix A and listed below.

- The AMATS Travel Demand Model will be refined and used for background traffic (without development).

- *Trip Generation, 8th Edition* by ITE doesn't have rates for this development land use. Use the existing South Airpark Place traffic counts to estimate trip generation.

- Trip distribution for background trips will use current distribution. Proposed development site trips will be oriented towards eastern origins and destinations. It is assumed that site traffic will have no reasons to travel into Kincaid Park.

- The study area includes the Sand Lake-South Airpark-Raspberry intersection (including NBRT turning lane), Carl Brady-Raspberry intersection, and proposed access road and existing local street intersections with Raspberry Road between Sand Lake Road and the Kincaid Park entrance at Beer Can Lake Road. The nearest signalized intersection to this development is the Jewel Lake Road and Raspberry Road signal, approximately 1.5 miles from the site, and was not named by the Municipality or State as a location of concern.

- The Design Year should be build-out (opening) plus 10 years, but may be 2027 as convenience to match AMATS Travel Demand Model output. ANC engineering indicates that there will be 3 phases, developed east to west, on about 10 year intervals. The first phase will be fully developed in 2019, the 2nd by 2029, and the final one by 2039. However, this analysis assumes all development in 2027 as a worst cast scenario. This TIA also includes 2010 as the opening year, and 2017 as the year when phase 1 is completed.

1.4 Analysis and Design Years

As described above, the South Airpark Expansion will occur in phases, over a period of up to 30 years. For purposes of this analysis, the study area's roadway network will be evaluated for the following years.

- **2009**- This year represents the current traffic conditions with existing observed traffic, prior to any South Airpark Expansion.

- **2010**- Access Road 1 will be open (see Figure 2 on page 2). In addition, it is assumed that the area between the road and the existing Taxiway Z will be developed and generating Traffic. In order to ascertain the incremental impacts of this development, the analysis considers performance measures for the background traffic only, as well as the background traffic with site traffic.

- **2017**- This is the year when Taxiway Z Extension 1 would be completed, along with apron development that will use Access Road 1. 2017 was used for the design year of phase 1 instead of 2019 for convenience, but also year 2017 is ten years before the assumed full development year of 2027. The analysis considers performance measures for the background traffic only, as well as the background traffic with site traffic.

- **2027**- This is the year assumed for the completion of the development of the South Airpark Expansion, which is before the 2039 design year discussed above, but would allow the site traffic to be overlain on Anchorage's 2027 travel demand model

2 INVENTORY OF EXISTING CONDITIONS

2.1 Streets and Intersections

2.1.1 Functional Classification

The following table presents functional classifications for the study area streets of this TIA.

Street	**Municipality of Anchorage Functional Classification** (Official Streets and Highways Plan)	**Department of Transportation and Public Facilities** (Central Region Traffic Volume Report)
Raspberry Road, Kincaid to Sand Lake Road	Class I Collector	Urban Collector
Raspberry Road, Sand Lake Road to Jewell Lake Road	Class II Minor Arterial	Urban Minor Arterial
Sand Lake Road, Dimond Boulevard to Jewel Lake Road	Class II Minor Arterial	Urban Collector

Table 1- Functional Classification

Those streets in the study area that are not listed in table above are functionally classified as local streets.

2.1.2 Street Typical Sections

The following table summarizes typical sections for key streets in the study area.

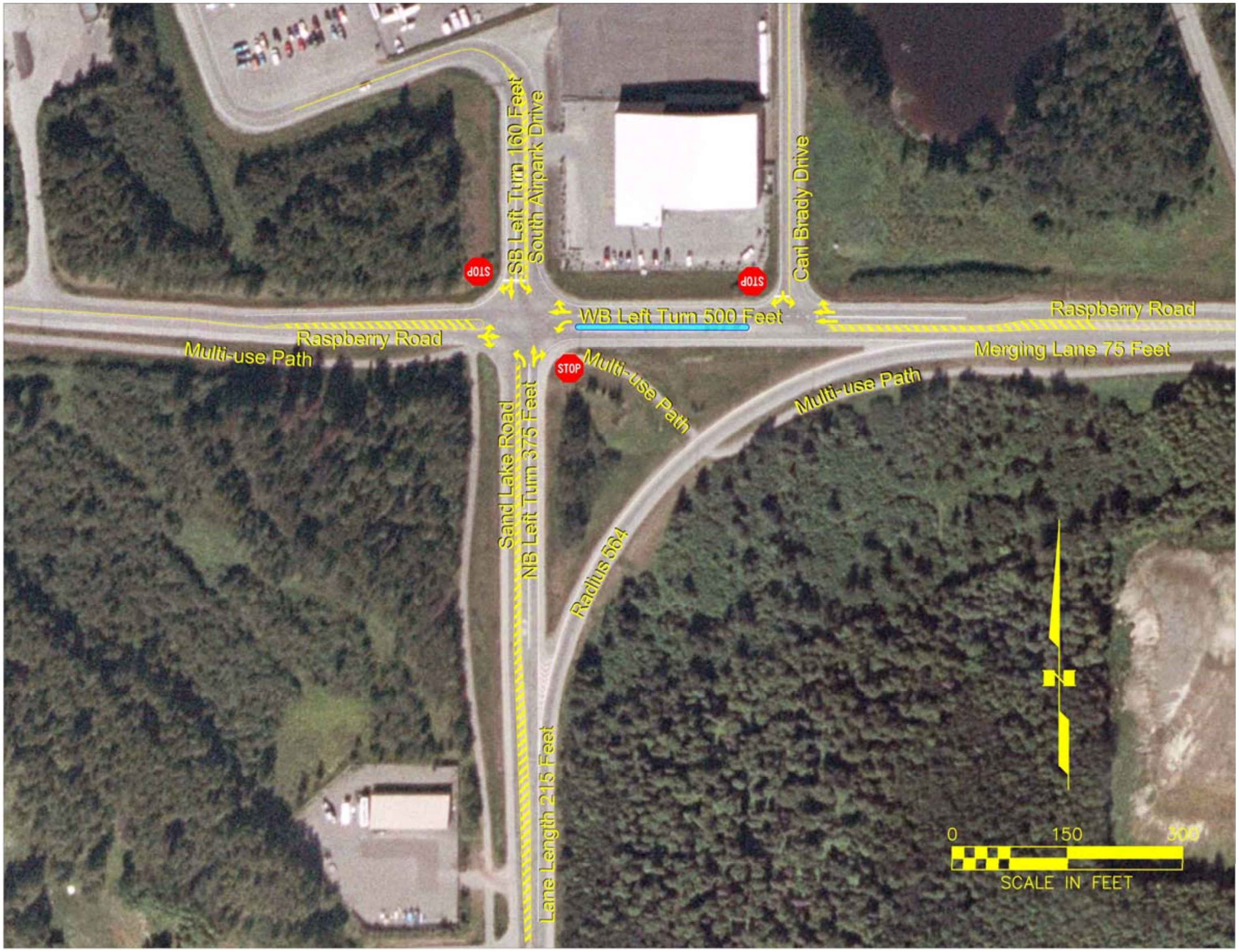
Location	**Geometric Element Width (Feet)**							
	Bike Path Width	**South Or East Shoulder Width (Including Curb And Gutter)**	**EB Or SB LT Lane Width**	**EB Or SB Lane Width**	**Median Width**	**WB Or NB LT Lane Width**	**WB Or NB Lane Width**	**North Or West Shoulder Width (Including Curb And Gutter)**
Raspberry Road Curb And Gutter West Of UPS Training Facility	9	6.5	-	11.5	-	-	11.5	6.5
Raspberry Road, West Of Sand Lake Road	10	10	-	13	-	-	13	8
South Airpark Place, At Intersection	-	8	12	12	4	-	12	8
South Airpark Place	-	1	-	11	-	-	11	1
Sand Lake Road, At Intersection	8	8	-	11	5	12	12	8
Sand Lake Road Northbound Ramp	-	-	-	-	4	-	13	8
Carl Brady Drive	-	-	-	11	-	-	12	-
Raspberry Road East Of Sand Lake Road Intersection	10	8	-	12	6	10	12	8
Raspberry Road, West Of Tall Spruce Drive	9	10	-	13	-	-	12	9

Table 2- Typical Sections

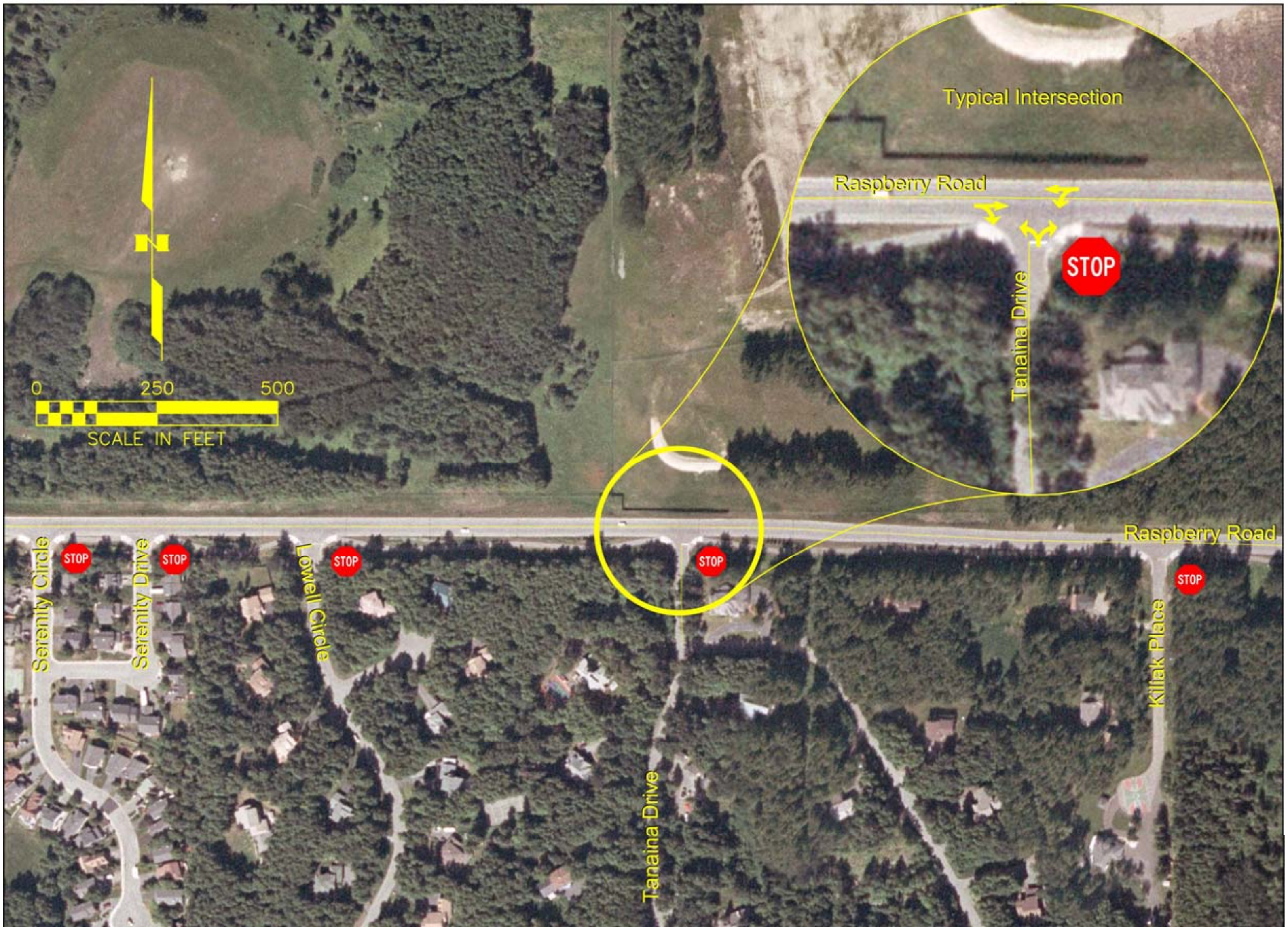
2.1.3 Intersections

All intersections are unsignalized one-way (tee, or three legs) or two-way (four legs) stop controlled intersections. Raspberry Road approaches are the uncontrolled or major street approaches at each intersection.

Figure 3 on page 9 and Figure 4 on page 10 present the existing intersection control and configuration in the study area.



Source- Background Photo: Google Earth
Figure 3- Sand Lake Road and Raspberry Road Intersection



Source- Background Photo: Google Earth

Figure 4- Raspberry Road Intersections

2.1.4 Posted Speeds

Raspberry Road to the west of Sand Lake Road is posted at 35 mph. Raspberry Road to the east of Sand Lake Road is posted at 45 mph. Sand Lake Road is posted at 50 mph.

2.1.5 Public Transit

There are no Peoplemover (transit) routes through the project area. Routes 7 and 7A run along Jewell Lake Road, about 1.5 miles from the project development (source: http://www.muni.org/Departments/transit/PeopleMover/Pages/Timetables.aspx). Because of the distance between the proposed facility and the transit routes, transit is probably not a viable mode of travel for the site employment trips.

2.1.6 Pedestrian and Bicycle Facilities

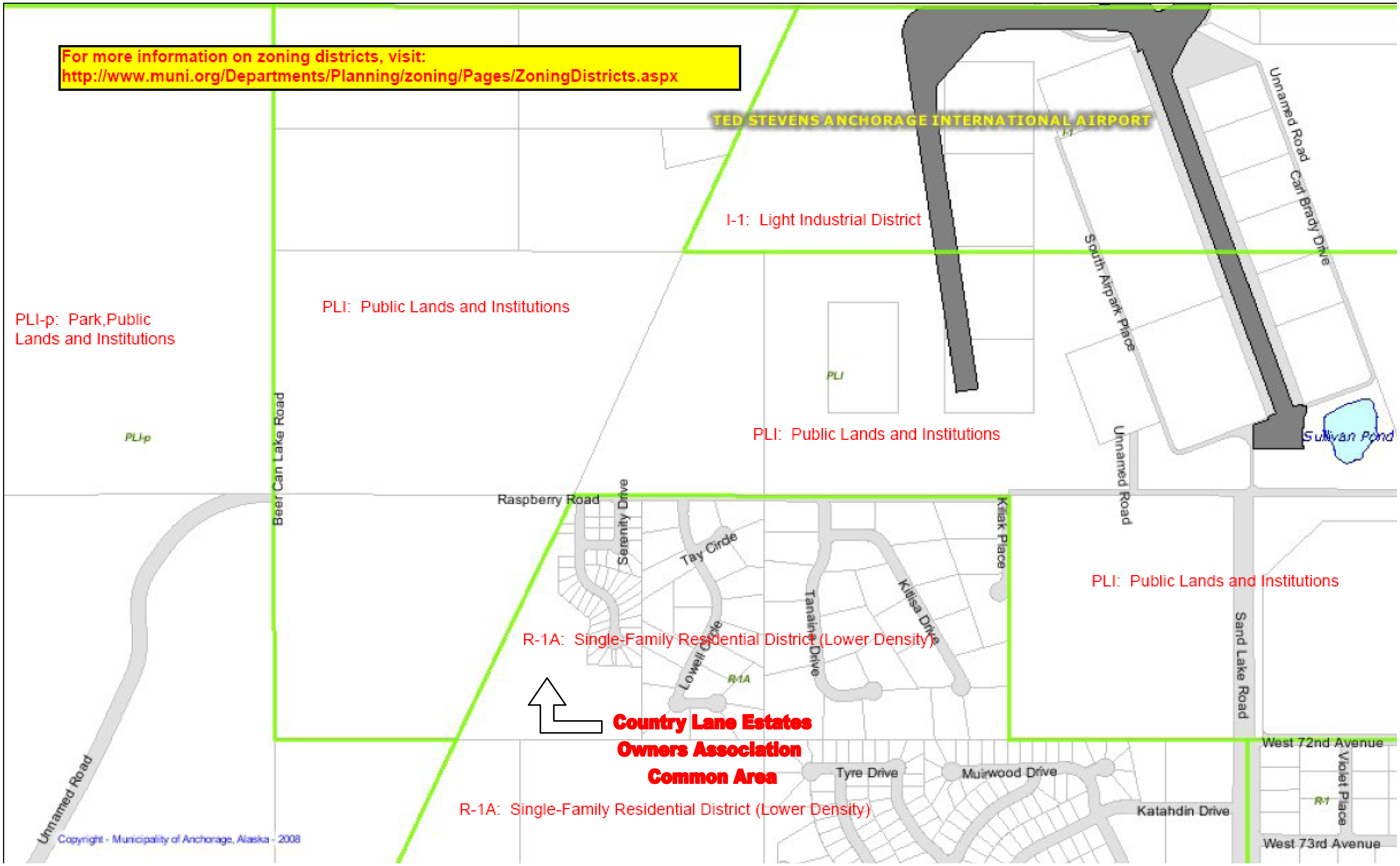
There is a multi-use pathway on the south side of Raspberry Road within the study area that provides connections to trails on Sand Lake Road (west side), Kincaid Park trail, and a Raspberry multi-use path (south side) that is between Sand Lake Road and Arctic Boulevard. In addition, the Sand Lake path connects to Dimond Boulevard pathways, and the eastern Raspberry Road path has connections with pathways on Jewel Lake Road, Arctic Boulevard, and C Street (future), as well as many connections to sidewalk or low-volume streets that are suitable for walking and cycling. Raspberry Road in the study area also has shoulders that are used as bike lanes.

There is good connectivity to the trail system and good continuity within the system. As such pedestrian and bicycle modes of travel may be viable for the site employment trips.

2.2 Land Use and Zoning

Figure 5 on page 12 and Figure 6 on page 13, respectively present the study area zoning and land use. As shown in Figure 5, the dominate zoning are Public Lands and Institution, and lower density Single Family Residential. Land uses include residential, transportation, industrial and institutional.

These figures indicate that under current zoning and land use, there is little potential residential development in the study area that would require access from Raspberry Road. As such, the current traffic generated by the residential area on the south side of Raspberry Road will likely be representative of traffic in the future.



Source: http://munimaps.muni.org/mox52/advanced.cfm?&action=mox52_if_frameset

Figure 5- Study Area Zoning

Source: http://munimaps.muni.org/mox52/advanced.cfm?&action=mox52_if_frameset
Figure 6- Study Area Land Use

3 PLANNING

3.1 Anchorage 2020 Plan

Anchorage 2020 Anchorage Bowl Comprehensive Plan, February 2001 by the Municipality of Anchorage calls for a Town Center in the vicinity of the Jewel Lake Road and Dimond Boulevard intersection, a Neighborhood Center at Jewel Lake Road and Raspberry Road, and a transit corridor along Jewel Lake Road.

3.2 Areawide Trails Plan

The Municipality's *Areawide Trails Plan*, 1997, depicted the existing pathways described under 2.1.6 Pedestrian and Bicycle Facilities, above, as planned. In addition to these existing pathways and trails, the plan designates Raspberry Road between C Street and Sand Lake Road as a planned Bicycle Route, function as a higher speed commuter route for the utilitarian rider. With the recent extension of Raspberry Road between Minnesota Drive and Rovena Street, and the addition of bike lanes and shoulders to Raspberry, this commuter route is largely in place as called for in the Areawide Trails Plan.

3.3 Official Streets and Highways Plan

The Municipality of Anchorage's *Official Streets and Highways Plan*, 1996 (OSHP) functionally classified Raspberry Road to the west of Sand Lake Road as a Class I Residential Collector, which would typically have 2 lanes that serve a daily demand of 2,000 to 10,000 annual average daily traffic (vehicles per day). The 1996 OSHP functionally classified Raspberry Road to the east of Sand Lake Road, and Sand Lake Road as a Class II Minor Arterials. Class II Minor Arterials typically have between 2 and 4 lanes, and serve a demand between 10,000 and 20,000 vehicles per day.

In 2005, the OSHP was amended to remove the word "residential" from the Class I Residential Collector, and as such Raspberry Road is now functionally classified as a Class I Collector.

3.4 Freight Mobility Study

The Municipality's *Freight Mobility Study*, June 2001 indicates that Raspberry Road east of Sand Lake Road, and Sand Lake Road are permitted through routes for larger trucks. These trucks would include single unit trucks (up to 40 feet length), tractor/semitrailer combination (up to 70 feet), and tractor trailer combination (up to 75 feet) that exceed 11,000 pounds gross weight. However, double trailers are not permitted.

Prior to the 2005, through truck travel on Raspberry Road to the west of Sand Lake Road may have been restricted by Title 9 of the Municipality's Code (9.46.410) because it was functionally classified as a residential collector. As such, this might have precluded South

Airpark commercial activities that generated truck traffic. With its reclassification to a Collector, this restriction was lifted.

The Study also indicates that Raspberry Road between Sand Lake Road and Minnesota Drive is a driver's preferred minor truck route.

3.5 AMATS Long Range Transportation Plan

The Municipality of Anchorage AMATS *Anchorage Bowl 2025 Long-Range Transportation Plan with 2027 Revisions*, April 2007 is a comprehensive document for surface transportation planning. The following sections discuss road, pedestrian, bicycle, transit and freight mobility elements of the LRTP with emphasis on how the LRTP will affect this development.

3.5.1 LRTP Roadway, Pedestrian, and Bicycle Elements

Project 308, Dowling Road Extension between Raspberry Road and Old Seward Highway is funded, short term project, currently under development in two phases. The LRTP project Purpose and Description is as follows:

> *"Add new facility—extend Dowling Rd. from Old Seward Hwy. to Minnesota Dr., improve the rest of the facility, and replace one bridge; Purpose: Circulation, access, and freight; Facility class: Major arterial (3); Length of project: 1.65 miles; Length of new sidewalk: 1.65 miles; Length of new pathway: 1.65 miles; Estimated cost: $115 (million); Funding source: TIP; Linked project(s): 201 (Dowling between Seward and Lake Otis, existing), 221 (Raspberry Road Extension, completed 2008), and 416 (Dowling Road Extension, Laurel to Elmore, completed 2009)."*

Raspberry Road will transition into Dowling Road just east of Minnesota Drive. The completion of Dowling Road provides another east-west corridor, with termini at Kincaid Park and Elmore Road. It will increase the mobility of commercial traffic generated by the expansion of South Airpark. This improvement is included in this study's demand models.

Project 507, Jewel Lake Road, Dimond Boulevard to International Road is a short-term project (2006-2015). The LRTP project Purpose and Description is as follows:

> *Reconstruct Jewel Lake to operate as a 2 lane with center turn lane; Purpose: Maintenance and safety; Facility class: Major arterial (3); Length of project: 2.9 miles; Length of new sidewalk: 2.9 miles; Length of new pathway: 2.9 miles; Estimated cost: $19.9 million; Funding source: Bond; Linked project(s): 640.*

The improvement of Jewel Lake Road would increase systems capacity, as well as improve pedestrian/bicycle continuity. This is modeled in this study's demand model.

Project 609, Jewel Lake Rd./ International Airport Rd. Grade Separation is a long-term (2016-2025) project. The LRTP project Purpose and Description is as follows:

> *Construct interchange at International Airport Road and Jewel Lake incorporating a grade separation of the railroad and construct a grade separation of International Airport Road near Northwood street with realignment of railroad to the south side of International Airport Rd.; Purpose: Circulation, access, and freight; Facility class: Not applicable; Length of project: Not applicable; Length of new sidewalk: 0 miles; Length of new pathway: 0 miles; Estimated cost: $45 million; Funding source: TIP; Linked project(s): None.*

3.5.2 LRTP Transit Elements

There are no new routes which would provide direct service to the proposed development. The LRTP calls for the Jewel Lake Road transit routes to have service scheduled for every 15 minutes.

3.5.3 LRTP Freight Elements

The LRTP indicates that Raspberry Road between Sand Lake Road and C Street is a preferred truck route. It also indicates that the projects 308 and 609 discussed above enhance freight mobility. These projects and Raspberry Road's status as a preferred route will facilitate freight movements that are generated by the expansion of the South Airpark development.

3.6 Proposed Development Consistency With Anchorage Planning

The proposed development includes three access roads into South Airpark Expansion. These access roads connect with Raspberry Road, a Class I collector, which in turn connects with the minor arterials of Raspberry Road and Sand Lake Road. As such there is good hierarchical movement for trips generated by the facility; and this expansion's traffic impacts are consistent with OSHP and LRTP objectives.

The traffic that will be generated by the facility will include employees in passenger vehicles (or alternative modes) and trucks that will deliver or pick up freight or provide necessary services to support the facility operations. For freight movements that are generated by the South Airpark expansion, Raspberry Road is a preferred freight movement route, and will connect with freight corridors.

4 TRAFFIC CONDITIONS

4.1 Speed Study

Posted speeds are presented in Section 2.1.4 above. A speed study (147 observations) was conducted with a radar gun on Raspberry Road to the west of Sand Lake Road, during the afternoon of September 9, 2009.

This section of Raspberry is currently posted at 35 MPH. The average speed, both directions was 39 MPH, and the 85th percentile speed is between 42 and 43 MPH. The 85th percentile speed is often the measure for setting a posted speed on unconstrained highways, but other factors are used in setting speeds for urban streets. Since the 85th percentile speeds exceed posted speed, the 85th percentile speed, rounded to 45 MPH, is preferred over posted speed in the evaluation of geometric elements.

4.2 Traffic Volumes

4.2.1 Average Annual Daily Traffic

The following table presents average annual daily traffic (AADT) that has been recorded by the State of Alaska Department of Transportation and Public Facilities, and published in the annual *Central Region Traffic Volume Report*.

1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average Between 1998 And 2007 (Crash Study Period)
Sand Lake Road Between Kincaid Road and Raspberry Road											
2,799	2,495	3,032	3,353	3,194	4,120	3,877	3,488	3,390	3,910	3,669	3,366
Raspberry Road Between Beer Can Road and Sand Lake Road											
1,747	1,188	1,565	1,135	1,516	1,701	1,184	1,376	1,812	2,463	1,680	1,569
Raspberry Road Between Sand Lake Road and Jewel Lake Road											
8,065	7,720	7,971	8,052	8,584	8,690	10,136	10,297	11,028	9,208	9,191	8,975

Table 3- Sand Lake Road and Raspberry Road AADT History

4.2.2 2009 State and Municipality of Anchorage Counts

The Municipality provided early July counts on Raspberry, to the west of Sand Lake Road and to the west of Serenity Circle. However, these directional counts were highly unbalanced, which may have been the result of hose configuration layout. As a conservative measure, the ADT from the MOA counts was estimated by doubling the highest volume direction of travel.

The State information included week long continuous bi-directional counts on Carl Brady, South Airpark, the UPS driveway and the west leg of Raspberry Road/Sand Lake Road Intersection.

There is a permanent traffic recorder (PTR) on Sand Lake Road, just to the north of Dimond Boulevard. The adjustment factors for the PTR are applied to the State and MOA counts to derive 2009 AADT.

Street	**2009 AADT (PTR Adjusted)**	**Morning Peak Hour**	**Noon Peak Hour**	**Evening Peak Hour**
Raspberry Road (west of Sand Lake Road) September DOTPF Machine Count	1,950	91	162	319
Raspberry Road (west of Sand Lake Road) July 8, 2009 MOA Machine Count	3,075 (2 times the highest directional volume)	Not reported because of unbalanced volumes		
[redacted]				
South Airpark Drive September DOTPF Machine Count	1,730	168	181	149
Carl Brady Drive September DOTPF Machine Count	590	76	65	72
UPS Driveway September DOTPF Machine Count	115	19	26	13

Table 4- 2009 August Counts

The existing South Park Development generates about 2,400 vehicles per day (sum of the access streets AADT).

4.2.3 Intersection Peak Hour Turning Movement Counts

Kinney Engineering, LLC counted traffic in early September during the morning, noon, and evening peak hours at the intersection of Raspberry Road with Sand Lake Road and South Airpark Drive, and evening peak hour traffic for the local residential access intersections with Raspberry Road that are west of Sand Lake Road. These are presented in Figure 7 and Figure 8 beginning on page 20 below.

Additional traffic parameters derived from the counts is presented under Appendix C. One of these, peak hour factor (PHF) is computed by the following equation:

$$\text{PHF} = \frac{\text{Total Volume During Hour}}{4 \times \text{Highest 15 Minute Volume}}$$

The PHF is divided into the total hour volume, yielding the highest 15-minute flow rate that is then used to determine the design condition for capacity analyses. This is important, because the lower PHF values that were observed and published under Appendix C produce higher service flow rates, and result in a decline in service quality.

Appendix C present PHF by movement, and % heavy vehicles (trucks and busses) that were observed during the September counts.

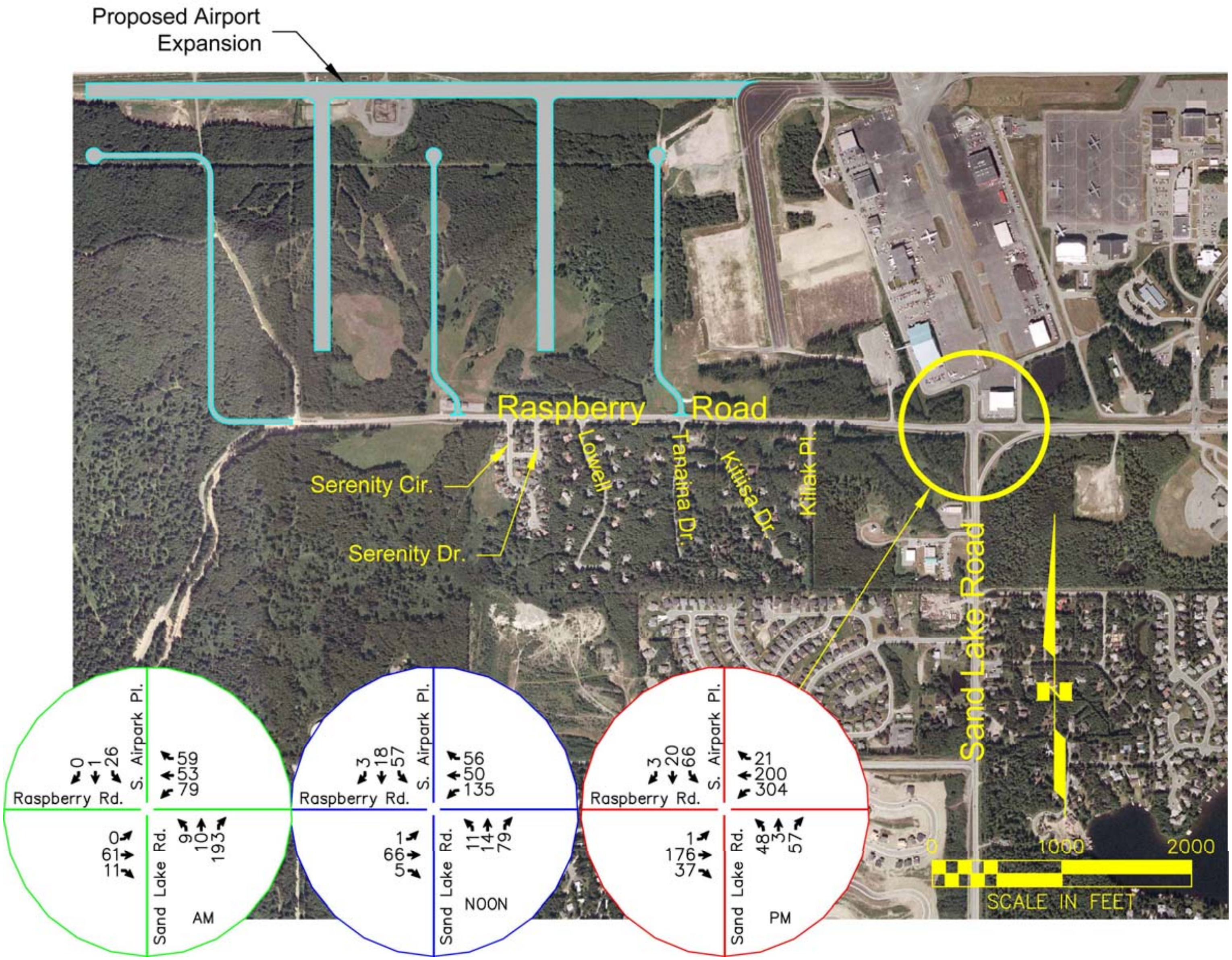


Figure 7- Sand Lake Road and Raspberry Road Peak Hour Turning Movements

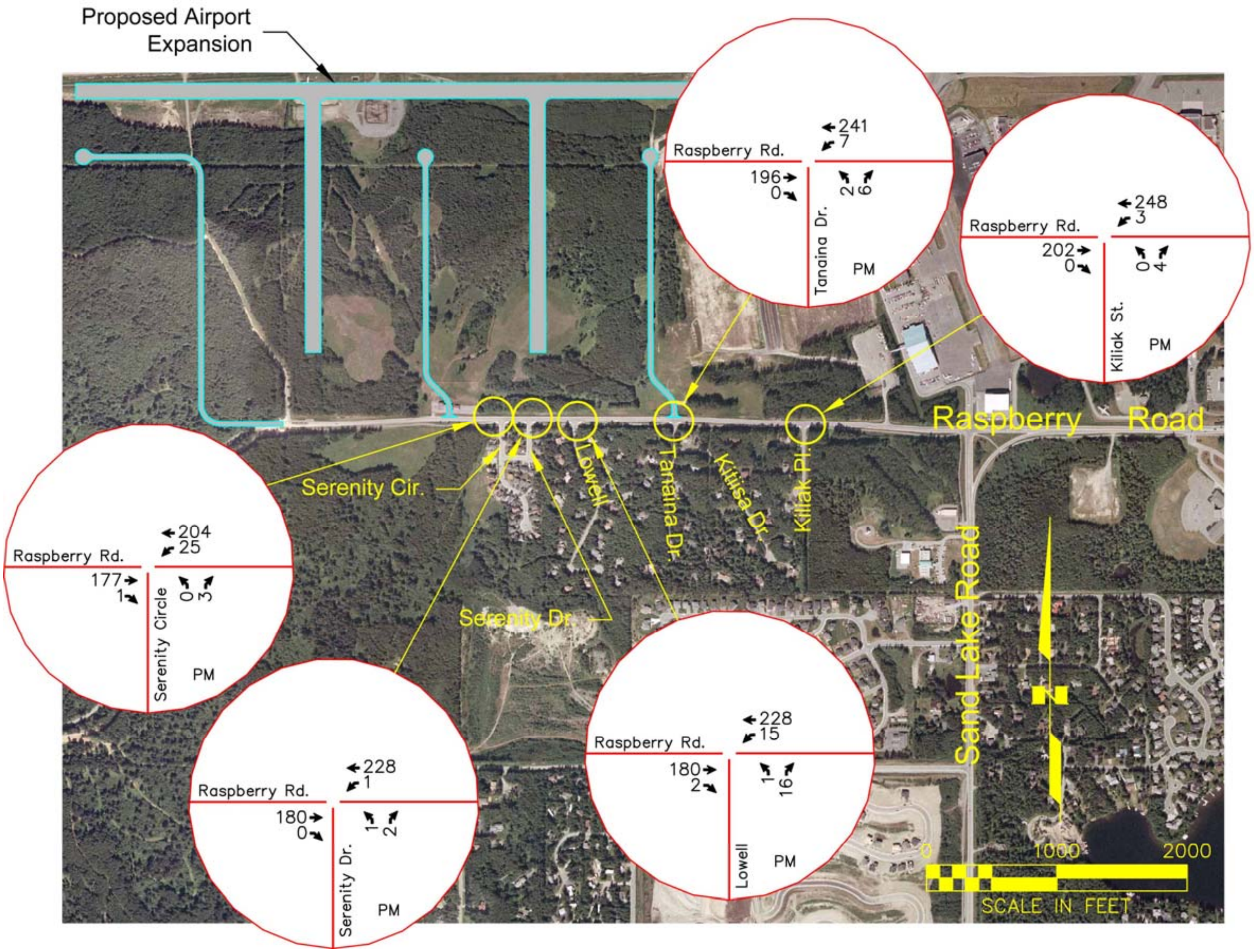


Figure 8- Local Road Intersections with Raspberry Road, PM Peak Hour

5 FUTURE TRAFFIC VOLUMES

5.1 AADT

5.1.1 Background Traffic AADT Volumes

The basis of the background traffic is the Anchorage Metropolitan Area Transportation Solutions (AMATS) travel demand model. This model was modified by Kinney Engineering, LLC by adding more centroid connectors to the model that better represents existing trip distribution from developed areas. Also, the predicted traffic from the ANC property north of Raspberry Road includes anticipated traffic from what is currently Kulis Airbase, which will be turned over to the airport sometime in the near future. To develop future turning movement counts, the additional ADT from Kulis property was subtracted from the ADT for South Airpark Drive and Carl Brady Drive. While the Kulis property will be utilized for ANC operations and leases, the access will likely remain at the current entrance to the airbase and South Airpark Drive and Carl Brady Drive should experience no additional traffic load from Kulis property leases.

Future traffic generated by Kincaid Park was estimated to increase at about 1% per year, which is similar to the forecasted population growth rates for Anchorage used in two recent studies. The Institute of Social and Economic Research's *Economic Projections For Alaska And The Southern Railbelt 2005–2030*, published in 2005 used a growth rate of about 0.9 to 1.2% per year. The Alaska Department of Labor and Workforce Development, Research and Analysis Section forecasts an Anchorage growth rate of about 0.9% per year (October 2007 Alaska Economic Trends *Population Projections, 2007 to 2030*).

The 2027 modified travel demand model is presented in the following figure. As discussed in the scoping meeting with the Municipality and State DOTPF (see 1.3.2 on page 5, Appendix A, and Section 1.4 on page 6), 2027 was selected as the design year for the development.

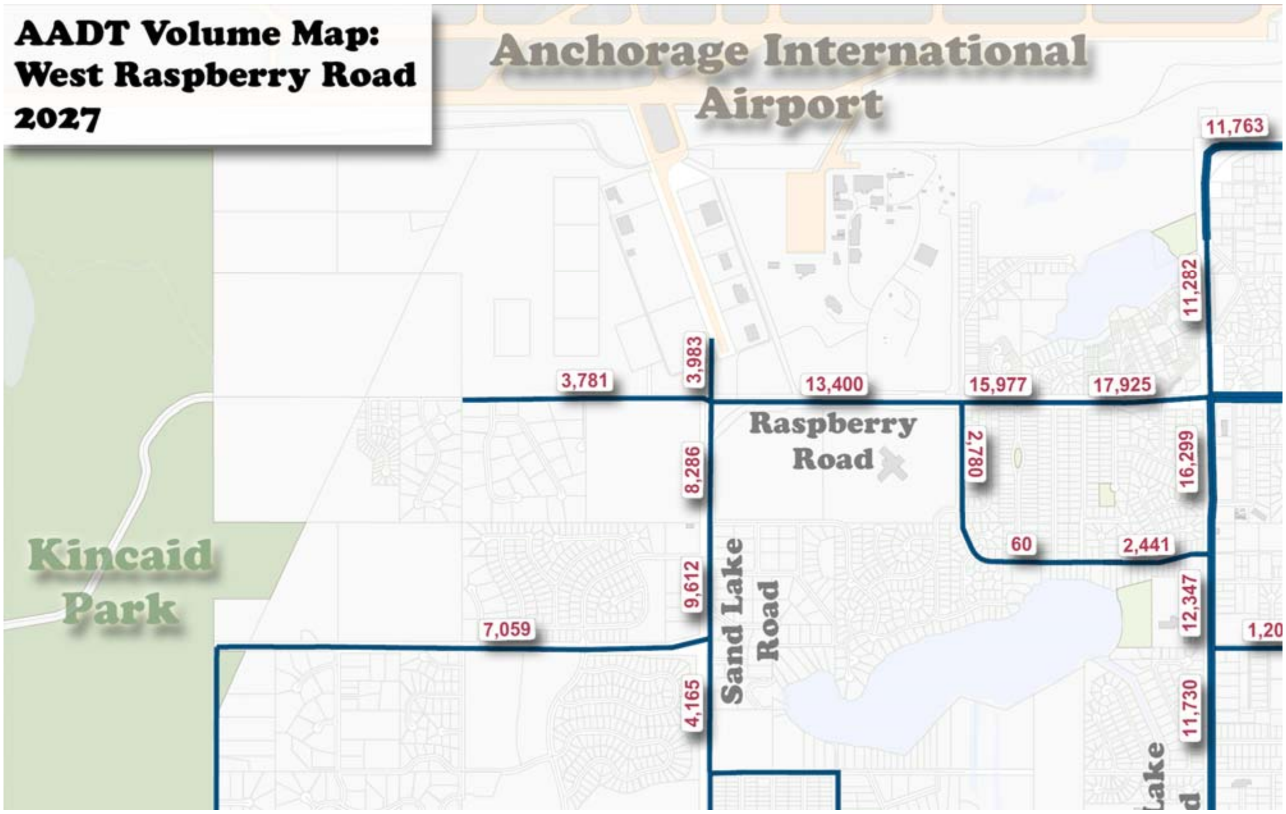


Figure 9– AMATS 2027 Travel Demand Model AADT, Background Traffic Modified by Kinney Engineering, LLC

Section 1.4 on page 6 describes intermediate analysis years and related conditions. The background AADT traffic for the intermediate years, 2009, 2010, and 2017 is estimated by applying the computed average annual growth rate to the latest observed AADT; 2008 for Sand Lake Road and Raspberry Road to the east of Sand Lake Road; and 2009 observations (Municipality counts in Table 4 on page 18). The segment growth rate assumes a compounding rate, with 2008 or 2009 volumes as the beginning period volume and 2027 volumes in Figure 9 above as end period volumes.

Figure 10 below presents the background AADT (without site traffic) for current, intermediate, and design years.

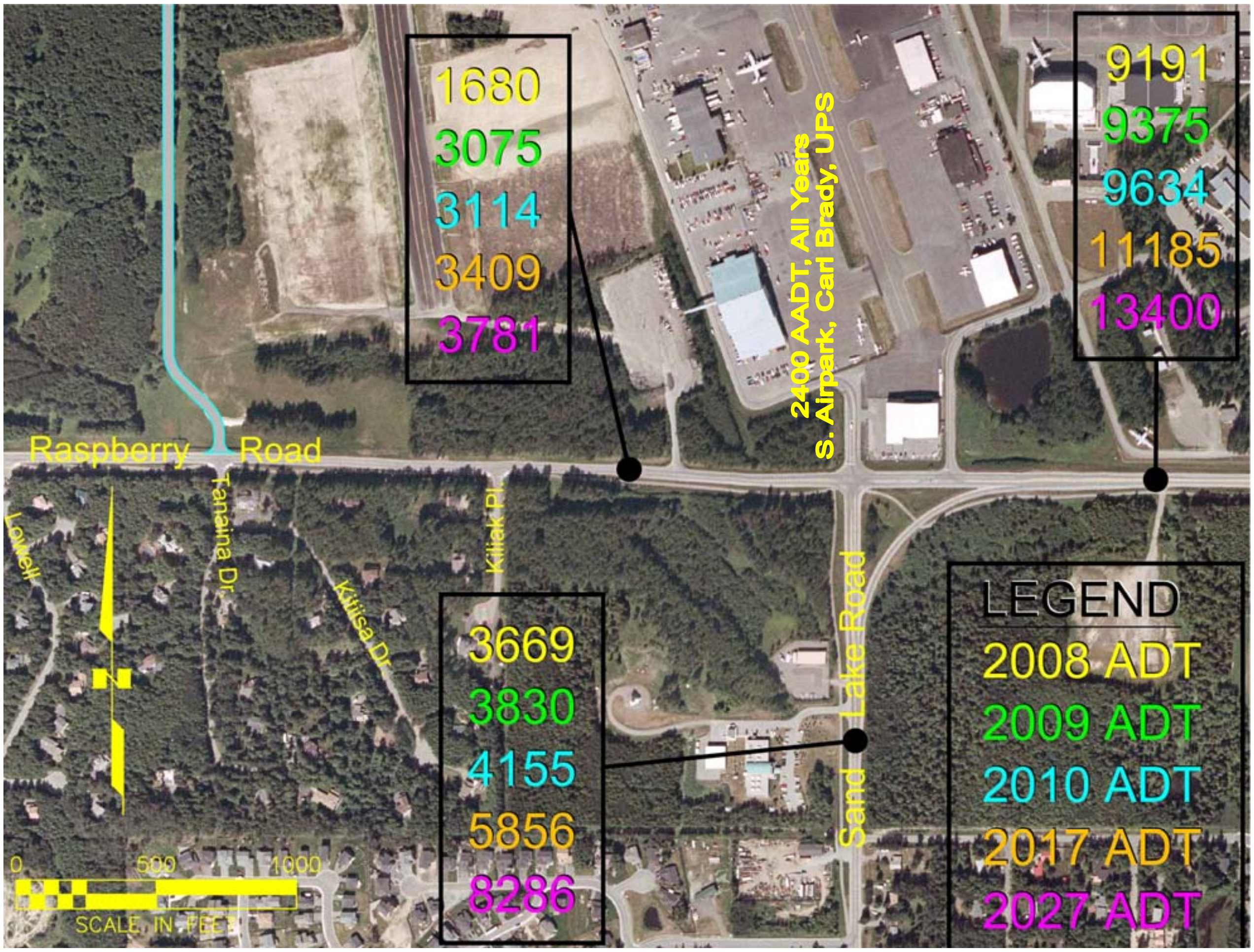


Figure 10- Current, Intermediate, and Design Year Background AADT on Raspberry Road, Sand Lake Road, and S. Airpark/Carl Brady/UPS Drive Segments

5.1.2 Future AADT With Background and Site Traffic

It is assumed that each phase will have similar development that is currently in South Airpark and will generate the volumes that were observed on the UPS, S. Airpark, and Carl Brady approaches. Section 1.4 on page 6, presents a schedule that estimates phasing. The site generated volumes and volumes shown in Figure 10 above result in the following background and site traffic for Raspberry Road AADT.

- In 2010, the expected AADT would be the sum of the background AADT of about 3,100 and ½ of the expected Phase 1 traffic, or about 1,200; for a total of 4,300 vehicles per day.

- In 2017, Phase 1 would be complete, with a total site traffic volume of 2,400 vehicles, and the background traffic would be about 3,400, which would result is about 5,800 vehicles.
- In 2027, Phase 1 through 3 would be completed, and total expansion site-generated AADT would be 7,200 vehicles. Raspberry background traffic AADT would be about 3,800, or the AMATS volumes shown in Figure 9. Total AADT in 2027 is estimated to be 11,000 vehicles per day between Access Road 1 and Sand Lake Road. The AADT segment volume between Access Roads 1 and 2 is estimated to be around 8,600 vehicles daily. The segment volume between Access Roads 2 and 3 would be around 6,200 vehicles per day.

Sand Lake Road and Raspberry Road AADT will cumulatively increase by about 7,200 trips with the proposed development. If the site trip distribution is weighted by AADT on east and south legs of the Sand Lake Road and Raspberry Road intersection, then 2027 traffic on Sand Lake Road south of Raspberry with the site traffic would be about 11,100 vehicles (compared to 8,300 with site traffic). Raspberry Road immediately to the east of the intersection increases by about 4,400 to 17,800 vehicles per day.

5.2 Peak Hour Turning Movement Volumes

5.2.1 Future Year Background Traffic Volumes

Kinney Engineering, LLC, conducted September 2009 turning movement counts of the intersection of Raspberry and Sand Lake and each local street access along Raspberry Road in the project area. DOTPF provided hourly counts spanning seven days in September 2009 for Carl Brady Drive, South Airpark Drive, and the access to the parking lot for the United Parcel Service flight simulator. The DOTPF counts at Carl Brady Drive during the design hour were converted to turning movement counts using the same leaving/arriving trip distribution rates found at South Airpark Drive.

Since the residential area to the south of Raspberry Road is fully developed, the 2009 observed turning volume into and out of each of the local streets is assumed to be constant over the analysis period, through the design year. Similarly, the volumes on South Airpark, Carl Brady and the UPS driveway are assumed to be constant. Peak hour changes for the study area, then, are largely because of increased activity in the Kincaid Park (1% per year growth per Section 5.1.1), and increased development in Sand Lake specifically, and Anchorage in general.

Base traffic turning movement volumes for the Raspberry Road and Sand Lake Road approaches are expected to increase over time because of the overall system growth. Future volumes for these approaches were derived using the methodology outlined in NCHRP 255. Turning movement volumes for 2010, 2017 and 2027 base traffic are shown in Appendix B.

5.2.2 Future Year Site Trip Generation

The ITE Trip Generation Manual does not have trip generation rates applicable to this project. ANC engineering staff foresees that development of each of the three new modules that are centered on the proposed access roads will be similar to the existing development served by South Airpark Place and Carl Brady Drive. Turning movements for each of the new modules are equal to the combined turning movement counts of airport traffic at South Airpark Place and Carl Brady Drive. Design traffic for 2010 was assumed to be equal to half of the existing airpark traffic, since only Access Road 1 will be built in 2010. No new taxiways assumed to be constructed until 2017.

Design turning movement counts are a combination of the base turning movement counts and site traffic. Design turning movement counts are shown for 2010, 2017 and 2027 design traffic in Appendix F.

6 OPERATIONAL ANALYSIS

This section presents operational analysis for the study area intersections. Since this is an urban area, the traffic typically operates under an interrupted flow regime, in which intersection quality of service dominates segment quality of service.

There are seven analysis cases:

- Year 2009 base turning movement counts;
- Year 2010 base turning movement counts;
- Year 2010 design turning movement counts, with ½ of Phase 1 completed (development on east side of Access Road 1);
- Year 2017 base turning movement counts;
- Year 2017 design turning movement counts, with one Phase 1 module constructed;
- Year 2027 base turning movement counts;
- Year 2027 design turning movement counts, with all three phases constructed.

6.1 Sand Lake Road, South Airpark Drive, and Raspberry Road Intersection

The intersection of Sand Lake Road, South Airpark Drive, and Raspberry Road consists of a main 4-way intersection, and a northbound right turning lane that merges into the eastbound lane of Raspberry Road. These are evaluated independently.

6.1.1 Main Intersection

The South Airpark Drive and Sand Lake Road approaches are controlled by stop signs. The following tables provide the performance measures for the traffic that passes through the 4-way intersection. The HCM analysis does not calculate levels of service for main street approaches, which are free flowing, unless, as in these cases, one or both of the main street approaches include left turning traffic. However, the volume to capacity ratios are presented for the free-flow movements so that the incremental impact of site traffic can be estimated on the intersection on the whole.

The peak hour factors and % heavy vehicles recorded and presented in Appendix C were applied to 2009 movements. Future capacity analyses assumed that the congestion increases and site traffic is brought on line, traffic would tend to distribute more equally in time during the peak hour factor. For convenience, it is assumed that the PHF would be 0.95 for all future PM peak hours.

2009 Base Traffic (See Appendix E, Figure 15) Using Observed Movement PHF							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.27	0.15	0.73	0.06	0.9	0.23
Queue Length 95th (ft)	0	28	0	97	5	139	21
Control Delay (s)	0.1	8.9	0	102.6	34.3	127.3	38.9
Lane LOS	A	A	-	F	D	F	E
Approach Delay (s)	0.1	5.1	-	96.2		106.6	
Approach LOS	-	-	-	F		F	

Table 5 – 2009 Raspberry Road & Sand Lake Road Intersection Performance Measures

2010 Base Traffic (See Appendix E, Figure 16) PHF =0.95							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.26	0.14	0.41	0.02	0.49	0.15
Queue Length 95th (ft)	0	26	0	44	2	58	13
Control Delay (s)	0	8.6	0	50.5	29.2	52.9	31.3
Lane LOS	A	A	-	F	D	F	D
Approach Delay (s)	0	5.1	-	49.3		47.3	
Approach LOS	-		-	E		E	
2010 Design Traffic (See Appendix F, Figure 19) PHF=0.95							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.27	0.15	0.48	0.02	0.57	0.17
Queue Length 95th (ft)	0	28	0	54	2	70	15
Control Delay (s)	0	8.9	0	64.3	32.7	67.7	35.9
Lane LOS	A	A		F	D	F	E
Approach Delay (s)	0	5.1		62.5		59.5	
Approach LOS				F		F	

Table 6 – 2010 Raspberry Road & Sand Lake Road Intersection Performance Measures

2017 Base Traffic (See Appendix E, Figure 17) PHF=0.95							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.33	0.14	0.83	0.03	0.73	0.22
Queue Length 95th (ft)	0	36	0	107	2	94	20
Control Delay (s)	0	9	0	142.4	40.7	110.2	46.5
Lane LOS	A	A		F	E	F	E
Approach Delay (s)	0	5.8		138		93.7	
Approach LOS				F		F	
2017 Design Traffic (See Appendix F, Figure 20) PHF=0.95							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.37	0.16	1.2	0.04	1	0.3
Queue Length 95th (ft)	0	42	0	147	3	128	27
Control Delay (s)	0	9.8	0	301.7	52.9	209.8	66.4
Lane LOS	A	A		F	F	F	F
Approach Delay (s)	0	5.9		290.9		172.8	
Approach LOS				F		F	

Table 7 – 2017 Raspberry Road & Sand Lake Road Intersection Performance Measures

2027 Base Traffic (See Appendix E, Figure 18)							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.42	0.15	2.1	0.05	1.27	0.37
Queue Length 95th (ft)	0	53	0	235	4	153	35
Control Delay (s)	0	9.8	0	711.1	66.5	336.5	89.5
Lane LOS	A	A		F	F	F	F
Approach Delay (s)	0	6.6		689.1		272.7	
Approach LOS				F		F	
2027 Design Traffic (See Appendix F, Figure 21)							
	EB-LTR	**WB-L**	**WB -TR**	**NB-L**	**NB-TR**	**SB-L**	**SB-TR**
Volume to Capacity	0	0.59	0.22	Err	0.15	3.84	1.11
Queue Length 95th (ft)	0	101	0	Err	11	Err	79
Control Delay (s)	0	14.4	0	Err	197.8	Err	483.8
Lane LOS	A	B		F	F	F	F
Approach Delay (s)	0	8.6		Err		7540	
Approach LOS				F		F	

Table 8 – 2027 Raspberry Road & Sand Lake Road Intersection Performance Measures

The intersection LOS for the stop controlled approaches is currently computed as F, and will continue to decline with the addition of site traffic. As discussed under Section 8.2 on page 46, the incremental impacts of the additional site traffic on this intersection require some level of mitigation.

6.1.2 Northbound Turning Lane, Merge With Eastbound Traffic

This junction has no formal HCM2000 analysis method, so it was evaluated as a yield intersection, where the northbound turning traffic yields to the eastbound traffic stream. In 2027, with site traffic and background traffic, the LOS for the controlled leg is C, with 19 seconds of delay per vehicle and v/c ratio of about 0.4. As such it can be concluded that the junction will operate at a LOS of C or better through the study period.

6.2 Raspberry Road Local Street Intersections: Residential Streets and Site Development Access Roads

6.2.1 Residential Street Intersections, With and Without Site Traffic

This section addresses operational impacts of the proposed South Airpark expansion on the existing residential local streets that will not be modified by this project, except that volumes will be increased over time. These streets include Serenity Circle, Serenity Drive, Lowell Circle, and Kiliak Place. No significant traffic volumes were observed at Beer Can Road, and it is not included in this section of the analysis, but is included as Access Road 3 under Section 6.2.2 below. The Tanaina Drive intersection is not in this section, but included under Section 6.2.2 below, since the intersection will be modified for the new leg of Access Road 1.

As discussed in Section 5.2.1 above, the turning movement volumes into and out the local streets do not change over the analysis period, but conflicting traffic on Raspberry Road increases with increasing park visits, and due to the site traffic. The peak hour factors and % heavy vehicles recorded and presented in Appendix C were applied to future movements, except when the movement is over capacity, in which case a PHF of 0.95 was used.

Operations are summarized in tables under their respective intersection headings. Where the design year operations with site traffic would not require mitigation under Alaska Administrative Code *17 AAC 10.070. Traffic impact analysis* and *17 AAC 10.075. Traffic impact mitigation* and, or the Municipality guidelines, only 2009 current operations and the 2027 design year with site traffic are presented. Appendix I contains Synchro operational output for the seven analysis cases described above.

6.2.1.1 Raspberry Road and Serenity Circle

The following table presents operations with 2009 and 2027 design conditions for the stop sign controlled Serenity Circle intersection with Raspberry Road. Raspberry Road is the free-flow roadway, and Serenity is controlled by a stop sign. As the table shows, the design year operations are LOS of B, and would be LOS B or better over the study period. As such, the impacts to this intersection by the South Airpark Expansion will not require any mitigation, since performance thresholds cited in Alaska Administrative Code and the Municipality guidelines are not exceeded.

2009 Base Turning Movement Counts (See Appendix E, Figure 15)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.03	2	1.4	A
NB-LR	0.01	1	9.3	A
2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.04	3	1.2	A
NB-LR	0.01	1	11.6	B
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 9- Raspberry Road & Serenity Circle Intersection Performance Measures, 2009 and 2027 Design

6.2.1.2 Raspberry Road and Serenity Drive

The following table presents operations in 2009 (current) and for 2027 traffic design conditions for the Raspberry/Serenity Drive unsignalized intersection. Serenity Drive is controlled by a stop sign. As the table shows, the design year operations are LOS of B, and would be LOS B or better over the study period. As such, the impacts to this intersection by the South Airpark Expansion will not require any mitigation, since performance thresholds cited in Alaska Administrative Code and the Municipality guidelines are not exceeded.

2009 Base Turning Movement Counts (See Appendix E, Figure 15)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.0	0	0.1	A
NB-LR	0.01	1	10.4	B
2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0	0	0.1	A
NB-LR	0.02	2	14.5	B
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 10- Raspberry Road & Serenity Drive Intersection Performance Measures, 2009 and 2027 Design

6.2.1.3 Raspberry Road and Lowell Circle

The following table presents operations in 2009 (current) and for 2027 traffic design conditions for the Raspberry Road and Lowell Circle unsignalized intersection. Lowell Circle traffic is under stop sign control. As the table shows, the design year operations are LOS of B, and would be LOS B or better over the study period. As such, the impacts to this intersection by the South Airpark Expansion will not require any mitigation, since performance thresholds cited in Alaska Administrative Code and the Municipality guidelines are not exceeded.

2009 Base Turning Movement Counts (See Appendix E, Figure 15)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.02	1	0.7	A
NB-LR	0.04	4	10.3	B
2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.02	2	0.7	A
NB-LR	0.07	6	14	B
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 11- Raspberry Road & Lowell Circle Intersection Performance Measures, 2009 and 2027 Design

6.2.1.4 Raspberry Road and Kiliak Place

The following table presents operations in 2009 (current) and for 2027 traffic design conditions for the Raspberry Road and Kiliak Place unsignalized intersection. Kiliak traffic is under stop sign control. As the table shows, the design year operations are LOS of B, and would be LOS B or better over the study period. As such, the impacts to this intersection by the South Airpark Expansion will not require any mitigation, since performance thresholds cited in Alaska Administrative Code and the Municipality guidelines are not exceeded.

2009 Base Turning Movement Counts (See Appendix E, Figure 15)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.0	0	0.1	A
NB-LR	0.01	1	9.5	A
2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0	0	0.1	A
NB-LR	0.03	2	13.6	B
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 12- Raspberry Road & Lowell Circle Intersection Performance Measures, 2009 and 2027 Design

6.2.2 Site Access Roads

6.2.2.1 <u>Raspberry Road, Tanaina Drive, and Access Road 1</u>

The existing intersection of Tanaina Drive with Raspberry Road is unsignalized with the Tanaina approach under stop sign control. Access Road 1 will be installed in 2010, and will become the north leg of the intersection. Access Road 1 will be under stop sign control.

The operations for the seven volume conditions are summarized under the following table (full reports are under Appendix I). The intersection operations will be satisfactory through 2017 with design traffic. However, after 2017 the level of service for the southbound site traffic will fall below a LOS of C, and eventually decline to a LOS of F in 2027. The added site traffic will reduce the LOS on the Tanaina approach by one grade (from B without site traffic to C with site traffic), but this drop does not exceed AAC or Municipality thresholds that would require treatment.

2009 Base Turning Movement Counts (See Appendix E, Figure 15)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.01	1	0.5	A
NB-LR	0.04	3	10.5	B
2010 Base Turning Movement Counts (See Appendix E, Figure 16)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.01	1	0.5	A
NB-LR	0.04	3	10.5	B
2010 Design Turning Movement Counts (See Appendix F, Figure 19)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.01	1	0.5	A
NB-LTR	0.04	3	10.6	B
SB-LTR	0.16	14	14.8	B
2017 Base Turning Movement Counts (See Appendix E, Figure 17)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.01	1	0.5	A
NB-LR	0.04	3	10.8	B
2017 Phase 1 Turning Movement Counts (See Appendix F, Figure 20)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.01	1	0.5	A
NB-LTR	0.04	3	10.9	B
SB-LTR	0.36	40	19.4	C
2027 Base Turning Movement Counts (See Appendix E, Figure 18)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.01	1	0.5	A
NB-LR	0.05	4	11.2	B
2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
WB-LT	0.02	1	0.5	A
NB-LTR	0.07	6	15.2	C
SB-LTR	0.7	110	57.2	F
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 13- Raspberry Road, Tanaina Drive, and Access Road 1 Intersection Performance Measures

For a design year of 2027, the decline in operational quality for the southbound traffic falls below State and Municipality thresholds for site traffic impacts. However, all traffic affected by the decline in LOS in 2027 will be site generated outbound traffic. Pass-by traffic and residential generated traffic will operate a good LOS. As discussed under Section 8.3 on page 53, the incremental impacts of the additional site traffic on this intersection require may require some level of mitigation.

6.2.2.2 Raspberry Road Intersections with Access Roads 2 and 3

Both of these access roads, 2 and 3, are assumed to be completed by 2027, and both would be under stop sign control.

The following table summarizes the design year operations for these intersections. As the table shows, the design year operations are LOS C, and would be LOS C or better over the study period. As such, the impacts to this intersection by the South Airpark Expansion will not require any mitigation, since performance thresholds cited in Alaska Administrative Code and the Municipality guidelines are not exceeded.

Raspberry Road and Access Road 2, 2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.37	41	19.9	C
Raspberry Road and Access Road 3, 2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.29	30	15.5	C
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 14- Raspberry Road Intersections with Access Roads 2 and 3

6.3 Carl Brady Drive and Raspberry Road

Carl Brady Drive and Raspberry Road is a “tee” intersection with the Carl Brady approach under stop sign control. The following table summarizes measures of effectiveness for the seven analysis cases. Carl Brady Drive approach turning movements was synthesized from machine counts and directional distribution trends at other locations. This location’s PHF and truck data is not known, so Synchro’s default PHF of 0.92 and 2% trucks was applied to the Carl Brady approach traffic. Appendix I contains Synchro operational output for the seven analysis cases described above.

2009 Base Turning Movement Counts (See Appendix E, Figure 15)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.16	14	17.7	C
2010 Base Turning Movement Counts (See Appendix E, Figure 16)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.13	11	17.9	C
2010 Design Turning Movement Counts (See Appendix F, Figure 19)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.15	13	19.6	C
2017 Base Turning Movement Counts (See Appendix E, Figure 17)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.15	13	20.5	C
2017 Phase 1 Turning Movement Counts (See Appendix F, Figure 20)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.19	17	25.1	D
2027 Base Turning Movement Counts (See Appendix E, Figure 18)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.19	17	25	D
2027 Design Turning Movement Counts (See Appendix F, Figure 21)				
Movement / Lane Group	*v/c*	*95th Percentile Queue Length*	*Control Delay (seconds / vehicle)*	*Lane LOS*
SB-LR	0.37	38	53.5	F
NB=Northbound, SB=Southbound, EB=Eastbound, WB=Westbound, L=Left Turn, T=Through, R=Right Turn				

Table 15- Raspberry Road and Carl Brady Drive Intersection Performance Measures

The Carl Brady approach in 2027 is forecasted to operate at a LOS D without any site traffic. With the additional site traffic generated by the development, the increased traffic reduces useable gaps for southbound traffic, and the Carl Brady LOS would be reduced to F.

By 2017, the decline in operational quality for the southbound traffic falls below the State and Municipality thresholds for site traffic impacts. However, all traffic affected by the decline in LOS in 2027 will be site generated outbound traffic. Pass-by traffic and residential generated traffic will operate a good LOS. As discussed under Section 8.4 on page 54 the incremental impacts of the additional site traffic on this intersection require may require some level of mitigation.

7 TRAFFIC SAFETY ANALYSIS

7.1 Substantive Safety Evaluation, Crash History

Crash data was collected from ADOT&PF for the 10 most recent years that are available. Table 16 below summarizes crash rates for the key intersections in the study area.

Rate analysis is especially useful when there is a population of facilities to which we can compare the study area. ADOT&PF has developed and distributes statewide populations for segments and intersections. A method known as the Rate Quality Control Method establishes an upper control limit (UCL) to determine if the facility's accident rate is significantly higher than accident rates in facilities with similar characteristics. If the UCL is exceeded, we would conclude that the high crash rate is not solely due to chance, and that there are truly crash issues at the location. Appendix D discusses crash evaluation methods and the UCL computation further.

Intersection	Intersection Crashes 1998 to 2007	Crashes / Million Entering Vehicles (MEV)	State Populations Crashes / MEV	Upper Critical Limit @ 95.00% Confidence	Above Average?	Above Critical?
Raspberry Rd. & Beer Can Lake Road	2	0.349	0.582	1.194	no	no
Raspberry Rd. & Serenity Circle	1	0.175	0.582	1.194	no	no
Raspberry Rd. & Serenity Drive	3	0.524	0.582	1.194	no	no
Raspberry Rd. & Lowell Circle	1	0.175	0.582	1.194	no	no
Raspberry Road & Tanaina Dr.	2	0.349	0.582	1.194	no	no
Raspberry Road and Sand Lake Road	20	0.717	0.736	1.021	no	no
Raspberry Road & Air Guard Drive	0	0.000	0.582	0.817	no	no

Table 16- Intersection Crashes and Crash Rates, 1998 to 2007

As shown in Table 16 above, the intersections within the proximity of the South Airpark development expansion have no extraordinary crash history.

7.2 Nominal Safety Analysis

7.2.1 Intersection Sight Distance

American Association State Highway Transportation Officials' (AASHTO) G*eometric Design of Highway and Streets* (GDHS) Chapter 9 discusses intersection sight distance (ISD) in which a sight triangle is formed by conflicting approach vehicles. Minimum ISD for the stop-controlled approach is the stopping sight distance (SSD) along the major, uncontrolled street. This would allow major street vehicles time to adjust speeds or stop in the case where an egress movement from the minor street fails to yield properly. Raspberry Road is the major street approach, and all cross streets are under stop sign control. As such, the SSD and minimum ISD standard for the 85th percentile speed of 45 mph on Raspberry Road is 360 feet.

A more conservative and desirable design condition would provide ISD to allow the minor-approach vehicle to view main-road vehicles and select safe gaps for egress maneuvers. The vehicles on the stop sign controlled approach are under Case B ISD, which is the most restrictive condition, and generally controls for when the main street is two-way traffic flow. Case B1 for left-turns onto the major road, requires 500 feet for 45 mph approach speeds on Raspberry Road. Desirable ISD for right turns and crossing (Case B2 and B3 respectively) is 430 feet.

The minor approach vertex of ISD sight triangle is 15 feet from the travel way, at a height of 3.5 feet. The major approach vertex of the sight triangle is at the center of the approach lane at a 3.5-foot height and the sight distance is the minimum ISD or desirable Case B distance. The following table presents a summary of field measured intersection sight distance, and the ISD compliance with minimum and desirable conditions for those existing and proposed intersections.

	Sight Distance To West			Sight Distance To East		
Street Name	**Measured**	**Minimum 45 MPH**	**Desirable 45 MPH**	**Measured**	**Minimum 45 MPH**	**Desirable 45 MPH**
Serenity Circle	800 feet		430 feet	*340 feet		500 feet
Serenity Drive	830 feet		430 feet	*265 feet		500 feet
Lowell Circle	581 feet		430 feet	*455 feet		500 feet
Tanaina Drive	*387 feet	360 feet	430 feet	668 feet	360 feet	500 feet
Kiliak Place	480 feet		430 feet	855 feet		500 feet
Sand Lake Road	1,766 feet		430 feet	705 feet		500 feet
South Airpark Place	1,895 feet		500 feet	570 feet		430 feet
Proposed Access Road 1 (across from Tanaina Drive)	1,088 feet		500 feet	1,740 feet		430 feet
Proposed Access Road 2 (FCC)	920 feet	360 feet	500 feet	992 feet	360 feet	430 feet
Proposed Access Road 3 (Beer Can Road)	432 feet		500 feet	477 feet		430 feet

** These sight distance lines are constrained by landscaping. Sight distance in the above table is measured from 15 feet in back of the travel way and is improved by moving closer to travel way.*

Table 17- Intersection Sight Distance

Some of the existing residential street intersections have landscaping in the sight triangle that reduces ISD. Access Road 1 and 2 locations would at meet the desirable ISD for the 85^{th} percentile speed of 45 mph. Access Road 3 location meets desirable ISD to the east, but only meets minimum ISD to the west. Landscaping, which could be removed with the access road, blocks desirable sight lines to the west of Access Road 3.

7.2.2 Left-Turn Lanes on Major Approaches of Unsignalized Intersections

AASHTO's Geometric Design of Highways and Streets, Exhibit 9-75 presents guidelines for installation of left-turn lanes on two-lane highways. This methodology was applied to the intersections with 2027 design volumes presented in Appendix F Figure 21. Under these guidelines for the 45 mph 85^{th} percentile speeds, there are no intersections where main street left-turn lanes are recommended on Raspberry Road approaches, including the eastbound approach of the Sand Lake Road-Raspberry Road- and South Airpark Drive intersection.

However, a left-turn lane should be considered for the eastbound approach of the Sand Lake Road-Raspberry Road- and South Airpark Drive intersection. The eastbound left turn demand shown in Appendix F volume cases may be understated in that there may be more travel between the proposed development and the existing South Airpark facilities than forecasted. If so, then eastbound through traffic are delayed by the additional left-turning vehicles that waiting for turning gaps while in the shared-movement travel lane. The increased westbound traffic generated by the development will have fewer acceptable turning gaps for left-turns resulting in further delay for eastbound traffic. Also, the additional Raspberry Road site generated eastbound traffic results in more impacted traffic under delay. It is important to recognize that the increase in delay will not drive the eastbound through or left-turn movements into a LOS that is not acceptable. However, since the northbound and southbound approaches have capacity issues (see Section 6.1 above), which will be worsened with the opening of the Phase 1 development in 2010 and subsequent development, capacity enhancements for other movements, for example a eastbound left-turn lane, reduces overall intersection delay.

A more beneficial aspect of the left-turn lane is that it removes the conflict between a target turning vehicle and a following through vehicle. Although the probability of conflict and risk is accounted for in the AASHTO Exhibit 9-75 guidelines described above, the turning demand may be understated. A left-turn lane substantially reduces risk of elevated accidents if a higher eastbound left-turn demand were to occur.

Finally, there is a painted median on that approach that could be converted to a left-turn lane. Based on the 45 mph 85^{th} percentile speed, a 200 foot length (exclusive of the bay taper) would be desirable for this auxiliary left-turn lane. If the posted speed of 35 mph is used as the basis of design, the lane may be reduced to 125 feet.

7.2.3 Access Spacing

There is widespread recognition that access control reduces vehicular conflicts and reduces crashes. To this end, there is an upstream and downstream functional area of intersection in which other conflicts should be removed or reduced to the extent possible. The Municipality of Anchorage and DOTPF have design criteria for driveway locations, but their respective design criteria manuals are silent on cross-street spacing, since public rights of ways are usually examined during a platting action and refined at that point. The *Access Management Manual* from TRB provides guidance on this matter that can be applied to the proposed Access Roads 1, 2, and 3.

Unsignalized street connection spacing on suburban collectors should be 330 feet or more (Table 9-11, *Access Management Manual*). The spacing between the Access Roads 1, 2, and 3 on the north side of Raspberry Road is presented in Figure 2 on page 2. The minimum spacing between the proposed access roads is well over 1,000 feet for all. More importantly the spacing intervals between the access roads and existing local street will also exceed the spacing guidelines.

Access Road 1 will connect to the Raspberry intersection with Tanaina, and will consolidate conflict points to one location. This modified intersection will be over 900 feet from Kiliak Place and over 700 feet from Lowell Circle. Access Road 2 will be about 400 feet from Serenity Circle. Access Road 3 is 1,300 from Access Road 2.

7.2.4 Pedestrian and Bicycle Facilities

There is a multi-use pathway on the south side of Raspberry Road in the vicinity of the South Airpark Access Roads. In addition, there are in-roadway bicycle lanes on

Raspberry Road to the west of Sand Lake Road. With the extensive pathways network described in Section 2.1.6 on page 11, there is a potential for pedestrians and bicycles commuters as an alternative mode to the passenger vehicle. Also, as will be discussed under mitigation alternatives, encouraging works to change modes from motor vehicles to bicycles or walking is a possible travel demand management strategy to mitigate impacts.

Designated crosswalks are not anticipated on Raspberry Road in the vicinity of the development. However, there will be a crossing demand at each of the Access Road intersections into the South Park expansion, and these should be considered unmarked crossings. Unmarked or marked, unsignalized pedestrian crossings should satisfy two sight distance and performance measures that indicate the availability of usable crossing gaps, or crossing opportunities through traffic.

7.2.4.1 Sight Distance

It is desirable that the sight lines between the pedestrian and the approaching vehicle exceed both stopping sight distance and pedestrian sight distance. The sight line is at a height of 3.5 feet above the pavement. Stopping sight distance for the 85^{th} percentile speed of 45 MPH is 360 feet. Pedestrian sight distance is the product of the crossing time, (24-foot width between edge of travel way divided by walking speed, 3.5 feet per second), which in this case is 6.9 seconds, and the approaching vehicle speed, which in this case would be 85^{th} percentile speed of 45 mph. Therefore, the computed desirable pedestrian sight distance for all three Access Road locations is 453 feet.

It can be assumed that the measure intersection sight distance that is summarized in Table 17 on page 40 will also apply to pedestrian sight lines. If so, Access Road 1 and 2 have sight lines that greatly exceed the stopping sight distance (360 feet) and pedestrian sight distance (453 feet). Access Road 3 crossings sight lines would exceed stopping sight distance and pedestrian sight distance to the east, but is just short of desirable pedestrian sight distance to the west. However, this will likely be improved when Access Road 3 is constructed, since landscaping is the sight obstacle.

It is concluded that there will be adequate sight distance for unmarked, unsignalized crossings of Raspberry at all three access road intersections.

7.2.4.2 Crossing Opportunities Through Vehicle Gaps

It is desirable that the traffic stream at an unsignalized crossing have frequent enough gaps of sufficient time to allow pedestrians to safely cross the street without excessive delay, and without them having to rely on motorists to adjust their speeds. There are three measures of pedestrian quality of service that are described in detail under Appendix G. These include crossing gap frequency per minute (>1 per minute is desirable), percent of time that pedestrian is delayed compared to a computed threshold, and HCM2000 level of service (generally LOS C or better is desirable.

The following table provides future performance measures for Raspberry Road crossings at the three access road locations. In general there will be sufficient crossing opportunities at these locations in the future.

[redacted]	**Raspberry Pedestrian Crossing at Access Road 1**					
	Gaps per minute	**% Time Delayed**		**HCM2000 Unsignalized LOS**		**Analysis**
		% Delay	**Maximum Delay for N=1 Rows**	**Average Ped Delay (sec)**	**Level of Service**	
2010	3.8 (OK > 1)	37%	84% (OK)	10	C (OK)	All criteria satisfied
2017	3.4 (OK > 1)	43%	84% (OK)	12	C (OK)	All criteria satisfied
2027	1.7 (OK > 1)	73%	84% (OK)	34	E	2 of 3 performance criteria satisfied
[redacted]	**Raspberry Pedestrian Crossing at Access Road 2**					
2027	2.6 (OK > 1)	57%	84% (OK)	19	C (OK)	All criteria satisfied
[redacted]	**Raspberry Pedestrian Crossing at Access Road 3**					
2027	2.9 (OK > 1)	52%	84% (OK)	16	C (OK)	All criteria satisfied

Table 18- Pedestrian Crossings Performance Measures for Access Road 1, 2, and 3

8 MITIGATION ALTERNATIVES

8.1 AADT Class I Collector Volume Ranges

As discussed in Section 5.1.2 on page 24above, the full development of the South Airpark Expansion will generate about 7,200 trips per day on Raspberry Road, which is forecasted to be distributed equally on the three access roads. Raspberry 2027 AADT with the background traffic and site traffic will be:

- 11,000 vehicles per day between Access Road 1 and Sand Lake Road,
- About 8,600 vehicles daily between Access Roads 1 and 2; and,
- Around 6,200 vehicles per day Access Roads 2 and 3.

The Access Road 1 to Sand Lake Road segment with 11,000 AADT would be inconsistent with the Class I Collector volume ranges of 2,000 to 10,000 vehicles per day that are presented in the OSHP. The collector functional classification is based upon its position in the system (linking local streets to arterial streets) and less on the volume that it carries. The 10,000 AADT limit provides a practical guide to collector planning, so that the frequency and spacing is such that streets are not too “busy”, but more importantly will not cause congestion issues at the arterial-collector intersection. Other reasons for trying to limit AADT on collectors in areas of higher pedestrian activity would be to facilitate unsignalized pedestrian crossings.

It should be recognized that the basis of the background volume component of the 2027 11,000 AADT was a Municipal machine count conducted in July of 2009, which exhibited inconsistent directional volumes and therefore may be in error. The Municipality count was used as the basis of forecasts in order to present a “worst”, or most conservative case. If the State count conducted in September were to be used, then the background component would be substantially less, and future AADT would fall below 10,000 vehicles.

One strategy that is used to increase collector capacity in urban and suburban areas is to install left-turn treatments at intersections. A three-lane roadway, with center-two-way-left-turn-lane (CTWLTL) has a capacity of well over 10,000 vehicles per day (DOTPF uses 15,000 vehicles per day capacity for 3-lanes, others use up to 20,000). However, 3-lane streets generally have little or no utility in street segments with low driveway or cross street density, as is the case here. Furthermore the capacity analyses in Section 6.2.1 and 6.2.2 above show good intersection capacity without main street left turn lanes. And finally, the major street left-turn lane analyses discussed under 7.2.2 Section 7.2.2 above do not indicate a need for left-turn lanes on Raspberry Road, except on the eastbound approach at Sand Lake Road.

The collector's compliance with volume ranges in the OSHP are outside of stated issues for Alaska Administrative Code or Municipality Policy on Traffic Impact Analysis. Instead, the real issues are capacity and safety, which are independent of functional classification, and are addressed in this TIA. In conclusion, the impact of the volumes exceeding the collector street recommended policy ranges are negligible, but are addressed under capacity impacts where necessary.

8.2 Sand Lake Road-Raspberry Road-South Airpark Drive Intersection

8.2.1 Incremental Impacts

The following table summarizes the performance measures for the northbound and southbound approaches of the intersection (condensed information from Table 5, Table 6, Table 7, and Table 8 beginning on page 28).

Case	Northbound Sand Lake Road		Southbound South Airpark Drive		Comments
	Average Approach Delay, Number of Vehicles Affected	Approach LOS	Average Approach Delay Number of Vehicles Affected	Approach LOS	
2009 Existing	96 s/veh for 51 veh	F	106 s/veh for 89 veh	F	←This analysis uses existing PHF
2010 Background	50 s/veh for 54 veh	E	48 s/veh for 89 veh	E	←These analyses use an assumed PHF=0.95; NB delay with site traffic increased by 26%; SB delay increased by 25%
2010 Site Traffic with Background Traffic	63 s/veh for 54 veh	F	60 s/veh for 89 veh	F	
2017 Background	138 s/veh for 69 veh	F	94 s/veh for 89 veh	F	←These analyses use an assumed PHF=0.95; NB delay with site traffic increased by 110%; SB delay increased by 85%
2017 Site Traffic with Background Traffic	291 s/veh for 69 veh	F	173 s/veh for 89 veh	F	
2027 Background	690 s/veh for 88 veh	F	273 s/veh for 89 veh	F	←These analyses use an assumed PHF=0.95; Increase estimates are not meaningful
2027 Site Traffic with Background Traffic	Not Meaningful	F	Not Meaningful	F	

Table 19- Summary of Unsignalized Approaches Performance Measures, Sand Lake Road-Raspberry Road- South Airpark Drive

Capacity analysis computations indicate that the unsignalized movements are at a LOS F currently, and will continue to be F through the study duration with only the background traffic. In these situations, the Municipality *Traffic Impact Analysis Policy* and Alaska Administrative Code provide this direction:

> *If a roadway has unacceptable LOS without traffic generated by the development, either at the opening date of the development or in the design year of the development, a developer shall make improvements to the roadway so the operation of the roadway does not deteriorate more than 10 percent in terms of delay time or other appropriate measures of effectiveness with the addition of the traffic generated by the development at the opening date of the development or in the design year.*

In all case years shown in Table 19 , the site traffic impacts creates approach delays in excess of 10% of the years with only the background traffic. On this basis of evaluation, mitigation measures would be justified. Another viewpoint would be to compute average total average delay for all entering vehicles, including those that are on the free-flow approaches. The following table presents these results.

Year (Assumed Level of Development)	**Intersection Average Delay for All Entering Vehicles**		**% Change**
	Background Traffic Only (s/veh)	**Site Traffic with Background Traffic (s/veh)**	
2010 (1/2 Phase 1)	8	11	+45% (overall delay is increased)
2017 (Phase 1 complete)	21	33	+57% (overall delay is increased)
2027 (Phase 2 and 3 complete)	75	>75	Increase is not measureable, likely far more than 10%

Table 20- Overall Intersection Delay, All Entering Vehicles, Sand Lake Road-Raspberry Road- South Airpark Drive Intersection

Table 19 and Table 20 results indicate that there is an impact caused by the South Airpark Expansion that requires mitigation per the Alaska Administration Code and Municipal Policy.

8.2.2 Mitigation Alternatives

8.2.2.1 <u>Eastbound Left-turn Lane; Travel Demand Management</u>

This Alternative would construct the 200-foot eastbound left-turn lane that is discussed under Section 7.2.2 above. This improvement would not improve the northbound and southbound stop approach delay. However, the lane would reduce Raspberry eastbound through delay and marginally reduces the overall intersection delay. More importantly it will reduce the probability of rear-end crashes that may be the result of increased congestion from the additional site development traffic. Because there is a painted median area that could be converted to an eastbound left-turn lane, an eastbound left-turn lane should be considered with the opening of the 2010 Phase 1 development.

Travel Demand Management strategies for tenants of the South Airpark may include staggered work hours that would distribute peak hour traffic in time over a longer period, and perhaps outside of the peak hours of the adjoining roadway. Also, South Airpark commuters might be encouraged to use alternative travel modes (transit, bike walking, rideshare), thereby removing the trips from the roadways.

The effectiveness of these measures may not be quantifiable, and may not be adequate for 2017 or 2027 traffic that will be generated in Phase 2 and 3 of the development.

8.2.2.2 Signalization

Signalization would reduce delay for the northbound and southbound traffic currently controlled by the stop signs. However, it would likely impose delay for the Raspberry Road eastbound and westbound traffic, which currently is free-flow, and may increase overall average delay for the intersection.

In order to be signalized, an intersection should satisfy one or more warrants set forth in the *Manual of Uniform Traffic Control Devices* (MUTCD). These warrants are described in more detail under Appendix H.

These warrants were applied to the traffic volumes that were recorded in September 2009 and summarized in the following table. It should be noted that there were seven hours of turning movement counts recorded. Those hours without hand counts used the machine counts on South Airpark Drive and the average hourly distributions from the Sand Lake Road permanent traffic recorder to estimate turning movement volumes. Right turn volumes were not included as warrant volumes on the minor approaches.

MUTCD Warrant	Criteria	Condition	Criteria	Condition	Results	
Warrant 1- 8-Hour Vehicular Volume, Condition A- Minimum Vehicular Volume	8 hours	0 hours			Warrant 1A Met?	No
Warrant 1- 8-Hour Vehicular Volume, Condition B- Interruption of Continuous Traffic	8 hours	2 hours			Warrant 1B Met?	No
Warrant 1- 8-Hour Vehicular Volume, Combination of A & B	8 hours	1 hours			Warrant 1 Combination of A & B Met?	No
Warrant 2- 4-Hour Vehicular Volume	4 hours	1 hours			Warrant 2 Met?	No
Warrant 3- Peak Hour Volume	1 hours	0 hours			Warrant 3 Met?	No
Warrant 7- Crash Experience	8 hours	5 hours	5 Crashes	3 Crashes	Warrant 7 Met?	No
Warrant 8- Roadway Network	Warrants 1, 2, or 3 Satisfied in 5 Years?	Yes	>1000 Entering Vehicles	1,327	Warrant 8 Met?	No (not a major intersection)

Table 21- 2009 Signal Warrants, Sand Lake Road-Raspberry Road- South Airpark Drive Intersection

Only 1 warrant, Warrant 8- Roadway Network, meets volume criteria, but this warrant should only be applied to major intersections. Warrant 8 justifies the signalization based on current poor level of service conditions combined with the strong likelihood of meeting a volume warrant (1, 2 or 3) within 5 years of the analysis. Since the intersection is formed from minor arterials on the Sand Lake Road leg and Raspberry Road east leg, a collector on the Raspberry west leg, and a local street on the Airpark north leg; the intersection is not considered a “major” intersection. As such, Warrant 8 would not apply here even though volumes are satisfied.

As a check, the analysis was re-run with 2015 volumes that were increased at 2.5% per year. The five year forecasts were based on an average growth rate of about 2.5% per year, derived from the segment volumes presented in Figure 10 on page 24. Under these conditions only Warrant 3- Peak Hour Volume would be satisfied and the Peak Hour Volume typically isn’t applied except in cases of an extreme generator. Warrant 2- 4-Hour Vehicular Volume is forecasted to be satisfied by 2018 under the background volume conditions.

With the addition of the 2010 Phase 1 site traffic volumes, Warrant 2- 4-Hour Vehicular Volume is forecasted to be satisfied by 2015; and Warrant 1, Condition A, Condition B, and Combination A and B would likely be satisfied by 2025.

The following table present signal evening peak hour operations for intersection volumes that include background and site generated traffic. The intersection is assumed to have:

- Northbound right-turning lane that by-passed the signal,
- Eastbound and westbound permissive-protected left-turn phasing,
- Northbound and southbound permissive left-turn phasing,
- Left-turn lanes on all approaches, and
- Fully-actuated, uncoordinated operations.

Year	Actuated Cycle Length (sec)	Intersection v/c Ratio	Average Control Delay (sec)	Level of Service
2010 (signal not warranted)	47.4	0.51	8.9	A
2017	57.5	0.58	11.6	B
2027	94.5	0.82	30.7	C

Table 22- Signalized Operations, Sand Lake Road-Raspberry Road- South Airpark Drive Intersection

The conceptual lane configurations for the signalization of the intersection are presented in the following figure.

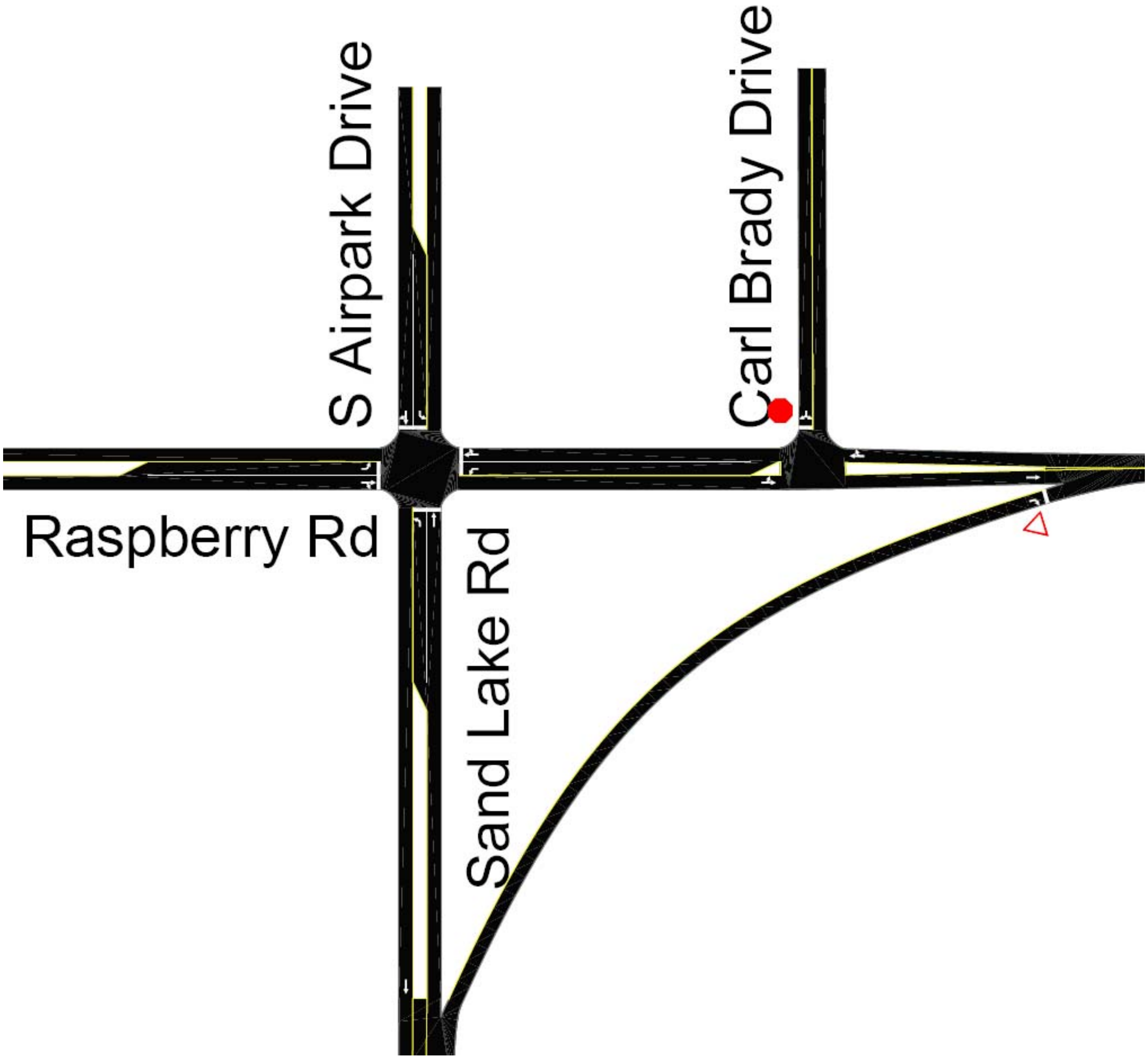


Figure 11- Signalized Intersection Lane Configurations

Finally, when comparing the average delay of the signalized intersection to the average intersection delay in Table 20 with unsignalized operations, it can be concluded that overall delay is reduced with signalized operations.

8.2.2.3 <u>Modern Roundabout</u>

The MUTCD describes roundabouts as good alternatives to signals, offering good operational performances, as well as crash reduction. NCHRP 457 Table 2-12, provides a framework to determine if a roundabout would be suitable for a location.

This screening analysis assumes one-approaches with a single circulation lane.

Roundabout Suitability Question		**Answer**
1) Will operation as an uncontrolled or two-way-stop-controlled intersection yield unacceptable delay?		Yes
2) Is the daily entering volume less than the maximum service volume for a roundabout? (Use Figure 2-3 of NCHRP 457)		Yes
Circulation Lanes	1	
2027 Entering Volume	20,700	
Maximum Service Volume	30,135	
3) Is the subject junction located outside of the coordinated signal network?		Yes
4) Is the ratio of major-road to minor-road volume less than 5?		Yes
Major-Road Entering Volume	13,500	
Minor-Road Entering Volume	7200	
5) Is the entering drivers view free of sight obstructions?		Yes
6) Will the subject junction infrequently be used by large or oversized trucks?		No
7) Will the subject junction infrequently be used by pedestrians and bicyclists?		No
[redacted]	Yes	5
	No	2

Table 23- Roundabout Suitability Questions

As NCHRP 457 points out, the more frequently that these questions are answered with “Yes”, then the more likely that this intersection would work well as a roundabout.

The 2027 background with site volumes were evaluated using the roundabout capacity analysis methodology found in NCHRP 572. The following table summarizes operations for single and multi-lane roundabout options.

Results	**N**	**E**	**S**	**W**
Single Lane Approaches, Single Circulation Lane				
Entry Capacity, pcu/h	408	1016	580	584
Leg v/c ratio	0.24	0.93	0.46	1.21
Control Delay, s/pcu	11.6	30.1	11.3	129.4
LOS	B	D	B	F
Double Approach Lanes East and West Legs, Single Approach Lanes North and South Legs, Double Circulation Lanes				
Crit. Entry Capacity pcu/h	554	1049	707	712
Crit. Lane Entry Flow pcu/h	97	479	265	408
Leg v/c ratio	0.17	0.46	0.38	0.57
Control Delay s/pcu	7.9	6.3	8.1	11.6
LOS	A	A	A	B

Table 24- 2027 Roundabout Operations, With Site Traffic, Sand Lake Road-Raspberry Road- South Airpark Drive Intersection

A multi-lane roundabout is required to attain acceptable levels of service.

8.3 Raspberry Road, Tanaina Drive, and Access Road 1

8.3.1 Channelization and Travel Demand Alternative

The southbound approach (Access Road 1) will have about 60 seconds of delay per vehicle in 2027, and will operate at a LOS of F (see Table 13 on page 35). This LOS only affects the traffic generated by the development. The approach LOS should operate at LOS C or better up until the development is completed. The LOS on all other approaches is acceptable (C or better) through the duration of the study period.

A change in control to signal or roundabout would not likely be feasible at this location. The approach could be expanded to allow a 100-foot length southbound right-turn lane to be constructed. The right-turn lane will not improve LOS for the left-turn demand, but will allow the occasional right-turn vehicle to proceed without significant delay.

Travel demand management might be implemented by the tenants of the Airpark Expansion, and may include alternative modes of travel, and flexible working hours.

8.3.2 Frontage Road Connection to South Airpark Drive

This alternative would construct a parallel frontage road to Raspberry Road and eliminate Access Roads 1, 2, and 3 connections to Raspberry Road. All site generated traffic would pass through the north leg of the Sand Lake Road-Raspberry Road- South Airpark Drive Intersection, and the LOS issues for the southbound approach of Access Road 1 approach would be solved.

The following table presents operations with the additional traffic through the South.

Year	Actuated Cycle Length (sec)	Intersection v/c Ratio	Average Control Delay (sec)	Level of Service
2010	49.1	0.51	10.1	B
2017	55.2	0.61	12.1	B
2027	76.7	0.83	28.7	C

Table 25- Signalized Operations, Sand Lake Road-Raspberry Road- South Airpark Drive Intersection, with Frontage Road Connection to South Airpark Drive

The intersection geometrics that are presented in Figure 11 on page 51 would be satisfactory with Phase 1 through 3 development volumes using the frontage road.

8.4 Carl Brady Drive and Raspberry Road

As summarized in Table 15 on page 37, the Carl Brady approach has a 2017 LOS of C with only background traffic, but D with site traffic added to the system. 2027 operations without site traffic is D, and with site traffic is F (54 seconds of delay per vehicle). Geometric or control alternatives are probably not feasible at this location. Travel demand management might be implemented by the tenants of the South Airpark, and may include alternative modes of travel, and flexible working hours.

Also, if signalization is implemented at the Sand Lake Road-Raspberry Road- South Airpark Drive Intersection, the signal phasing will create gaps that should enhance opportunities to turn onto Raspberry Road.

APPENDIX A

Scoping Meeting Summary

Agenda

Traffic Impact Analysis Scoping Meeting- *Minutes and Actions 9-22-09*

Date: September 16, 2009
MOA Traffic Conf. Room, 10:30 AM

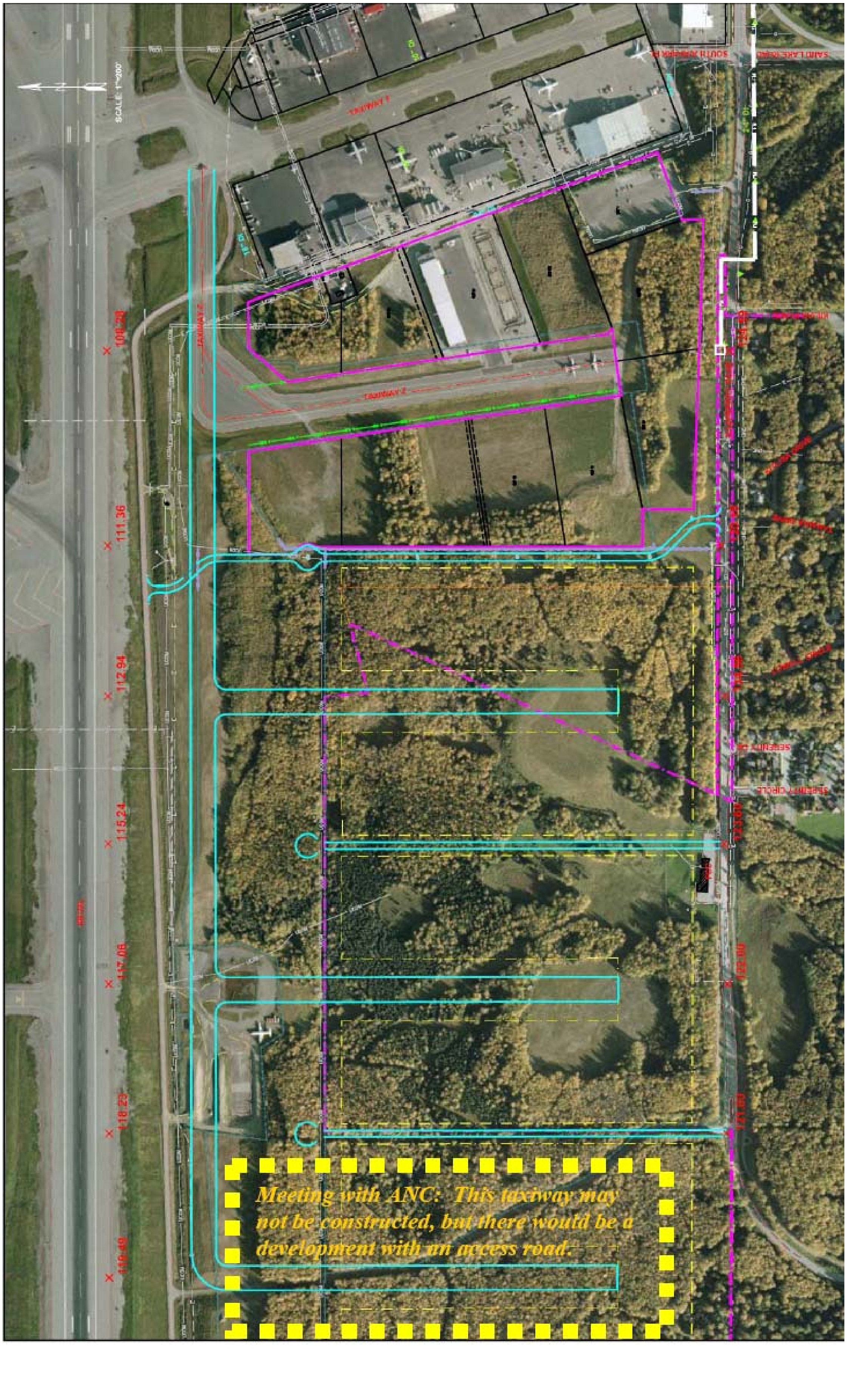
Purpose of meeting:	Determination of the scope of the TIA for the proposed development

For: AIA Expansion Project

Attendees:	Bob Kniefel; Traffic Section, MOA; Scott Thomas, ADOT; Randy Kinney, Kinney Engineering LLC; Karyn Wise, Kinney Engineering, LLC.
Please bring:	Project description (location, size, number and location of driveways), trip generation rates, trip distribution, study area, and any other relevant data

Agenda topics	Proposed:	Action (After Mtg):
Trip Generation Rates➔	*Propose to use Trip Gen 8th ed, and/or use existing counts to project new trips. (Trip Generation doesn't have a LU category, meeting with ANC today to discuss development)*	*Trip Gen won't work; In our meeting with ANC Engineering Staff, they indicated that the each of the 3 new modules would likely be similar to the existing development served by South Airpark Place. As such a conservative method would be to use the South Airpark Place traffic counts to estimate generation.*
Trip Distribution➔	*Propose to distribute trips by %, according to directional distribution of Raspberry Road, Sand Lake Road.*	*Background trips, use current distribution. Proposed development will be oriented towards east (no or few trips with O or D towards Kincaid Park.*
Study Area – Roadway and Intersections to be Studied➔	*TBD at Meeting (see attached figure)*	*Sand Lake-South Airpark-Raspberry intersection, all local intersections between SLR and Park entrance.*

Design Year/Design Hour	*From current intersection counts, the existing facility generates>100 trips per hour. Expansions may triple that, so new development will generate >250 trips/hour.* *We are meeting with ANC today to determine opening and full-buildout schedule; and to determine development levels.* *State DOT requirement AAC 17: Design Year is full buildout year, to be determined in a meeting today with ANC .* *MOA requirement: Design Year is buildout year, or depending upon facility, may be build out year +10 years (typical).*	*Bob and Scott- Design Hour PM, Design Year should be buildout +10 years, but may be PM hour in 2027 (for convenience to match AMATS Travel Demand Model).* *Our meeting with ANC indicates that they believe that the modules will be developed east to west, on about 10 year intervals. The first will be fully developed in 2019, the 2nd by 2029, and the final one by 2039.* *We will check the assumption that all modules will be developed by 2027; and if there are operational issues, we will use the planned ANC phasing.*
Existing Data - volumes, geometrics, accidents	*ADOT ADT Counts,* *MOA counts;* *Counts by Kinney Engineering in 2009;* *ADOT Accident Records.*	*In addition, we'll get the DSR for Raspberry Road from CRW to check previous volume assumptions.*
➢ Background Traffic Growth➔	*Use 2009 data and AMATS model 2027 forecasts to interpolate background traffic for Design Year.*	*Use 2027 volumes from AMATS model as background. We will adjust the AMATS model for local conditions.*
➢ Other Development to be Included➔	*If we use AMATS for Background, this may not be required.*	None
Construction Projects Within Study Area	*TBD at Meeting*	None
Circulation Issues (see site plans)	*TBD at Meeting*	None
Other (brought up in meeting): ➢ Fire Department ➢ Access Road to Lake ➢ ➢		*We will check with Fire Department to ascertain their requirements for frontage roads (two access points vs. cul-de-sac).* *Access to Beer Can Lake? ANC indicates that it will be maintained or re-established.*


Meeting with ANC: This taxiway may not be constructed, but there would be a development with an access road.
108.28
111.36
112.94
115.24
117.06
118.23
119.49

APPENDIX B

Existing South Airpark Occupancy

This occupant list and location was obtained by a drive-by survey.

Building #	Description
1	No name on building other than street address.
2	Phillips 66 Aviation
3	UPS
4	Northern Air Aviation Services
5	Lynden Air Cargo, 2 buildings
6	No name on building other than street address.
7	Signiature Flight Sevices
8	Great Circle Flight Services LLC
9	Security Aviation
10	Anchorage Executive Park (2 new buildings, 1 still under construction, but almost complete)
11	No name on building other than street address.
12	Aviation Instrument Repair
13	Era Aviation
14	GSE Million Air
15	Bell Helicopter Services
16	American Eurocopter Services
17	Era Helicopters
18	Era Aviation
19	Million Air
20	AVFuel

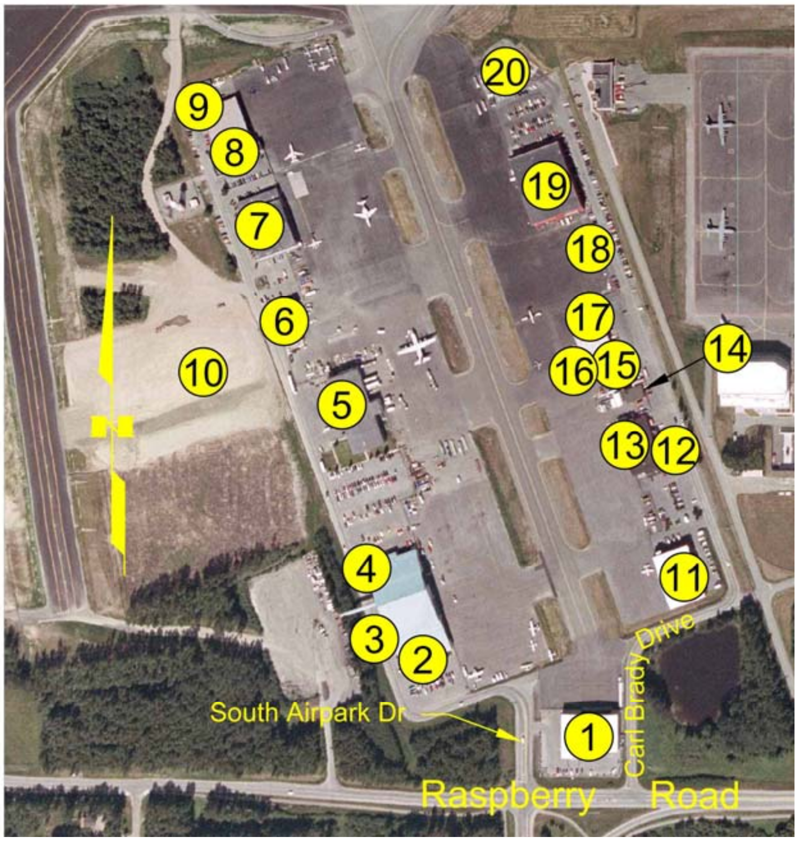


Figure 12- Appendix B: Existing Occupancy

APPENDIX C

Existing Peak Hour Turning Movements Peak Hour Factor, % Trucks and Busses

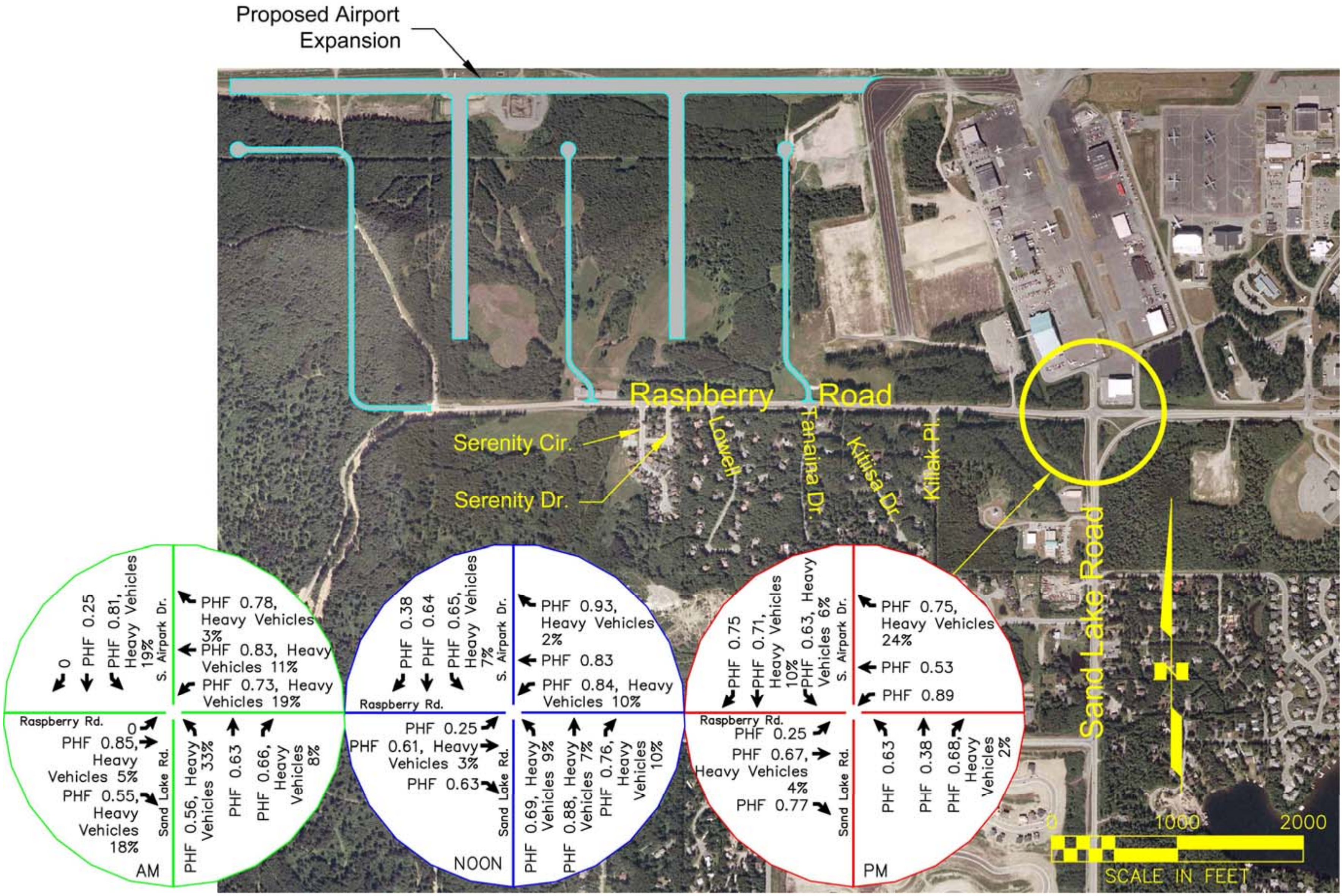


Figure 13- Appendix C: PHF and % Commercial Vehicles, 1

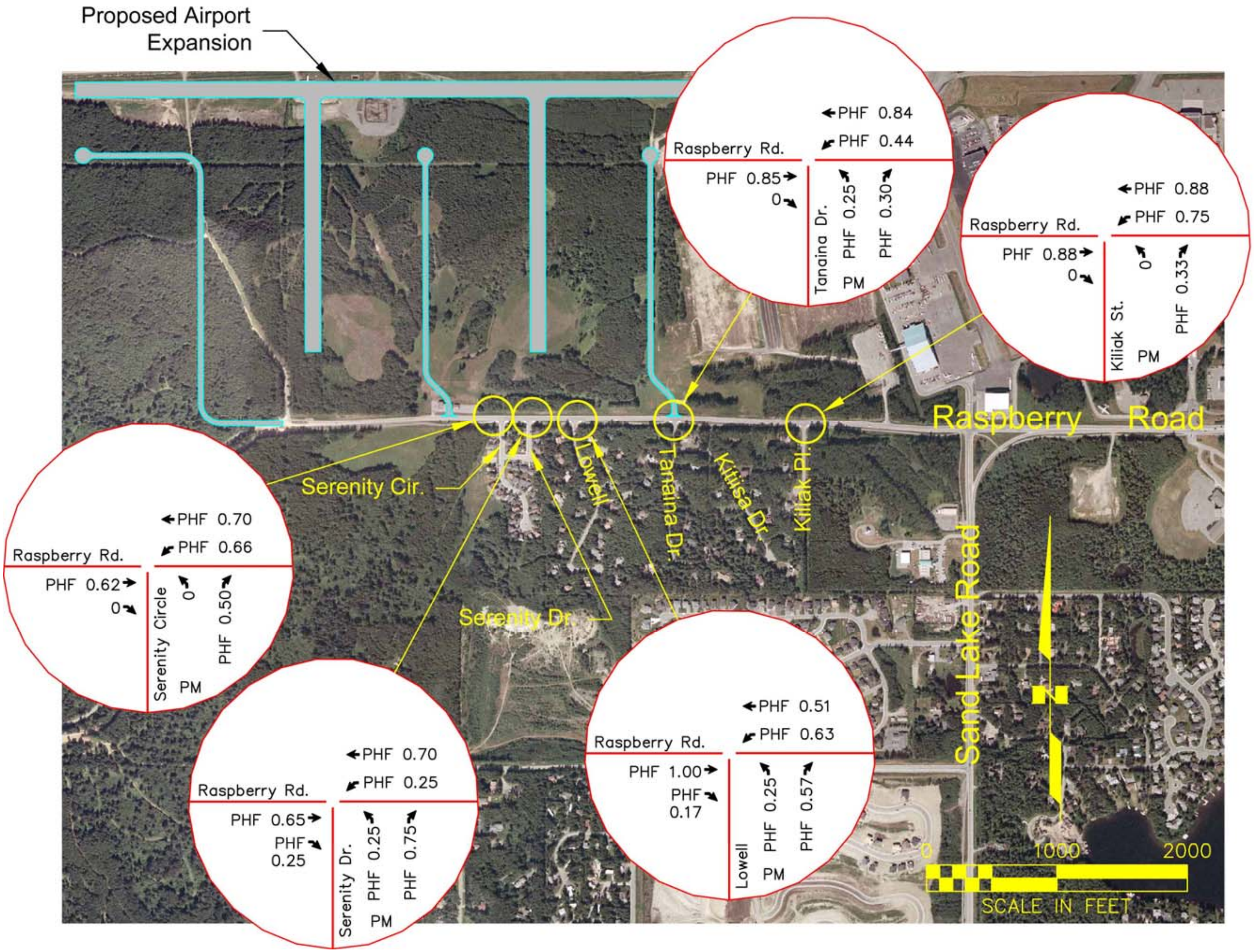


Figure 14- Appendix C: PHF and % Commercial Vehicles, 2

Appendix D

Crash Evaluation Methodology

The accident evaluation methodology uses elements from the *Highway Safety Improvement Program Handbook* 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.

Intersection accident rates are calculated with the following formula:

Equation A1. $$R = \frac{1{,}000{,}000 \times A}{365 \times N \times V}$$

The variables in this equation are:

R= Accident rate for the intersection expressed as accidents per million entering vehicles (MEV),
A= Frequency of accidents in the study period,
N= Number of years of data,
V= Traffic volumes entering the intersection daily, usually ½ of the sum of the Average Annual Daily Traffic (AADT) volumes on the intersection's legs for two way approaches, or the sum of entering AADT volumes on one-way approaches.

Segment rates are defined as:

Equation A2. $$R = \frac{1{,}000{,}000 \times A}{365 \times N \times ADT \times L}$$

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

Rate analysis is especially useful when there is a population of facilities to which we can compare the study area. ADOT&PF has developed statewide populations for segments and intersections, and provides this data in the HSIPHB and supplements and the annual *Traffic Accident Report*.

We can calculate accident rates using Equation A1 or A2 to compare the facility to the corresponding like State of Alaska accident populations. However, by only comparing the rate of the facility under analysis to an average, we may erroneously infer that those facilities with higher than average rates are problem areas.

Instead, we would like to establish an upper limit for the rate that is our threshold of concern. The Rate Quality Control Method establishes an upper control limit (UCL) to determine if the facility's accident rate, as calculated in Equation 1, is significantly higher than accident rates in facilities with similar characteristics. The UCL is determined statistically as a function of the statewide average accident 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 A3. $$UCL = Ra + Z \times \sqrt{\frac{Ra}{M}} + \frac{1}{2 \times M},$$

The variables in this equation are:

- R_a= Average Accident Rate for the population in accidents per MEV (intersections) or accidents per MVM (road segments);
- M= Facility Exposure in MEV for the intersections or MVM for roadway section;
- Z= Normal Distribution Transformation Variable (1.64 for 95% confidence)

Intersections or segments with rates that exceed the UCL are considered truly to have an accident rate above average.

APPENDIX E

Base Turning Movements (Without Site Traffic)

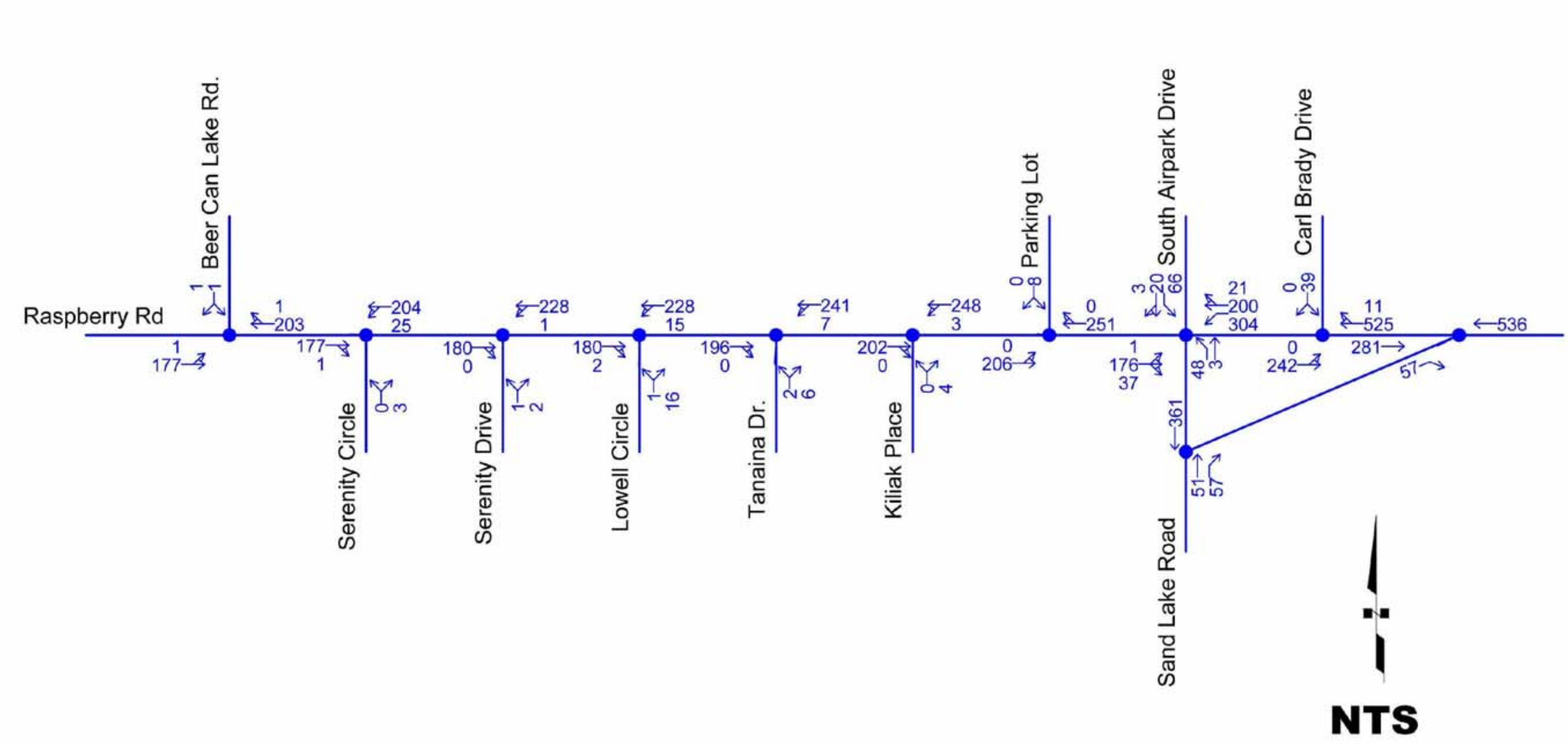


Figure 15- Appendix E: 2009 Background Traffic Turning Movement Counts

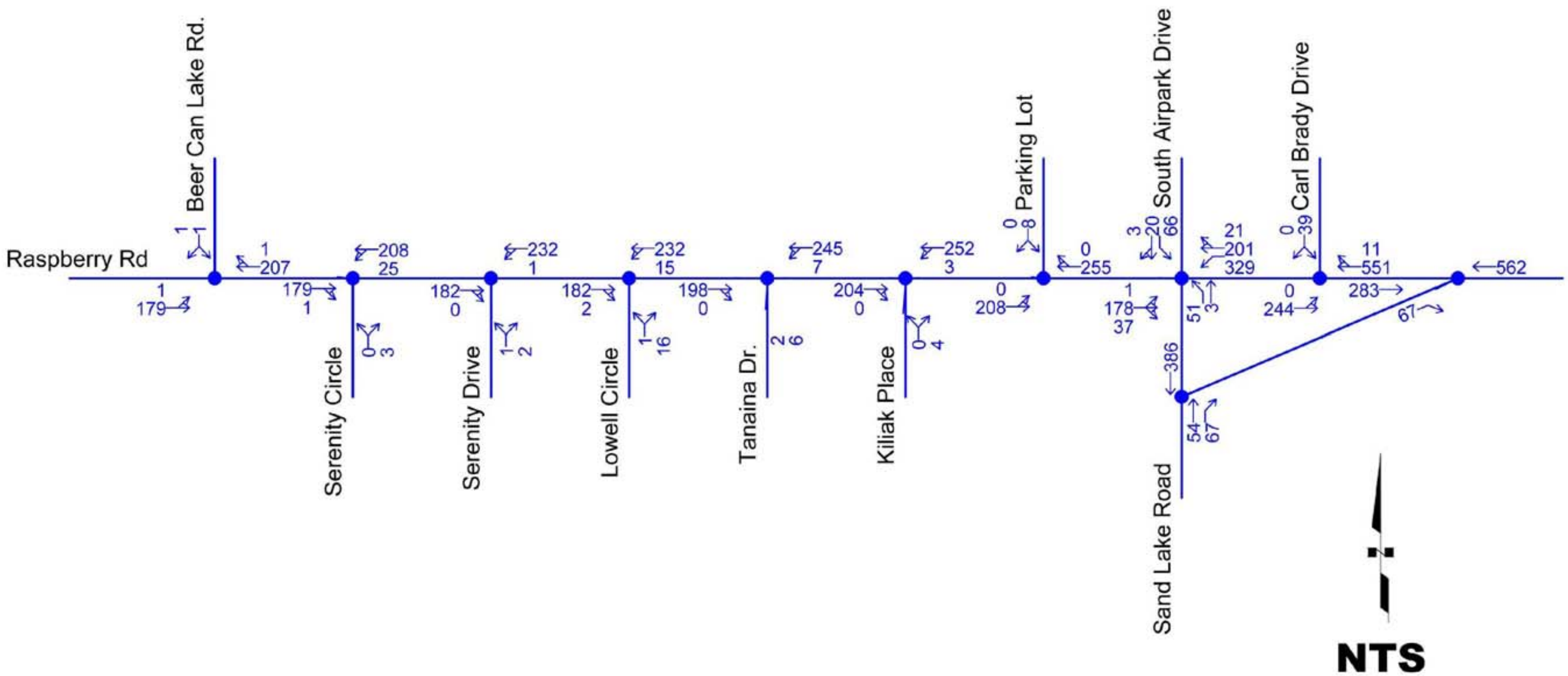


Figure 16- Appendix E: 2010 Background Traffic Turning Movement Counts

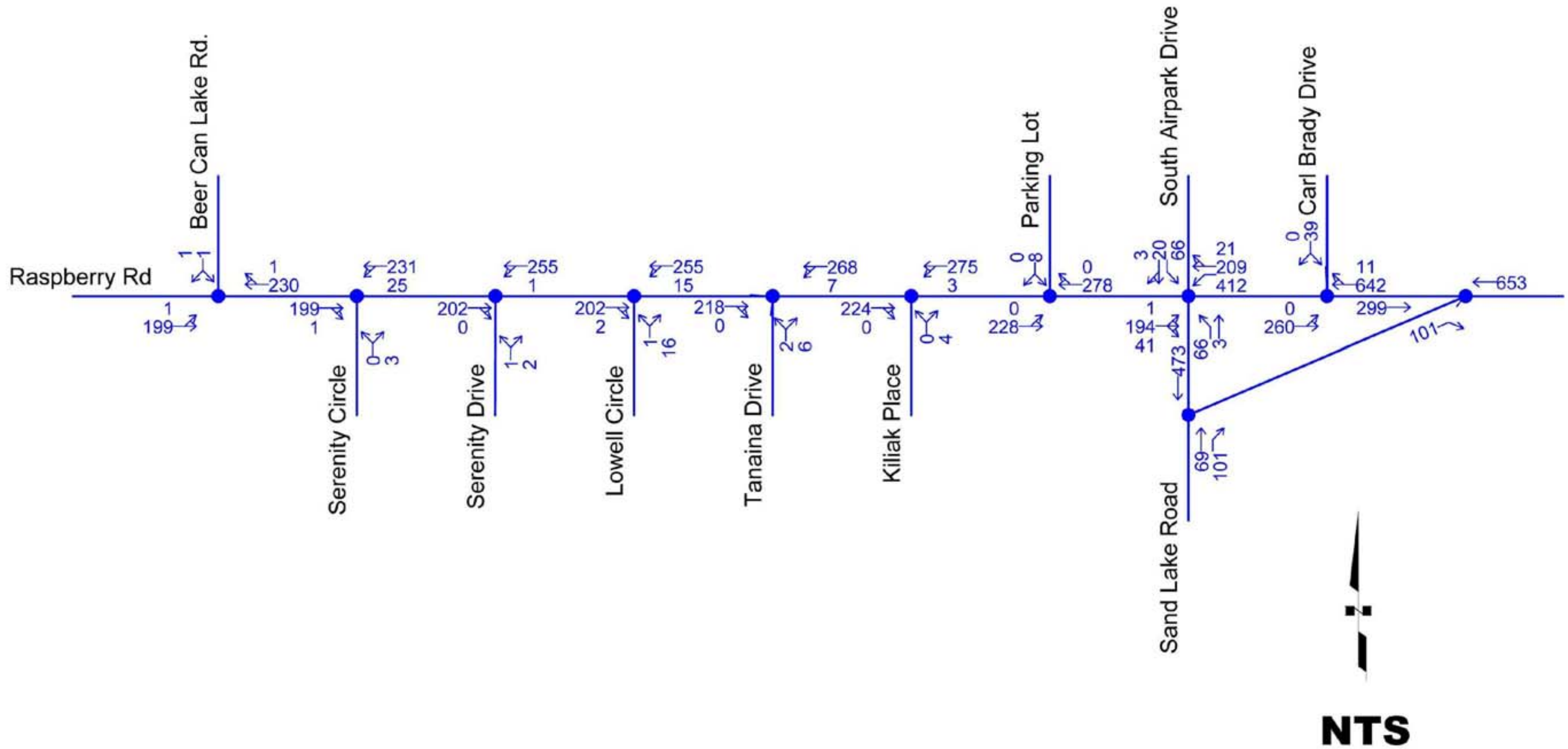


Figure 17- Appendix E: 2017 Background Traffic Turning Movement Counts

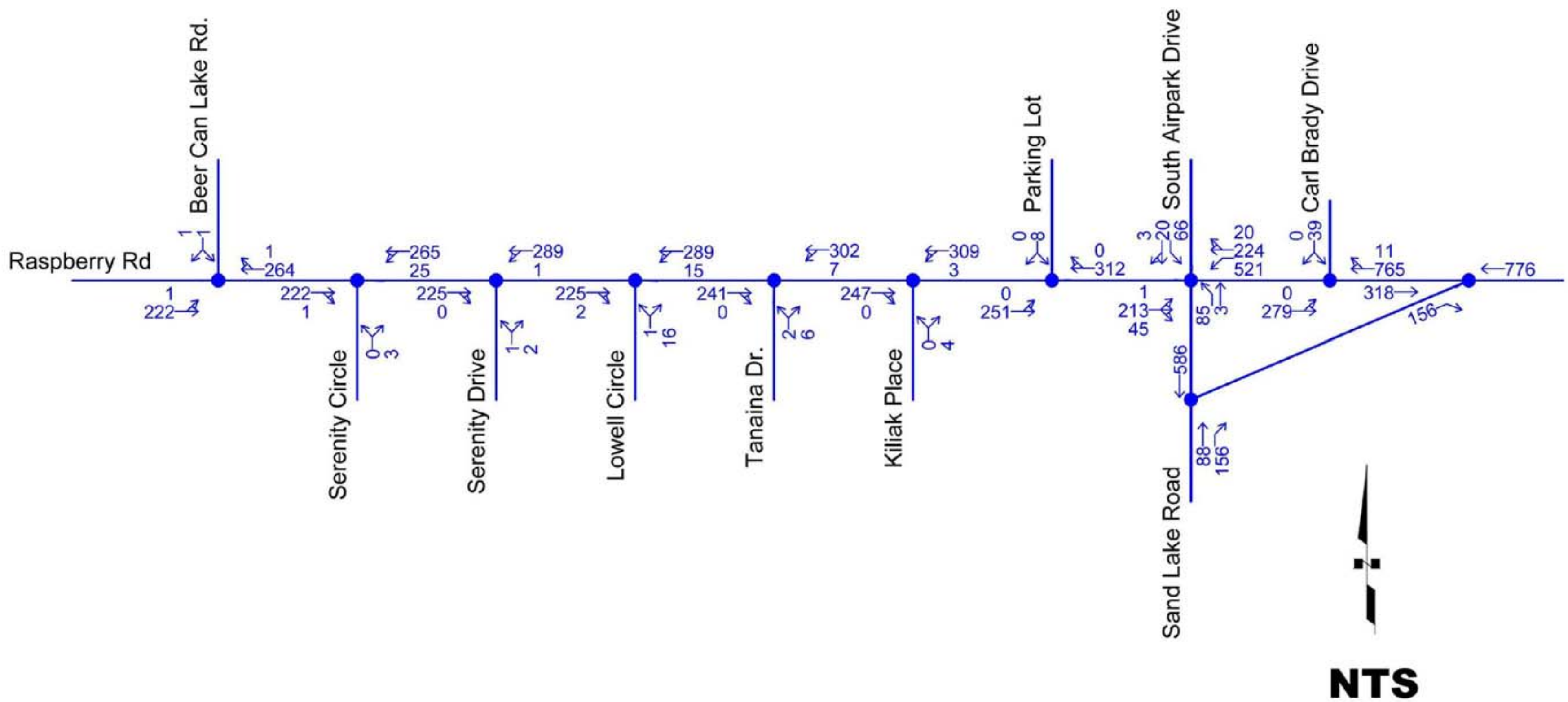


Figure 18- Appendix E: 2027 Background Traffic Turning Movement Counts

APPENDIX F

Design Turning Movements (With Site Traffic)

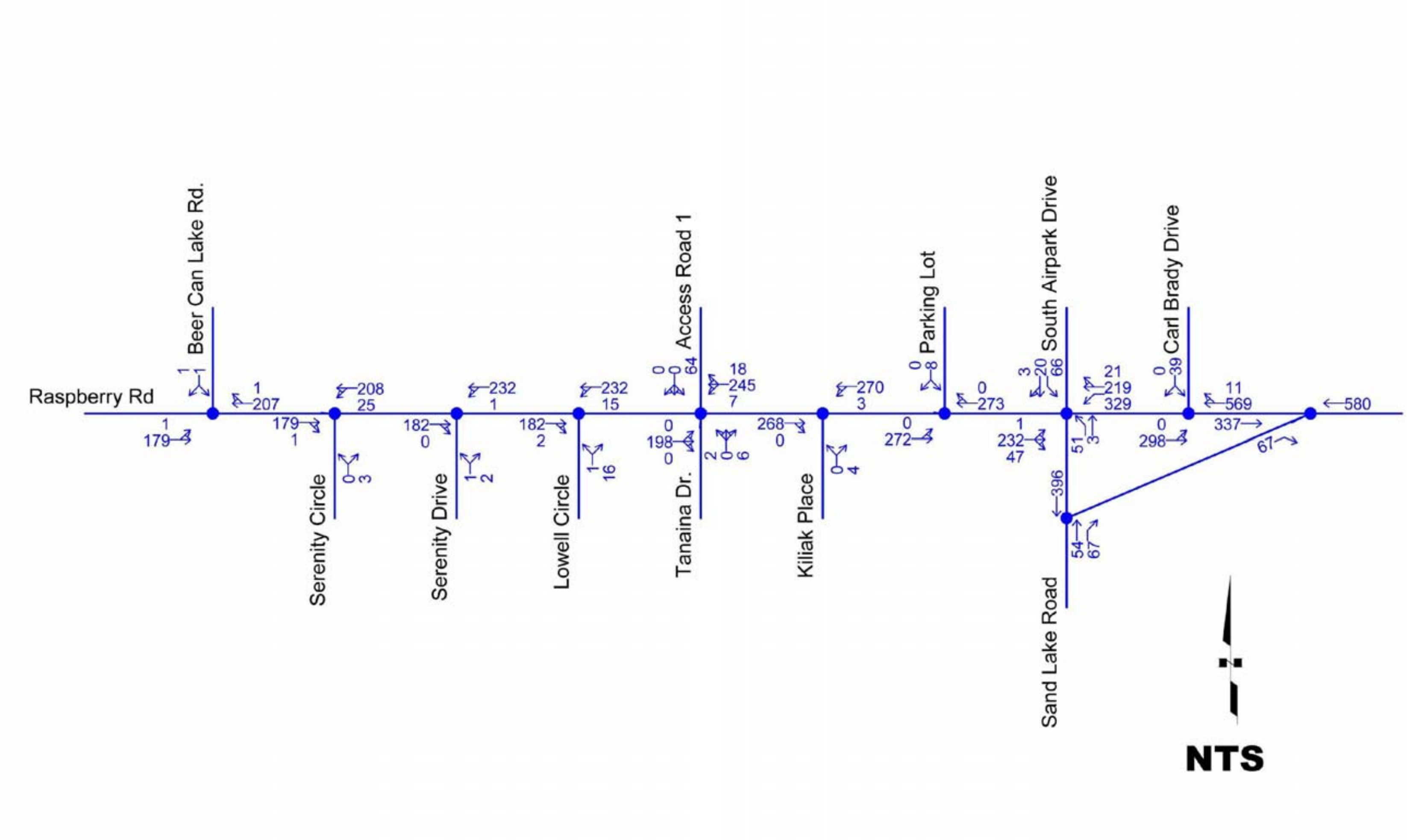


Figure 19- Appendix F: 2010 Design Traffic Turning Movement Counts

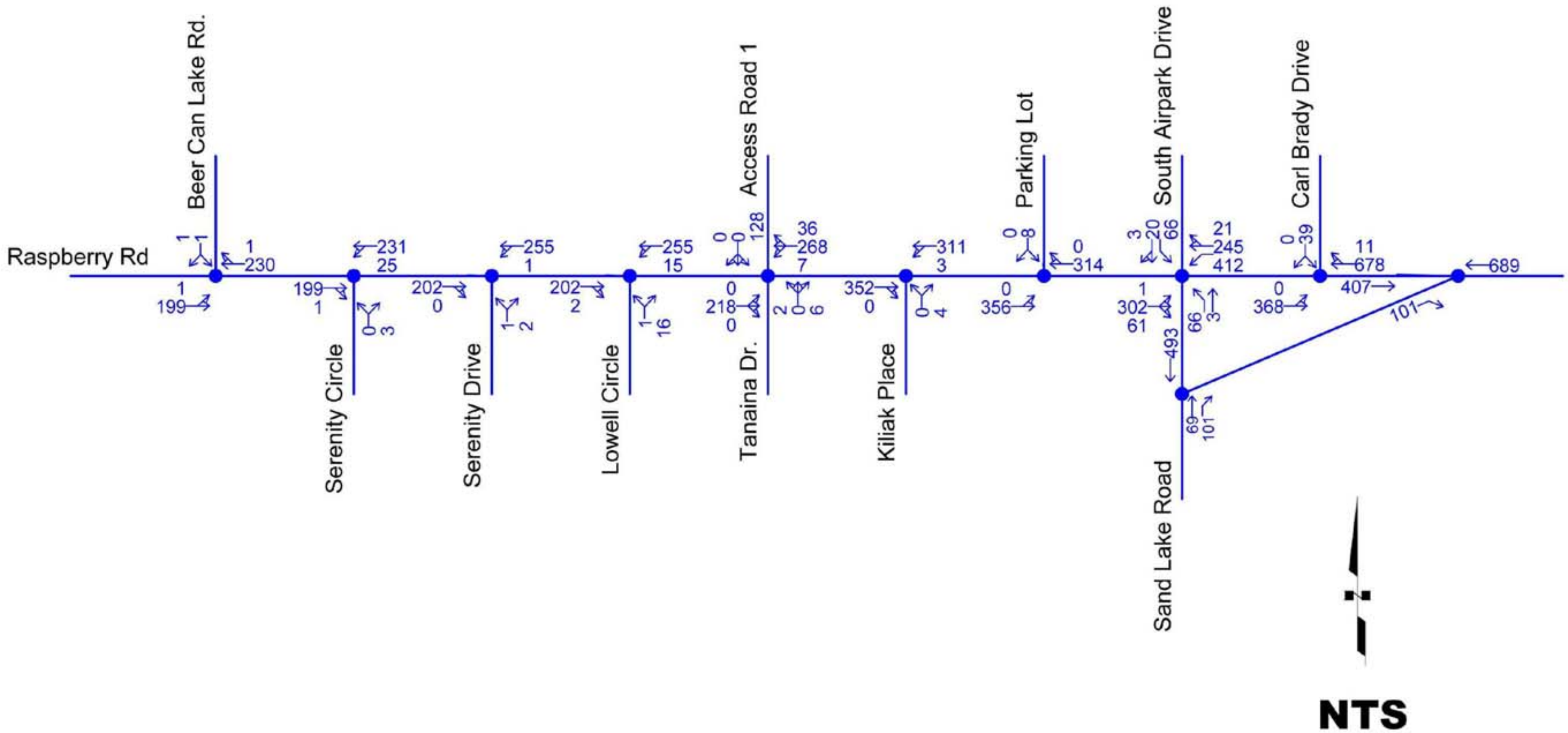


Figure 20- Appendix F: 2017 Design Traffic Turning Movement Counts

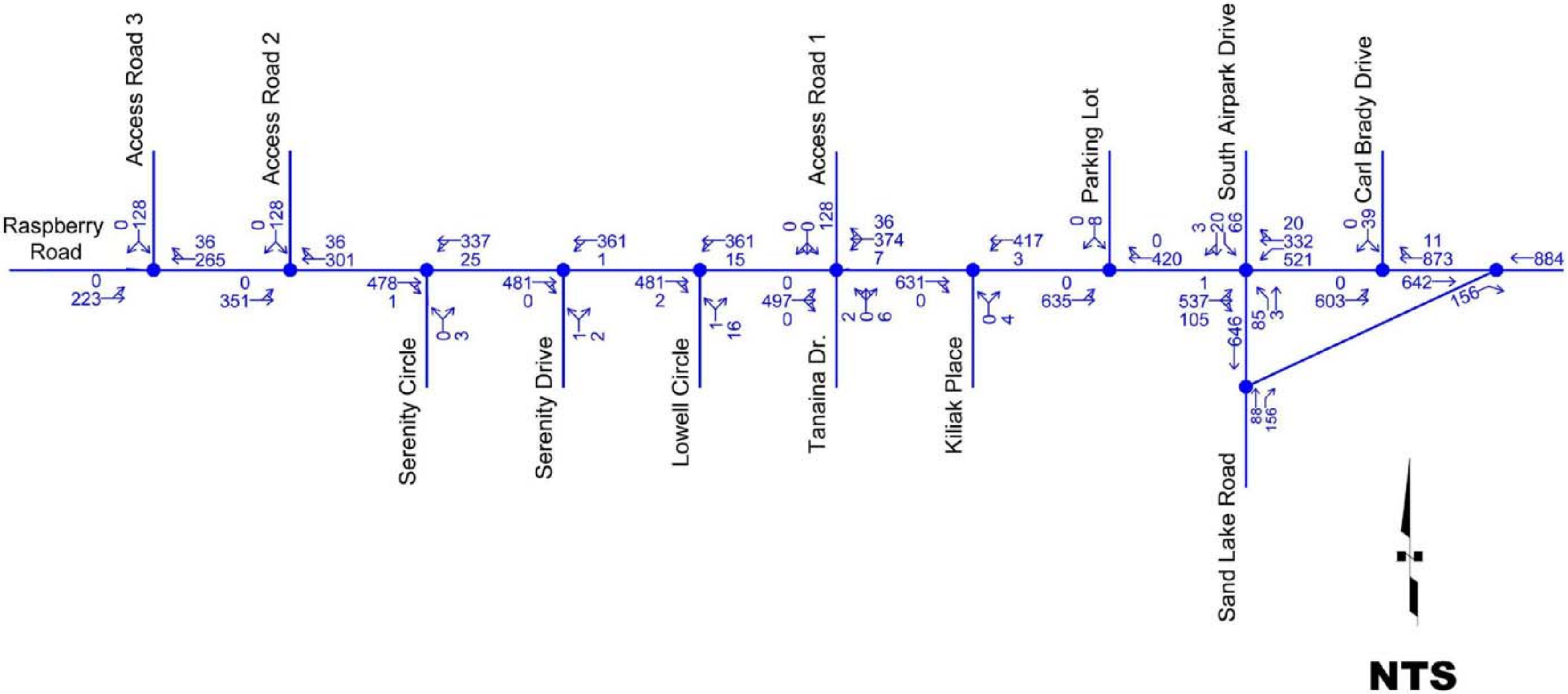


Figure 21- Appendix F: 2027 Design Traffic Turning Movement Counts

APPENDIX G

Signalized Intersections Performance Measures

The following narrative from Chapter 9 of the 1997 HCM defines LOS for signalized intersections. (Note that these definitions have not changed with the 2000 edition of HCM)

- LOS A describes operations with very low control delay, up to 10 seconds per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

- LOS B describes operations with control delay greater than 10 and up to 20 seconds per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

- LOS C describes operations with control delay greater than 20 and up to 35 seconds per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

- LOS D describes operations with control delay greater than 35 and up to 55 seconds per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high v/c ratios. Many vehicles stop and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

- LOS E describes operations with control delay greater than 55 and up to 80 seconds per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high v/c ratios. Individual cycle failures are frequent occurrences.

- LOS F describes operations with control delay in excess of 80 seconds per vehicle. This level, considered unacceptable to most drivers, often occurs with over saturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high v/c ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing factors to such delay.

Unsignalized Intersections Performance Measures

Intersection capacity analysis was performed in accordance with the procedures outlined in Transportation Research Board Highway Capacity Manual 2000 (HCM) for interrupted flow facilities, using Highway Capacity Software 2000 by McTrans.

The operational performance measures used for this intersection analysis are levels of service, control delay (seconds delay per vehicle), and volume to capacity ratio, v/c. A common limit for v/c values is 0.85, or 85% of capacity. This upper value represents good design practice, in that there is some reserve capacity to absorb surges in volumes or flow turbulence.

The methodology for unsignalized intersections only computes LOS for the minor movements of the intersection, which include the minor street approaches under sign control, or major movements that must yield to oncoming traffic, such as left-turning traffic. Unsignalized LOS is defined as follows (HCM Exhibit 17-2):

- 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

Pedestrian Crossing Performance Measures Performance Measures

The minimum gap time for crossing uncontrolled streets is computed with the following formula (from ITE's *A Program for School Crossing* and HCM 2000 Chapter 18, Equation 18-17 and 18-20):

$$t_G = \frac{L}{S_P} + t_s + 2(N-1)$$

Where:

t_G= critical gap for single pedestrian crossing (seconds)
L= width of crossing (feet)
S_P= walking speed (fps), assumed to b 3.5 fps (from ITE)
t_s= startup time (sec), 3 seconds (from ITE)
N= spatial distribution of pedestrians (rows), N=1, up to 5 children in one crossing.

Percent pedestrian delay, $D_{\%}$, is directly computed from a pedestrian gap study as:

$$D_{\%} = \frac{Time_{Total} - \sum(Gaps \geq t_G)}{Time_{Total}}$$

Where:

$Time_{Total}$= total observation time (seconds)

$\sum Gaps \geq t_G$= sum of individual gap recordings that are equal to or greater than the critical gap crossing (seconds)

The following figure is from *A Program for School Crossing Protection*, Institute of Transportation Engineers (ITE), 1971, which indicates when control (schools) may be needed.

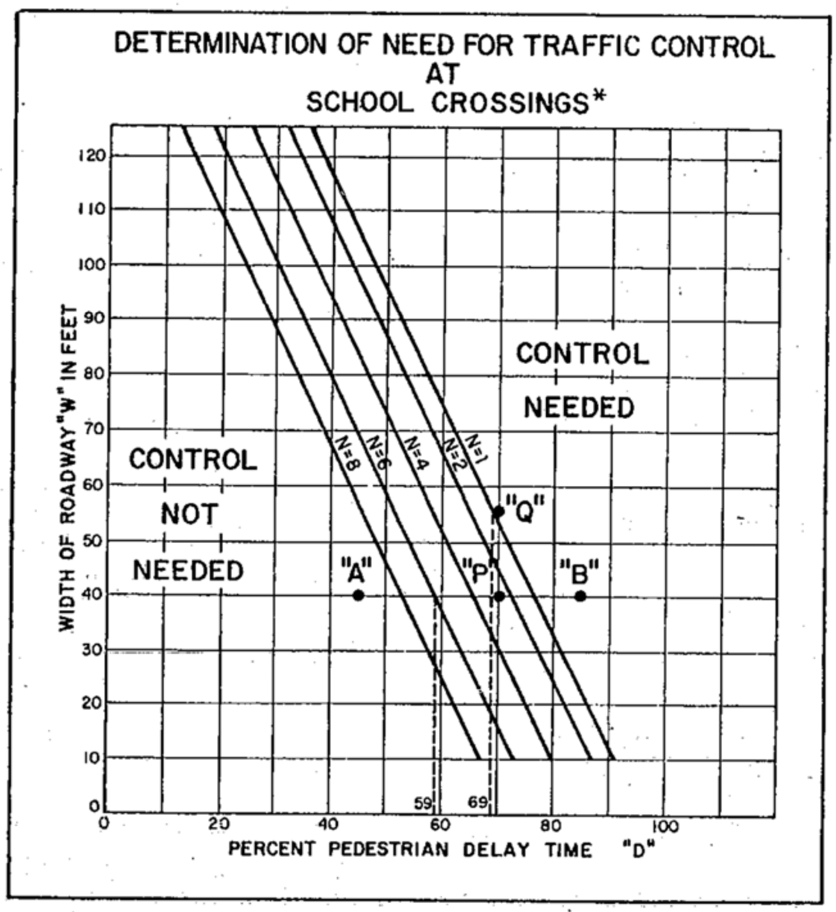


Exhibit No. 2

*See Appendix B, "Analysis of School Crossings at Signalized Intersections", for equation of the family of lines and for the assumption upon which they are plotted.

Figure 22- Appendix G: Exhibit No. 2 From ITE "A Program for School Crossing Protection"

The MUTCD Warrant 5, School Crossing establishes that a signal should be considered where available safe crossing gaps are less than 1 gap per minute on the average, and 20 or more children use the crossing. MUTCD suggests other remedial measures be considered such as signage and flashing beacons, reduced speed zones, crossing guards, and grade separated crossings. Also, ITE's *School Trip Safety Program Guidelines* indicates that there should be at least one gap per minute

Number of adequate crossing gaps per minute, A_{gap} is computed as:

$$A_{gap} = \frac{\sum (Gaps \geq t_G)}{t_G} x \frac{60}{Time_{Total}}$$

If a pedestrian gap study is not available, or if delay and adequate crossing are to be established for future traffic flows, then this information can be computed upon the basis that gaps generally are well modeled with a negative exponential distribution.

For a negative exponential distribution, the probability that a gap exceeds any value "t" is calculated as:

$$P(h \geq t_G) = e^{-vt_G}$$

Where:

t is the critical time, seconds

h is any gap, seconds

v is the vehicular flow rate, vehicles per second (volume in an hour divided by 3,600 seconds). The value v is also the gap flow rate (1 vehicle ≈ 1 gap).

The estimated frequency of gaps in any time bin, h, would be the product of the probability of h by the Volume, V, or:

$$N_h = P(h) \times V$$

And if:

$$P(h) = P(t_{h-i}) - P(t_{h+i})$$

Then:

$$P(h) = e^{-vt_{h-i}} - e^{-vt_{h+i}}$$

Where:

v is the forecasted vehicular and gap flow rate, vehicles (gaps) per second,

t_{h+1}, t_{h-1} are the time bins immediately adjacent to the bin of interest, h.

The following presents the pedestrian unsignalized crossing delay equation from HCM2000. HCM2000 based this equation on pedestrian delay equations in Gerlough & Huber 1975 Special Report 165 *Traffic Flow Theory A Monograph*.

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

Where:

d_P= average pedestrian delay (seconds)

v= vehicular flow rate (vehicles per second)

Gerlough and Huber's derivation for Equation 3 assumes that traffic gaps are in a random traffic flow state, and gaps distributions are represented well by the negative exponential distribution.

HCM Exhibit 18-13 provides pedestrian unsignalized crossing LOS based on delay. This is summarized the following table.

LOS	**Average Delay per Pedestrian**	**HCM2000 Comments on Risk**
A	<5 seconds	Low likelihood of accepting gaps that are less than t_G
B	≥5 and ≤10 seconds	-
C	>10 and ≤20 seconds	Moderate likelihood of accepting gaps that are less than t_G
D	>20 and ≤30 seconds	-
E	>30 and ≤45 seconds	High likelihood of accepting gaps that are less than t_G
F	>45 seconds	Very high likelihood of accepting gaps that are less than t_G

Table 26- Appendix G: HCM2000 Pedestrian Unsignalized Crossing Levels of Service

APPENDIX H

Intersection Signal Warrants

The Manual on Uniform Traffic Control Devices (MUTCD) uses warrants to determine if signal may be used in traffic control. Meeting one or more of the warrants doesn't necessarily mandate a signal, especially where other, less restrictive remedies can be used. The warrants include:

- Warrant 1- Eight-Hour Volume
- Warrant 2- Four-Hour Volume
- Warrant 3- Peak Hour Volume
- Warrant 4- Minimum Pedestrian Volumes
- Warrant 5- School Crossings
- Warrant 6- Coordinated Signal System
- Warrant 7- Crash Experience
- Warrant 8- Roadway Network

The MUTCD warrant system described above only evaluates recent or current conditions. Cal-Trans has a methodology for future signal warrants based that is presented in the Institute of Transportation Engineers (ITE) *Manual of Traffic Signal Design*, Second Edition, by James H. Kell and Iris J. Fullerton. The method uses future estimated average daily traffic (in this case AADT from the demand models) as the input variables and estimates whether the intersection with future estimated average daily traffic would meet the Manual of Uniform Traffic Control Devices signal Warrant 1, Condition A- Minimum Vehicular Volume; Condition B- Interruption of Continuous Traffic; and the combination of warrants allowed in MUTCD procedure.

The method uses future estimated average daily traffic as the input variables and includes the sum of both approach volumes, or AADT for the major road; and highest minor approach entering AADT volume. The following figure provides volume thresholds for the Cal-Trans method from *Manual of Traffic Signal Design*

TRAFFIC SIGNAL WARRANTS

(Based on Estimated Average Daily Traffic—See Note 2)

URBAN ______ RURAL ______		Minimum Requirements EADT			
1. Minimum Vehicular Satisfied ______ Not Satisfied ______		**Vehicles per day on major street (total of both approaches)**		**Vehicles per day on higher-volume minor-street approach (one direction only)**	
Number of lanes for moving traffic on each approach					
Major Street	Minor Street	**Urban**	**Rural**	**Urban**	**Rural**
1	1	**8,000**	**5,600**	**2,400**	**1,680**
2 or more	1	**9,600**	**6,720**	**2,400**	**1,680**
2 or more	2 or more	**9,600**	**6,720**	**3,200**	**2,240**
1	2 or more	**8,000**	**5,600**	**3,200**	**2,240**
2. Interruption of Continuous Traffic Satisfied ______ Not Satisfied ______		**Vehicles per day on major street (total of both approaches)**		**Vehicles per day on higher-volume minor-street approach (one direction only)**	
Number of lanes for moving traffic on each approach					
Major Street	Minor Street	**Urban**	**Rural**	**Urban**	**Rural**
1	1	**12,000**	**8,400**	**1,200**	**850**
2 or more	1	**14,400**	**10,080**	**1,200**	**850**
2 or more	2 or more	**14,400**	**10,080**	**1,600**	**1,120**
1	2 or more	**12,000**	**8,400**	**1,600**	**1,120**
3. Combination Satisfied ______ Not Satisfied ______ No one warrant satisfied but following warrants fulfilled 80% or more ___ ___ 1 2		**2 Warrants**		**2 Warrants**	

NOTE:

1. Left turn movements from the major street may be included with minor street volumes if a separate signal phase is to be provided for the left-turn movement.
2. To be used only for NEW INTERSECTIONS or other locations where actual traffic volumes cannot be counted.

Figure 23- Appendix H: CALTRANS Future EADT Signal Warrant Method

MUTCD warrants suggest that right-turns from the minor approach may be removed from the minor street volumes. NCHRP 457 has a method to determine reduction given volumes, major road approach lanes, and whether minor road right-turns share a lane with other movements. The follow graph, Figure 2-11 from NCHRP 457, may be used to determine the number of right-turners that should be removed from the minor street approach.

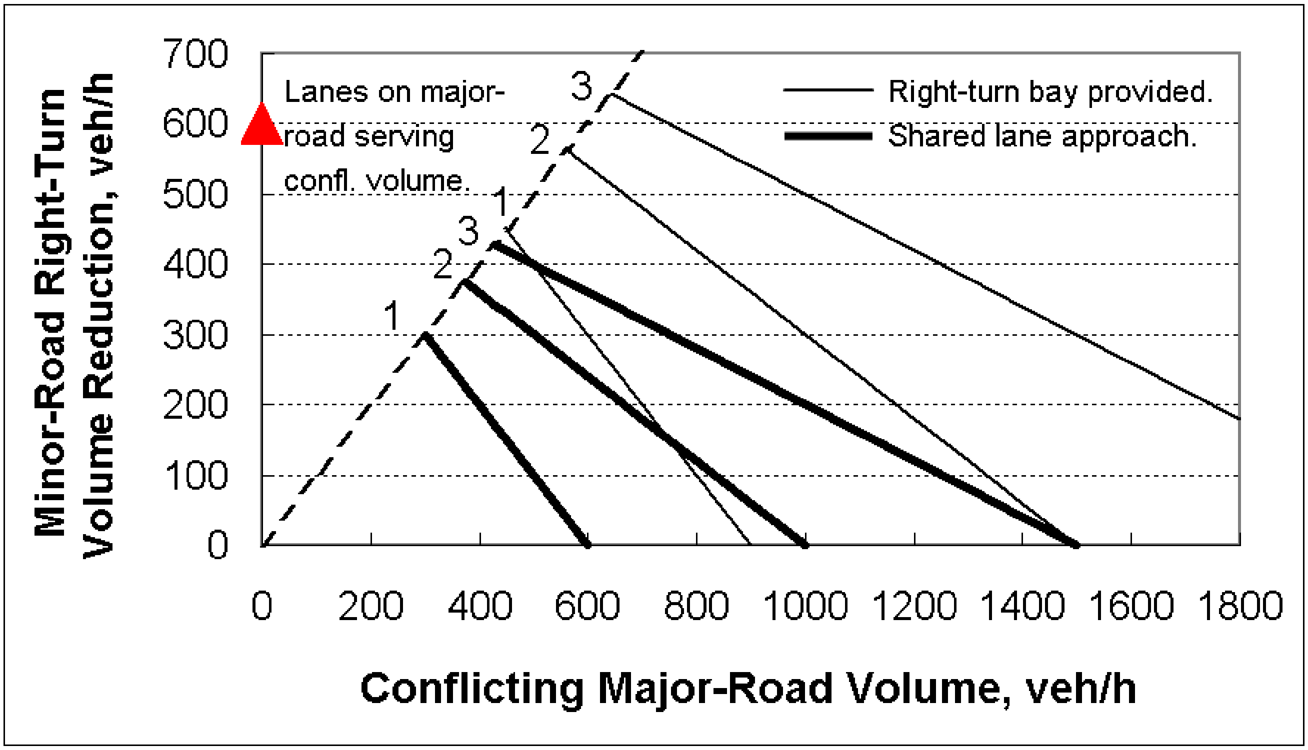


Figure 24- Appendix H: NCHRP 457 Method For Reducing Right-Turn Volumes On Minor Street Approaches During Signal Warrant Evaluation

APPENDIX I

Synchro Capacity Analysis Reports

Synchro capacity analysis reports for each intersection and case follows this page.

Appendix J

References

- *Geometric Design of Streets and Highways*, 2001, (GDSH) AASHTO (AASHTO).
- The *Alaska Preconstruction Manual* (PCM) published by the ADOT&PF.
- National Cooperative Highway Research Program (NCHRP) Report 162, *Methods for Evaluating Highway Safety Improvements*, Laughland, et. al.
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- *Highway Capacity Manual*, (HCM2000) TRB, 2000.
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- Manual on Uniform Traffic Control Devices 2003 (MUTCD), FHWA.
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- Synchro and SimTraffic, Trafficware.
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- *Central Region Annual Traffic Volume Report* for the years between 1996 and 2006 published by ADOT&PF.
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- Municipality of Anchorage websites:
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  http://munimaps.muni.org/mox52/advanced.cfm?&action=mox52_if_frameset

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- *Economic Projections For Alaska And The Southern Railbelt 2005–2030*, Institute of Social and Economic Research 2005

- Alaska Economic Trends *Population Projections, 2007 to 2030*, Alaska Department of Labor and Workforce Development, Research and Analysis Section, October 2007

- *Access Management Manual* , TRB, 2003

- NCHRP Report 255, *Highway Traffic Data For Urbanized Area Project Planning and Design*, Pederson and Samdahl, 1982.

- NCHRP Report 572, *Roundabouts in the United States,* Rodegerdts et., al. 2007.